B.Tech. 3rd Year V Semester ECE Scheme

S. No.	Course Code	Course Title	Periods			Evaluation Scheme				End Semester		Total	Credits
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KEC-501	Integrated Circuits	3	1	0	30	20	50		100		150	4
2	KEC-502	Microprocessor & Microcontroller	3	1	0	30	20	50		100		150	4
3	KEC-503	EMFT & Wave Propagation	3	1	0	30	20	50		100		150	4
4	KEC-051 – 054	Department Elective -I	3	0	0	30	20	50		100		150	3
5	KEC-055 - 058	Department Elective -II	3	0	0	30	20	50		100		150	3
6	KEC-551	Integrated Circuits Lab	0	0	2				25		25	50	1
7	KEC-552	Microprocessor & Microcontroller Lab	0	0	2				25		25	50	1
8	KEC 553A-553D	Lab for Department Elective-II*	0	0	2				25		25	50	1
9	KEC-554	Mini Project or Internship Assessment**	0	0	2				50			50	1
10		Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	15	10	25		50			NC
11		MOOCs (Essential for Hons. Degree)											
		Total										**950**	**22**
**The Mini Project or internship (4 weeks) conducted during summer break after IV semester and will be assessed during V semester.													

Department Elective-I

KEC-051 Electronic Switching
KEC-052 Industrial Electronics
KEC-053 VLSI Technology
KEC-054 Real Time Systems

Department Elective-II

KEC-055 Digital Signal Processing
KEC-056 Advance Semiconductor Devices
KEC-057 Electronic Instrumentation & Measurements
KEC-058 Optical Communication

***Lab for Department Elective -II**

KEC-553A Digital Signal Processing Lab
KEC-553B Advance Semiconductor Devices Lab
KEC-553C Electronic Instrumentation & Measurements Lab
KEC-553D Optical Communication Lab

*Students will opt one subject from the list of Department Elective-II with its corresponding lab. i.e. if someone has opted Digital Signal Processing (KEC-055) from Department Elective-II then it will be mandatory to opt the DSP Lab (KEC-553A).

B.Tech. 3rd Year VI Semester ECE Syllabus

S. No.	Course Code	Course Title	Periods			Evaluation Scheme				End Semester		Total	Credits
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KEC-601	Digital Communication	3	0	0	30	20	50		100		150	4
2	KIC-602	Control System-I	3	0	0	30	20	50		100		150	4
3	KEC-603	Satellite Communication	3	0	0	30	20	50		100		150	4
4	KEC-061 – 064	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	KEC-651	Digital Communication Lab	0	0	2				25		25	50	1
7	KIC-652	Control System-I Lab	0	0	2				25		25	50	1
8	KEC-653	PCB Design & Fabrication Lab	0	0	2				25		25	50	1
9		Essence of Indian Traditional Knowledge/ Constitution of India	2	0	0	15	10	25		50			NC
10		MOOCs (Essential for Hons. Degree)											
		Total										**900**	**21**

Department Elective-III

KEC-061 Microcontroller for embedded System
KEC-062 Analog Signal Processing
KEC-063 Data Communication Networks
KEC-064 Random Variable Stochastic Process

Open Elective-I

1. Artificial Intelligence https://swayam.gov.in/nd2_cec20_cs10/preview
2. Embedded System Design https://swayam.gov.in/nd1_noc20_cs14/preview

B.Tech. 3rd Year V Semester ECE Syllabus

KEC-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: first and second order low pass, high pass, band pass and band stop filter, all pass active filters, KHN Filters.	8
III	**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.	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.	8
V	**D/A Converters**: Binary weighted resistor and R-2R ladder, A/D converters: dual slope, successive approximation type and flash converter. **Integrated Circuit Timer:** Timer IC 555 pin and functional block diagram, Monostable and Astable multivibrator using the 555 IC. **Phase Locked Loop (PLL)**: Basic principle of PLL, block diagram, working, Ex-OR gates and multipliers as phase detectors, applications of PLL.	8

Text Book:

1. "Microelectronic Circuits", Sedra and Smith, Adopted by Arun N. Chandorkar, Sixth Edition, Oxford, 2013.

Reference Books:

1. Gayakwad : Op-Amps and Linear Integrated Circuits , 4th edition Prentice Hall of India, 2002.
2. Michael Jacob, "Applications and Design with Analog Integrated Circuits", PHI, 2nd Edition, 2004
3. Salivahnan, Electronics Devices and Circuits, TMH, 2nd Edition, 2015
4. Millman and Halkias: Integrated Electronics, Tata Mc.Graw Hill, 2nd Edition, 2010.

Course Outcomes:

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

1. Students will be able to gain in-depth knowledge of complete analysis of Op-Amp 741-IC.
2. Students will acquire knowledge about Op-Amp based circuits and basic components of ICs such as various types of filters.
3. Students will be able to understand the concept of Op-Amp based non-linear and wave- shaping circuits.
4. Students will learn about CMOS digital integrated circuits and digital memory circuits.
5. Students will gain knowledge about the working principle of data converters along with application specific ICs such as 555 timer and PLL.

KEC-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", 5th Edition, Penram International Publication (India) Pvt. Ltd.,2009
2. D. V. Hall : Microprocessors Interfacing, TMH (2nd Edition),2006
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
4. V. Udayashankara, M.S. Mallikajunaswamy, "8051 Microcontroller Hardware, Software and Applications", McGraw-Hill, 2017

Course Outcomes:

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

1. Apply a basic concept of digital fundamentals to Microprocessor based personal computer system.
2. Analyze a detailed software & hardware structure of the Microprocessor.
3. Learn the basics of 8086 Microprocessor and Peripheral Devices like timer, USART etc.
4. Understand the difference between Microprocessors & Microcontrollers, and details Architecture of 8051 Microcontroller.
5. Learn the concept of 8051 instruction set and implement them to design projects on real time problems.

KEC-503	EMFT & Wave Propagation	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Coordinate Systems and Transformation:** Cartesian, Cylindrical, Spherical transformation. Vector calculus: Differential length, area and volume, line, surface and volume integrals, Del operator, Gradient, Divergence of a vector, Divergence theorem, Curl of a vector, Stokes's theorem, Laplacian of a scalar.	6
II	**Electrostatic fields and Magnetostatic fields**: Electric field intensity, Electric field due to charge distribution, Electric flux density, Gauss's Law- Maxwell's equation, Continuity equation and relaxation time, boundary conditions, Magneto-static fields, Ampere's circuit law, Maxwell's equation, magnetic scalar and vector potential, Magnetic boundary conditions, Maxwell's equation in final form.	10
III	**Antenna fundamental and definitions:** Introduction, Basic antenna parameters, Patterns, Beam area (or Beam solid angle) ΩA, Radiation intensity, Beam efficiency, Directivity D and Gain G, Directivity and resolution, Antenna apertures, Effective height, The radio communication link, Fields from oscillating dipole, Single-to-noise ratio (SNR), Antenna temperature, Antenna impedance.	8
IV	**Antenna Design:** Electric dipoles, The 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, Longwire antennas, Folded dipole antennas.	8
V	**Wave Propagation:** Plane earth reflection, Space wave and surface wave. Space wave propagation: Introduction, Field strength relation, Effects of imperfect earth, Effects of curvature of earth. Sky wave propagation: Introduction structural, details of the ionosphere, Wave propagation mechanism, Refraction and reflection of sky waves by ionosphere, Ray path, Critical frequency, MUF, LUF, OF, Virtual height and skip distance, Relation between MUF and the skip distance, Multi-Hop propagation, Wave characteristics.	8

Text Books:

1. MNO Sadiku, "Elements of Electromagnetic', Oxford University Press, 2014.
2. John D Kraus, Ronald J Marhefka and Ahmad S. Khan, "Antennas and Wave Propagation", Fourth Edition, Tata McGraw Hill, 2011.
3. C. A. Balanis, "Antenna Theory Analysis and Design", John Wiley, 2016.

Reference Books:

1. WH Hayt and JA Buck, "Engineering Electromagnetic", McGraw- Hill Education, 2013.
2. A. R. Harish, M. Sachidananda, "Antennas and Wave Propagation", Oxford University Press, 2007.
3. R.L. Yadava, Electromagnetic Waves, Khanna Publishing House, Delhi, 2018.
4. A.Das, Sisir K. Das, "Microwave Engineering", Tata McGraw Hill, 2001.

Course Outcomes:

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

1. Apply different coordinate systems and their application in electromagnetic field theory, establish a relation between any two systems and also understand the vector calculus.
2. Understand the concept of static Electric field and Magnetic field.
3. Understand antenna fundamentals and basic concepts of radiation mechanism of the antenna.
4. Design different types of basic antennas.
5. Analyze the concept of wave propagation mechanism.

KEC-051	Electronic Switching	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Evolution of switching systems:** Introduction, Message switching, Circuits switching, Functions of a switching system, Register translator-senders, Distribution frames, Crossbar switch, A general trucking, Electronic switching, Reed- electronic system, Digital switching systems.	8
II	**Digital Switching:** Switching functions, Space Division Switching, Time Division Switching, Two-Dimensional Switching, Digital Cross-Connect Systems, Digital Switching in an Analog Environment.	8
III	**Telecom Engineering**: Network Traffic Load and Parameters, Grade of Service and Blocking Probability, Modeling Switching Systems, Incoming Traffic and Service Time Characterization, Blocking models and Loss Estimates, Delay Systems	8
IV	**Control of switching systems:** Introduction, Call-processing functions, Common control, Reliability, availability and security; Stored-program control. **Signaling:** Introduction, Customer line signaling, Audio-frequency junctions and trunk circuits, FDM carrier systems, PCM signaling, Inter-register signalling, Common-channel signaling principles, CCITT signaling system no. 6 and 7, Digital customer line signaling.	8
V	**Packet Switching:** Packet Switching, Statistical Multiplexing, Routing Control (dynamic routing, virtual circuit routing and fixed-path routing), Flow Control, X.25, Frame Relay, TCP/IP ATM Cells, ATM Service Categories, ATM Switching (ATM Memory Switch, Space-Memory Switch, Memory-Space Switch, Memory-Space Memory switch, Banyan Network Switch, Clos Networks).	8

Text Book:

1. Thiagarajan Viswanathan & Manav Bhatnagar, “Telecommunication Switching Systems and Networks”, PHI, 2018

Reference Books:

1. J.E. Flood, “Telecommunication Switching, Traffic and Networks”, Pearson Education 2007.
2. John C. Bellamy, “Digital Telephony”, John Wiley, 3rd Ed, 2000

Course Outcomes:

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

1. Understand the fundamentals of circuit switching and analyze complex telephone systems.
2. Analyze the fundamentals of Space division switching and time division switching.
3. Design, model and estimate the telecom traffic to meet defined specifications and needs.
4. Understand the control of switching networks and signalling concepts.
5. Understand the engineering concepts of packet switching and routing and will be able to design various switch architectures also apply knowledge for future research work

KEC-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. 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. B. Paul, Industrial Electronic and Control, Prentice Hall of India Private Limited (2004).
3. M.H. Rashid, "Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3rd Edition, 2004.
4. Ned Mohan, T.M. Undeland and W.P. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Ltd, 2008.
5. P.C.Sen, "Power Electronics", McGraw Hill Education (India) Pvt. Ltd.
6. P.S. Bhimbra, "Power Electronics", Khanna Publishers.

Reference Books:

1. M.S. Jamil Asghar, "Power Electronics" Prentice Hall of India Ltd., 2004
2. Chakrabarti&Rai, "Fundamentals of Power Electronics & Drives" Dhanpat Rai & Sons.
3. V.R. Moorthy, "Power Electronics: Devices, Circuits and Industrial Applications" Oxford University Press, 2007.
4. S.N.Singh, "A Text Book of Power Electronics" Dhanpat Rai &Sons.
5. G.K. Dubey, Power Semiconductor Controlled Drives, Prentice Hall inc. (1989).
6. J.M.D. Murphy, F.G. Turnbull, Power Electronic Control of Ac Motors, Pergamon (1990).

7. P.C. Sen, Thyristor DC Drives, John Wiley and Sons (1981).

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. Understand the requirements SCR Protection, Describe the Functioning of SCR their Construction and Performance.
3. Analyze and Design the Converter Based on SCR for various Industrial Applications.
4. Demonstrate ability to understand High Frequency, Heating Systems, Timers, Relevant Sensors & Actuator and their Application in Industrial Setting.
5. Demonstrate the ability to understand and apply Data Communication, Telemetry & SCADA System in Industrial Applications.

KEC-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, 2003
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. Analyze the basics of crystal growth, wafer preparation and wafer cleaning.
2. Evaluate the process of Epitaxy and oxidation.
3. Analyze the lithography, etching and deposition process.
4. Knowledge of process of diffusion and ion implantation
5. Learn the basic process involved in metallization and packaging.

KEC-054	Real Time Systems	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction** Definition, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Dead-lines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency.	8
II	**Real Time Scheduling** Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Rate Monotonic Algorithm, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems.	8
III	**Resources Sharing** Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority- Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Module Resources, Controlling Concurrent Accesses to Data Objects.	8
IV	**Real Time Communication** Basic Concepts in Real time Communication, Soft and Hard RT Communication systems, Model of Real Time Communication, Priority-Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols.	
V	**Real Time Operating Systems and Databases** Features of RTOS, Time Services, UNIX as RTOS, POSIX Issues, Characteristic of Temporal data, Temporal Consistency, Con-currency Control, Overview of Commercial Real Time databases.	8

Text Books:

1. Real Time Systems – Jane W. S. Liu, Pearson Education Publication

Reference Books:

1. Real Time Systems – Mall Rajib, Pearson Education
2. Real-Time Systems: Scheduling, Analysis, and Verification – Albert M. K. Cheng, Wiley.

Course Outcomes:

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

1. Understand concepts of Real-Time systems and modeling
2. Recognize the characteristics of a real-time system
3. Understand and develop document on an architectural design of a real-time system
4. Develop and document Task scheduling and resource management
5. Develop and document real-time operating systems and fault tolerant applications of Real-Time Systems.

KEC-055	DIGITAL SIGNAL PROCESSING	3L:0T:0P	3 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. Johnny R. Johnson, Digital Signal Processing., PHI Learning Pvt Ltd., 2009.

Reference Books:

1. John G Prokias, Dimitris G Manolakis, Digital Signal Processing. Pearson Education. 4th edition, 2007
2. Oppenheim & Schafer, Digital Signal Processing. PHI,1999

Course Outcomes:

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

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

KEC-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, 2006.
2. Boylestad, Robert L. Electronic devices and circuit theory. Pearson Education India, 2009.
3. Jacob Millman, Christos C. Halkias, Satyabrata Jit, Electronic Devices and Circuits. Publisher: Mcgrawhill HED, 4th edition 2015.

Reference Books:

1. J. P. Colinge and C. A. Colinge, "Physics of Semiconductor Devices", 2002 edition, Kluwer Academic Publisher, 2005.
2. Pierret, Robert F. Semiconductor device fundamentals. 2nd Edition, Pearson Education India, 1996.
3. Ben G. Streetman, SK Banerjee, Solid State Electronic Devices, 7th Edition, 2015

Course Outcomes:

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

1. Understand the physics of semiconductor devices.
2. Design circuits using field effect transistors.
3. Learn about various diodes.
4. Analyze about transferred electron devices
5. Work on photodetectors and solar cells.

KEC-057	Electronic Instrumentation & Measurements	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Electrical Measurements**: Measurement system, Characteristics of instruments, Methods of measurement, Errors in Measurement & Measurement standards, Measurement error combination ,**Review of indicating and integrating instruments:** PMMC instrument, Galvanometer, DC ammeter, DC voltmeter, Series ohm meter.	8
II	**Electronic Instruments :** Transistor voltmeter circuits, AC electronic voltmeter, current measurement with electronic instruments, probes, **Digital voltmeter systems**: Digital multimeter, digital frequency meter System, **Instrument calibration:** Comparison method, digital multimeter as standard instrument, Calibration instrument.	8
III	**Measuring Methods:** Voltmeter and Ammeter methods, Wheatstone bridge, Measurement of low, medium and high resistances, Insulation resistance measurement, AC bridges for inductance and capacitance measurement, Q meter.	8
IV	**CRO**: CRT, Wave Form Display, Time Base, Dual Trace Oscilloscope, measurement of voltage, frequency and phase by CRO, Oscilloscope probes, Delay time based Oscilloscopes, Sampling Oscilloscope, DSO, DSO applications.	8
V	**Instrumentation**: Transducers, classification & selection of transducers, strain gauges, Thermistors, Thermocouples, LVDT, Inductive & capacitive transducers, Piezoelectric and Hall-effect transducers, Measurement of motion, force, pressure, temperature, flow and liquid level, basic concepts of smart sensors and application, Data Acquisition Systems.	8

Text Book:

1. A K Sawhney, "Electrical & Electronic Measurement & Instrument", DhanpatRai& Sons, India (1976)
2. BC Nakra& K. Chaudhary, "Instrumentation, Measurement and Analysis," Tata McGraw Hill 2nd Edition (2006)
3. Purkait, "Electrical & Electronics Measurement & Instrumentation", TMH (2004)

Reference Books:

1. Forest K. Harris, "Electrical Measurement", Willey Eastern Pvt. Ltd. India (2003)
2. M. Stout , "Basic Electrical Measurement", Prentice Hall of India (1970)
3. WD Cooper, "Electronic Instrument & Measurement Technique", Prentice Hall International(2001)
4. EW Golding & F.C. Widdis, "Electrical Measurement &Measuring Instrument", AW Wheeler & Co. Pvt. Ltd. India(2002)

Course Outcomes:

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

1. Understand the basics of units, dimensions, standards, PMMC instrument and also various measurement errors.
2. Analyze and design voltmeter circuits, AC electronic voltmeter, digital frequency meter and current measurement with electronic instruments.
3. Understand various resistance and impedance measuring methods, Q-meter operation and will be able to evaluate balance condition in bridges.
4. Understand and analyze fundamental operation of CRO and some special type of oscilloscopes like DSO, Sampling oscilloscope
5. Apply calibration method to calibrate various instruments and will understand transducers like for force ,pressure ,motion, temperature measurement etc.

KEC-058	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. Gerd Keiser, "Optical Fiber Communications", McGraw Hill, 5th Edition, 2013.
2. John M. Senior, "Optical Fiber Communications", PEARSON, 3rd Edition, 2010.

Reference Books:

1. Sanjay Kumar Raghuwanshi, Santosh Kumar, "Fiber Optical Communications", University Press, 2018.
2. Govind P. Agrawal, "Fiber Optic Communication Systems", John Wiley, 3rd Edition, 2004.
3. Devi Chadha, "Terrestrial Wireless Optical Communication", Tata-McGraw Hill, 2012.

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

1. Familiarize with basic concepts and theory of optical communication.
2. Understand the signal loss with their computation and dispersion mechanism occurring in optical fiber cable.
3. Gain knowledge of different source of light as well as receiver and their comparative study.
4. Gain knowledge of different optical components on receiver side, assemble them and solve problems on optical communication system.
5. Understand the performance analysis of receiver to get idea about power budget and ultimately be an engineer with adequate knowledge in optical domain.

KEC-551	Integrated Circuits Lab	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Design the following using Op-Amp:
   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:
   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
9. Design and construct a monostable multivibrator using IC 555 and
   a) Plot the output waveform
   b) Measure the time delay
10. Study the operation of analog to digital converters.
11. Study the operation of digital to analog converters.
12. Implement voltage controlled oscillator using IC566 and plot the waveform.

Course Outcomes:

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

1. Analyze and design different non-linear applications of operational amplifiers such as log, antilog amplifiers and voltage comparators.
2. Analyze and design different linear applications of operational amplifiers such as filters.
3. Able to generate different types of waveforms using wave shaping circuits.
4. Design multivibrators circuits using IC555.
5. Understand and perform analog to digital, digital to analog conversions and voltage to current, current to voltage conversion.

KEC-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.
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
3. To perform multiplication and division of two 8 bit numbers using 8085.
4. To find the largest and smallest number in an array of data using 8085 instruction set.
5. To write a program to arrange an array of data in ascending and descending order.
6. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8085 instruction set.
7. To write a program to initiate 8251 and to check the transmission and reception of character.
8. To interface 8253 programmable interval timer to 8085 and verify the operation of 8253 in six different modes.
9. To interface DAC with 8085 to demonstrate the generation of square, saw tooth and triangular wave.
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.

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 learn and demonstrate arithmetic and logical operations on 8 bit data using microprocessor 8085.
2. Analyze 8085 microprocessor and its interfacing with peripheral devices.
3. Learn about various conversion techniques using 8085 and generate waveforms using 8085.
4. Learn programming concept of 8051 Microcontroller.
5. Learn to Interface peripheral devices with Microcontroller so as to design Microcontroller based projects.

KEC-553A	Digital Signal Processing Lab	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Introduction to MATLAB and or Open Source Software, Scilab (Using Spoken Tutorial MOOCs).
2. Write a Program for the generation of basic signals such as unit impulse, unit step, ramp, exponential, sinusoidal and cosine.
3. Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency.
4. Verify Blackman and Hamming windowing techniques.
5. Evaluate 4-point DFT of and IDFT of x(n) = 1, $0 \leq n \leq 3$; 0 elsewhere.
6. Verify Linear convolution of two sequences using FFT
7. Verify Circular Convolution of two sequences using FFT.
8. To verify FFT as sample interpolator.
9. To implement Tone Generation.
10. To implement floating point arithmetic.
11. To study about DSP Processors and architecture of TMS320C6713 DSP processor.
12. **VIRTUAL Lab by NME-ICT available at:** http://vlabs.iitkgp.ernet.in/dsp/
    - 12.1 Study of Discrete Fourier Transform (DFT) and its inverse.
    - 12.2 Study of FIR filter design using window method: Lowpass and highpass filter.
    - 12.3 Study of FIR filter design using window method: Bandpass and Bandstop filter.
    - 12.4 Study of Infinite Impulse Response (IIR) filter.

Spoken Tutorial (MOOCs):

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (http://spoken-tutorial.org/)

Course Outcomes:

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

1. Understand the handling of discrete/digital signals using MATLAB/Scilab.
2. Implement and understand the basic operations of Signal processing
3. Analyse the spectral parameter 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 algorithm using MATLAB/Scilab.

KEC-553B	Advance Semiconductor Devices Lab	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. To study Bipolar Junction Transistors (BJT) (i) DC biasing (ii) BJT CE amplifier input and output characteristics.
2. To study Bipolar Junction Transistors (BJT) (i) Emitter follower circuit. (ii) BJT current mirror.
3. To study Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) (i) DC biasing (ii) MOSFET CS amplifier characteristics.
4. To study Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) (i) Source follower circuit. (ii) MOSFET current mirror circuit.
5. Study the performance of Tunnel diode. Also draw its V-I characteristics.
6. Study the performance of IMPATT diode. Also draw its V-I characteristics.
7. Study the performance of Light-Emitting Diode (LED). Also draw its V-I characteristics.
8. Study the performance of Photoconductor, Photodiodes and its V-I characteristics.
9. Study the performance of Phototransistor, Charge-Coupled Device and its V-I characteristics.
10. Study the performance of Metal-Semiconductor-Metal Photodetector and its V-I characteristics.

Course Outcomes:

At the end of this course students will able to

1. Demonstrate the behavior of BJT and MOSFET in DC biasing and as CE amplifier circuit.
2. Demonstrate the Tunnel diode and IMPATT diode.
3. Demonstrate the Light-Emitting Diode (LED) and the performance of Photoconductor and photodiode.
4. Demonstrate the performance of Photoconductor, photodiode, Phototransistor, Charge-Coupled Device
5. Demonstrate the performance of Metal-Semiconductor-Metal Photo detector.

KEC-553C	Electronic Instrumentation & Measurements Lab	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Study of semiconductor diode voltmeter and its use as DC average responding AC Voltmeter.
2. Study of L.C.R. Bridge and determination of the value of the given components.
3. Measurement of low resistance Kelvin's double bridge.
4. To measure unknown capacitance of small capacitors by using Schering's bridge.
5. To measure unknown Inductance using Hay's bridge
6. Measurement of capacitance by De Sauty Bridge
7. Characteristics of Thermocouples and RTD.
8. Study of the following transducer (i) PT-100 Transducer (ii) J-Type Transducer (iii) K-Type Transducer (iv) Pressure Transducer
9. Measurement of phase difference and frequency using CRO (Lissajous Figure)
10. Characteristics of LDR, Photo Diode, and Phototransistor:
    (i) Variable Illumination.
    (ii) Linear Displacement
11. Characteristics of LVDT.
12. Study of the transistor tester and determination of the parameters of the given transistors

Course Outcomes:

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

1. Understand of AC voltmeter
2. Apply bridge theory to determine unknowns in LCR Bridge, Kelvin double bridge, Schering bridge, Hay's bridge,De sauty bridge.
3. Analyze and evaluate different types of transducers like J-type, K-type, PT-100 and RTD.
4. Evaluate frequency and phase difference from Lissajous figure.
5. Evaluate hybrid parameters of transistor and will learn about transducer like LDR and LVDT.

KEC-553D	Optical Communication Lab	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS (ANY TEN):

1. To establish analog link using Optical Fiber.
2. To establish digital link using Optical Fiber.
3. To measure Propagation Loss in Optical Fiber.
4. To measure Bending Loss in Optical Fiber.
5. To measure Numerical Aperture in Optical Fiber.
6. Time Division Multiplexing of signals using Optical Fiber.
7. Framing in Time Division Multiplexing using optical fiber link.
8. To study the Manchester Coding/Decoding used in Optical Fiber.
9. To study Voice Digitization: A Law using optical fiber link / Study of voice coding and codec chip.
10. To compare the effect of Electromagnetic Interference on a copper medium and on an optical fiber medium.
11. To study the characteristics of Optical Source and Photo Detector.
12. Design, Simulation and Performance Measurement & Analysis of Optical Fiber based communication system.
13. Simulation of Free Space Optics (FSO) based communication system.

Course Outcomes:

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

1. Familiarize with the basics and practical concepts of Optics with components required for Optical Communication.
2. Design of communication links using Optical Fiber.
3. Understanding of different types of losses occurring in Optical Fiber with their measurement.
4. Gain knowledge of concepts of Coding/Decoding and Multiplexing in Optical Fiber.
5. Simulate the Optical Fiber based communication system.

B.Tech. 3rd Year VI Semester ECE Syllabus

KEC-601	Digital Communication	3L:0T: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	8
II	**Digital Communication Basics:** Introduction to Digital communication systems, PSD of Line Coding schemes, Pulse shaping, Scrambling, Eye diagram, Gram-Schmidt orthogonalization scheme.	8
III	**Digital Modulation:** Modulation and Demodulation of Digital modulation schemes-ASK, FSK, PSK, DPSK, QPSK. Constellation diagram, Introduction to M-ary communication.	8
IV	**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
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 decoding	8

Text Books:

1. B.P. Lathi, "Modern Digital and Analog communication Systems", 4th Edition, Oxford University Press, 2010.
2. John G. Proakis, "Digital Communications", 4th Edition, McGraw-Hill International.

Reference Books:

1. H. Taub, D L Schilling, Gautam Saha, "Principles of Communication", 3rd Edition, Tata McGraw-Hill Publishing Company Ltd.
2. Simon Haykin, "Communication Systems", 4th Edition, Wiley India.
3. H P HSU & D Mitra, "Analog and Digital Communications", 2nd Edition, Tata McGraw-Hill Publishing Company Ltd.

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 design equipments related to digital modulation schemes
4. To analyze the performance of digital communication systems
5. To apply the concept of information theory in digital systems

KIC-602	Control System-I	3L:0T: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. B.C. Kuo & Farid Golnaraghi, "Automatic Control Systems", 8th Edition, John Wiley India, 2008.

Reference Books:

1. I. J. Nagrath & M. Gopal, "Control System Engineering", New Age International Publishers, 2006.
2. A. Anand Kumar, " Control Systems", Second Edition, PHI Learning private limited, 2014.
3. A. Ambikapathy, Control Systems, Khanna Publishing House, Delhi, 2013.
4. Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Control Systems" Schaums Outlines Series, 3rd Edition, Tata McGraw Hill, Special Indian Edition, 2010.
5. William A. Wolovich, "Automatic Control Systems", Oxford University Press, 2010.

Course Outcomes:

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

1. Students will learn the basics of control systems along with different types of feedback and its effect. They will also understand the techniques such as block diagrams reduction, signal flow graph and modelling of various physical systems along with modelling of DC servomotor.
2. Students will understand the concept of state variables for the representation of LTI system. They will also learn different state variable representations and relationship among them along with the concept of controllability and observability.
3. Students will be able to formulate the time domain response analysis for various types of inputs along with the time domain specifications. Also, they will be able to analyse the steady state errors for different types of systems.
4. Students will understand the concept of absolute and relative stability for continuous data systems along with different methods of determining the stability such as Routh Hurwitz Criterion and Root locus methods.
5. Students will be able to understand the concept of frequency domain response analysis and their specifications. They will also able to calculate relative stability of systems using frequency domain methods such as Nyquist stability criterion and Bode plot methods.

KEC603	Satellite Communication	3L:0T:0P	4 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", McGrawhill Education, 4th Edition, 2001.
3. Digital Satellite Communications/ Tri T. Ha./ McGraw-Hill, 2nd Edition, 1990.

Reference Books:

1. " Satellite communication" By "Dr. D.C. Agrawal" Paperback: 1024 pages; Publisher: Khanna Publishers; 7th Edition (1989).

Course Outcomes:

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

1. Understand the overview and benefits of Satellite communication**.**
2. Mathematically evaluate the orbital mechanics and functional principles of satellite communication systems and Analyze atmospheric effects on Satellite communication.
3. Analyze and evaluate a satellite link and suggest enhancements to improve the link performance.
4. Specify, design, prototype and test new technologies of satellite communication systems as per given specifications.
5. Understand Advanced technologies of Satellite launching and they will be Familiarized with the Indian Satellite system.

KEC-061	MICROCONTROLLER FOR EMBEDDED SYSTEMS	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. Expose to the advance concept of 8051 architecture and AVR family architecture
2. To learn the basics of MSP430x5x Microcontroller
3. To explore the I/O interfacing and peripheral devices associated with Microcontroller SoC(system on chip).
4. To understand the concept of Serial communication protocol and learn to implement its interfacing with MSP430
5. Understand the basics of IoT, WSN and its application sectors and design IoT based projects.

KEC-062	Analog Signal Processing	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	Introduction to new analog building blocks: Current Conveyor and Introduction to domains and the analogue/digital trade off, Type of filters, Element scaling, Analog signal filtering: introduction to bilinear transfer functions, active realizations and effect of A(s). Second-order filter realization, filter design parameters (Q and ω_0), frequency response, , Single Op-amp biquad: Sallen-Key biquad and effect of A(s) on its parameters, Three op-amp biquad: KHN and Tow Thomas 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 Books:

1. R. Schaumann and M.E. Van Valkenberg, "Design of Analog Filters", Oxford University Press-2001

Reference Books:

1. Raj Senani, D R Bhaskar, A K Singh, V K Singh "Current Feedback Operational Amplifiers and their Applications" - By Springer Publishing House, 2013.
2. Raj Senani, D R Bhaskar, A K Singh "Current Conveyors-Variants, Applications and Hardware Implementations" Springer Publishing House, 2015

Course Outcomes:

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

1. Realize the analog filter circuits and analyze the impact of non-idealities over it.
2. Realize practical higher order filter circuits for given set of specifications.
3. Control the overall delay of given circuit and to analyze the impact of circuit parameter variation and limiting strategies.
4. Transform existing ladder filters to their analog active counterparts using various embedding techniques and to realize synthetic components.
5. Realize various analog circuits using Operational Transconductance Amplifier with its inherent tuning feature.

KEC-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", 4th Edition, McGraw-Hill Education, 2006.

Reference Books:

1. S. Tanenbaum, "Computer Networks", 4th Edition, Prentice Hall of India,2003.
2. W. Stallings, "Data and Computer Communication", 2nd Edition, New York, Macmillan, 1998.

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. Use 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.

KEC-064	Random Variables Stochastic Process	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Probability**: Introduction to set theory, experiments and sample spaces, joint probability, conditional probability, concept of total Probability, Bayes' Theorem, and independent events, Bernoulli's trials, combined experiments.	8
II	**Random Variables:** Introduction, types of random variables, cumulative distribution function and probability density functions, Standard distributions: Gaussian, exponential, Rayleigh, uniform, Bernoulli, binominal, Poisson, discrete uniform and conditional distributions. Functions of one random variable: distribution, mean, variance, moments and characteristics functions.	8
III	**Multiple Random Variables:** Joint distributions, joint density function and properties, marginal distribution and density functions, conditional distribution and density Functions, statistical independence, functions of two random variables, joint moments, Multiple random variables: multiple functions of multiple random variables, jointly Gaussian random variables, sums of random variable, Central limit theorem.	8
IV	**Stochastic Processes:** Definitions, Random process concept, Statistics of stochastic processes: Mean, Autocorrelation, Covariance Functions and its properties, Strict and Wide sense stationary, random processes, Time Averages and Ergodicity, Mean-Ergodic Processes.	8
V	**Stochastic Processes in Frequency Domain:** Power spectrum of stochastic processes, Properties of power spectral density, Relationship between Power Spectrum and Autocorrelation Function, the Cross-Power Density Spectrum and Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function, Transmission over LTI systems, Gaussian and White processes.	8

Text Books:

1. Probability, Random Variables And Stochastic Processes, Papoulis, TMH (2002)
2. Stochastic Processes, 2ed, Ross, Wiley.(1996)

Reference Books:

1. Devore – Probability and statistics for engineering and sciences, Cengage learning 2011
2. Mendenhall – Introduction to probability and statistics, Cengage learning 2012
3. Probability, Random Variables And Random Signal Principles, Peebles, TMH 2002
4. Probability Theory and Stochastic Processes for Engineers, Bhat, Pearson 2011
5. Probability and Random Processes with Application to Signal Processing, 3/e, Stark, Pearson 2002
6. Random Variables & Stochastic Processes, Gaur and Srivastava, Genius publications 2003
7. Random Processes: Filtering, Estimation and Detection, Ludeman, Wiley 2002
8. An Introduction to Probability Theory & Its App., Feller, Wiley 1969

Course Outcomes:

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

1. Students will be able to understand the basic learning of Probability.
2. Students will be able to demonstrate the concept of Random Variables.
3. Students will be able to analyze Multiple Random Variables.
4. Students will be able to interpret the basics of Stochastic Processes.
5. Students will be able to express Stochastic Processes in Frequency domain.

KEC-651	Digital Communication Lab	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

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. To study generation and detection of ASK using MATLAB
7. To study generation and detection of FSK using MATLAB
8. To study generation and detection of PSK using MATLAB
9. To simulate M-ary Phase shift keying technique using MATLAB
10. To study generation and detection of DPSK using MATLAB
11. To study generation and detection of QPSK using MATLAB
12. To study encoding and decoding of Linear Block Codes
13. To study the working of Convolution encoder

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 demonstrate the concepts of line coding techniques
3. To design equipments related to digital modulation schemes
4. To analyze the performance of digital communication systems
5. To conceptualize error detection & correction using different coding schemes in digital communication

KIC-652	Control System - I 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. Students will understand about different tools in MATLAB along with the basic matrix operations used in MATLAB.
2. Students will learn to plot the poles and zeros on s-plane and also able to determine the transfer function of a given system.
3. Students will be able to determine the time domain response of a given system and its various specifications
4. Students will be able to understand the concept of relative stability by determining the stability in time domain using graphical method such as root locus.
5. Students will be able to determine the stability in frequency domain using Bode plot method and also determine the relative stability parameters such as gain margin and phase margin.
6. Students will be able to determine stability in frequency domain using Nyquist Plot method and also determine gain margin and phase margin of the given system.

KEC-653	PCB Design & Fabrication Lab	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Identification of Active & Passive Components.
2. Winding shop: Step down transformer winding of less than 5VA.
3. Soldering shop: Fabrication of DC regulated power supply.
4. PCB Lab: (a) Artwork & printing of a simple PCB. (b) Etching & drilling of PCB.
5. General Instructions to design PCB Layout using TINA PCB Editor.
6. Full wave rectifier design: (i) To create a schematic drawing with TINA Editor. (ii)To design a PCB layout using PCB Design Editor
7. To assemble and test full wave rectifier circuit and to measure voltage drop across resistive network.
8. To fabricate single side PCB for full wave rectifier circuit and resistive network.
9. Wiring & fitting shop: Fitting of power supply along with a meter in cabinet.
10. Testing of regulated power supply fabricated.

Course Outcomes:

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

1. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
2. Use the techniques, skills and modern engineering tools necessary for engineering practice.
3. Design the basic electronics circuits like full wave rectifier circuits on PCB.
4. Work in fitting and wiring shop.
5. Check the regulated power supply of fabrication.