DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY UTTAR PRADESH, LUCKNOW

EVALUATION SCHEME & SYLLABUS

FOR

B. TECH. THIRD YEAR

- ELECTRONICS ENGINEERING
- ELECTRONICS AND COMMUNICATION ENGINEERING
- ELECTRONICS AND TELECOMMUNICATION ENGINEERING

AS PER

AICTE MODEL CURRICULUM

[Effective from the Session: 2024-25]

B.Tech. V Semester
Electronics and Communication Engineering

S. No.	Subject Code	Subject	Type	Category	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit
					L	T	P	CT	TA	CT+TA	TE/PE		
1	BEC501	Integrated Circuits	T	PC	3	1	0	20	10	30	70	100	4
2	BEC502	Microprocessor & Microcontroller	T	PC	3	1	0	20	10	30	70	100	4
3	BEC503	Digital Signal Processing	T	PC	3	1	0	20	10	30	70	100	4
4	BEC-051–054	Department Elective-I	T	PC	3	0	0	20	10	30	70	100	3
5	BEC-055–058	Department Elective-II	T	PC	3	0	0	20	10	30	70	100	3
6	BEC551	Integrated Circuits Lab	P	PC	0	0	2		50	50	50	100	1
7	BEC552	Microprocessor & Microcontroller Lab	P	PC	0	0	2		50	50	50	100	1
8	BEC553	Digital Signal Processing Lab	P	PC	0	0	2		50	50	50	100	1
9	BEC-554	Mini Project/Internship **	P	PC	0	0	2		50	50		50	1
10	BNC501 / BNC502	Constitution of India/ Essence of Indian Traditional Knowledge	T	VA	2	0	0	20	10	30	70	100	NC
11		Honors Degree / Minor Degree Courses											
		Total										**850**	**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
BEC-051	IoT – Architecture, Communication, Technology & its applications
BEC-052	Bio-Medical Sensors & Instrumentation
BEC-053	Intelligent Systems and Robotics
BEC-054	VLSI Technology
	Department Elective-II
BEC-055	Electronics Switching
BEC-056	Bio-Medical Signal Processing
BEC-057	Optical Communication
BEC-058	CMOS Analog VLSI Design

B.Tech. VI Semester
Electronics and Communication Engineering

S. No.	Subject Code	Subject	Type	Category	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit
					L	T	P	CT	TA	CT+TA	TE/PE		
1	BEC601	Digital Communication	T	PC	3	1	0	20	10	30	70	100	4
2	BEC602	Control System	T	PC	3	1	0	20	10	30	70	100	4
3	BEC603	Antenna and Wave Propagation	T	PC	3	1	0	20	10	30	70	100	4
4	BEC-061-064	Department Elective–III	T	PC	3	0	0	20	10	30	70	100	3
5		Open Elective-I	T	PC	3	0	0	20	10	30	70	100	3
6	BEC651	Digital Communication Lab	P	PC	0	0	2		50	50	50	100	1
7	BEC652	Control System Lab	P	PC	0	0	2		50	50	50	100	1
8	BEC653	Antenna and Wave Propagation Lab	P	PC	0	0	2		50	50	50	100	1
9	BNC601/ BNC602	Constitution of India/ Essence of Indian Traditional Knowledge	T	VA	2	0	0	20	10	30	70	100	NC
10		Honors Degree / Minor Degree Courses											
		Total										**800**	**21**

Course Code	Course Title
	Department Elective-III
BEC-061	Satellite Communication
BEC-062	Data Communication Networks
BEC-063	CMOS Digital Design Techniques
BEC-064	Microwave Engineering

B.Tech 3rd Year
V Semester
Syllabus

BEC -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 lowpass 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 circuit's 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-ORgates 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 filters.
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.

BEC-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 peripheralinterface, 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, Pentium-Pro Processor, Pentium-II, Pentium-III, 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 8085microprocessors.
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.

BEC-503	DIGITAL SIGNAL PROCESSING	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Introduction to Digital Signal Processing**: Basic elements of digital signalprocessing, 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- Sub-band 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.

Reference Books:

1. Oppenheim & Schafer, Digital Signal Processing. Pearson Education 2015
2. S.K. Mitra, 'Digital Signal Processing–A Computer Based Approach, TMH, 4th Edition.
3. Digital Signal Processing-a computer-based approach by S. K. Mitra, McGraw Hill.
4. Digital Signal Processing by A. Anand kumar, PHI learning PVT. ltd.
5. Digital Signal Processing - a modern introduction by Ashok Ambardar, Cengage learning.

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.

BEC-051	IoT – ARCHITECTURE, COMMUNICATION, TECHNOLOGY & ITS APPLICATIONS	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to IoTs:** Understanding IoT's fundamentals and Significance, Definition and Characteristics of IoT, Elements of an IoT ecosystem, Sensors, Actuators, Data Management, Overview of Governance, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization.	8
II	**IoT Architecture:** Software defined networks, Network function virtualization, Difference between SDN and NFV for IoT, IoT Open-source architecture (OIC) - OIC Architecture & Design principles, IoT Devices and deployment models - IoTivity: An Open Source IoT stack, Overview - IoTivity stack architecture, Resource model and Abstraction.	8
III	**IoT Communication Protocols:** Protocol Standardization for IoT, M2M and WSN Protocols, Issues with IoT Standardization, SCADA and RFID Protocols, Unified Data Standards – Protocols, Short, Medium and Long-Range Wireless Connectivity, Wired Connectivity, IOT Networking – Networking Architecture, Networking Protocols, IoT Devices Application-Level Protocols.	8
IV	**Interfacing With Physical Devices**: Introduction to Arduino and Raspberry Pi- Installation, Interfaces (Serial, SPI, I2C), Introduction to the Arduino environment, the Arduino board, the Arduino IDE, and the Arduino compatible shields together with their libraries. Interfacing Hardware with the Raspberry Pi, Raspberry Pi Remote Access, Communication with devices through the pins of the Raspberry Pi, Range of sensors interfacing such as voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors and others.	8
V	**IoT Applications:** Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business toMaster IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.	8

Text Books:

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", November 2013, John Wiley and Sons.
2. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", John Wiley and Sons.
3. Simon Monk, "Programming the Raspberry Pi: Getting Started with Python", January 2012, McGraw Hill Professional.

Reference Books:

1. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
2. Dr. Ovidiu Vermesan, Dr. Peter Friess "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers.
3. Donald Norris, "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and Beagle Bone Black", McGraw Hill, 2015.
4. Eben Upton and Gareth Halfacree, "Raspberry Pi User Guide", August 2016, 4th edition, John Wiley & Sons

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

1. Understand the fundamentals of IoT's.
2. Understand the vision of IoT's from a global context.
3. Building State of the art architecture in IoT.
4. Interface mechanism of different Sensors, Gateways, and other external Devices with microcontroller board
5. Application of IoT in Industrial and Commercial Building Automation.

BEC- 052	BIO-MEDICAL SENSORS & INSTRUMENTATION	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Generalized configurations, functional descriptions, and performance characteristics of measuring instruments:** General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamiccharacteristics of a measurement system, Statistical analysis of measurement data. Standards and Calibration.	8
II	**Introduction of Bio-medical Instrumentation, Sources of Bioelectric Potentials and Electrodes**: Introduction to man-instrument system, components of the man-instrument system, Physiological system of the body, Problems encountered in measuring a living system. Resting and action potentials, Propagation of action potentials, bioelectric potentials, Bio potential electrodes, Biochemical transducers. Review of transducers.	8
III	**Cardiovascular System and Measurements:** The heart and cardiovascular system, ECG, blood pressure and its measurement, respiration and pulse rate, characteristics and measurement of blood flow meter, cardiac output, plethysmography, pacemaker, defibrillators, heart sounds and its measurement.	8
IV	**Respiratory and Neuro-muscular System:** The physiology of the respiratory system, test and instrument for the mechanics of breathing, the somatic nervous system, EEG, EMG and GSR.	8
V	**Measurement and Recording of Non-invasive Diagnostic Instrumentation, Patient Care and Electrical Safety:** Principle of ultrasonic measurement, ultrasonic, thermography, elements of intensive care monitoring, X-ray, CT – Scan and MRI, tonometer, dialysis**,** diathermy, Shock hazards from electrical equipment.	8

Textbooks

1. Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.
2. Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall (2000) 4th ed.

Reference Books

1. Geddes, L.A., and Baker, L.E., Principles of Applied Biomedical Instrumentation, Wiley Inter-Science (1989) 3rd ed.
2. Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2003) 2nd ed.
3. Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2007) 3rd ed.

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

1. Understand the basics of measurement system.
2. Differentiate and analyse the biomedical signal sources
3. Elucidate cardiovascular system and related measurements
4. Exhibit the knowledge of working principle and applications of the respiratory and nervous related measurements.
5. Measure the parameters non-invasive diagnostic.

BEC -053	INTELLIGENT SYSTEMS AND ROBOTICS	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**System Modeling:** Biological and Cognitive Paradigms for Robot Design, Declarative-Procedural-Reflexive Hierarchy for Decision-Making and Control, Articulated Robots, Joint-Link (Denavit - Hartenberg) Transformations, Mobile Ground Robots, Uninhabited Air Vehicles, Intelligent Agents.	8
II	**Control System Principles:** Open- and Closed-Loop Control, Time-domain and Frequency-domain Analysis, Optimality and Constraints, Stability and Performance, Adaptation, Control Actuation, Closed-form and Probabilistic Path Planning.	8
III	**Computing, Measurement, State, and Parameter Estimation:** Sensors and Sensing, Formal and Fuzzy Logic, Turing Machines and Concepts of Machine Learning, Analog and Digital Systems, Probability and Error Models, Sensor-Based Estimation, Extended Kalman and Particle Filters, Simultaneous Location and Mapping (SAM).	8
IV	**Decision-Making and Machine Learning:** Decision Trees, Bayesian Belief Networks, Classification of Data Sets, Task Planning for Individual and Multiple Agents.	8
V	**Numerical Methods for Evaluation and Search:** Monte Carlo Simulation, Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Production Systems, Forward Chaining, Backward Chaining, Training and Implementation of Network Architectures, Feed-Forward Networks, Associative Networks, Cerebellar Model Articulation Controller, Deep-Learning Algorithms.	8

Text Books:

1. H. Asada and J.-J. Slotine, Robot Analysis and Control, J. Wiley & Sons, 1986.C. Asfahl, Robots and Manufacturing Automation, J. Wiley & Sons, 1992.
2. D. Auslander, J. Ridgely, and J. Ringgenberg, Control Software for Mechanical Systems, Prentice-Hall, 2002.
3. G. Bekey, Autonomous Robots, MIT Press, 2005.
4. Albus, J. I., and Meystel, A. M., Engineering of Mind, J. Wiley & Sons, 2001.
5. P. Antsaklis and K. Passino, An Introduction to Intelligent and Autonomous Control, Kluwer, 1993.

Reference Books:

1. J. Craig, Introduction to Robotics Mechanics and Control, Pearson, 2018
2. R. Dorf, Robotics and Automated Manufacturing, Reston (Prentice-Hall), 1983
3. D. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989.

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

1. Apply the concept of Open- and Closed-Loop Control.
2. Apply Fourier to understand Time-domain and Frequency-domain Analysis
3. Apply the fundamental concepts of Closed-form and Probabilistic Path Planning
4. Analyze Formal and Fuzzy Logic.
5. Analyze Simultaneous Location and Mapping (SAM).

BEC 054	VLSI TECHNOLOGY	3L:0T:0P	3 Credits

Unit	Topic	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, Photomasks, 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 OUTCOME: After completion of the course, student will be able 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.

BEC -055	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
2. J.E. Flood, "Telecommunication Switching, Traffic and Networks", Pearson Education 2016.
3. John C. Bellamy, "Digital Telephony", John Wiley, 3rd Ed, 2006

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

1. Describe the fundamentals of circuit switching and distinguish complex telephone systems.
2. Differentiate the fundamentals of Space division switching and time division switching.
3. Design, develop and evaluate the telecom traffic to meet defined specifications and needs.
4. Identify the control of switching networks and signaling concepts.
5. Classify the engineering concepts of packet switching and routing which will help to design various switch architectures for future research work.

BEC-056	BIO-MEDICAL SIGNAL PROCESSING	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Bio-Medical Signals:** Classification, Acquisition and Difficulties during Acquisition. Basics of Electrocardiography, Electroencephalography, Electromyography & electro-retinography Role of Computers in the Analysis, Processing, Monitoring & Control, and image reconstruction in bio-medical field.	8
II	**ECG:** Measurement of Amplitude and Time Intervals, QRS Detection (Different Methods), ST Segment Analysis, Removal of Baseline Wander and Power line Interferences, Arrhythmia Analysis, Portable Arrhythmia Monitors.	8
III	**Data Reduction:** Turning Point algorithm, AZTEC Algorithm, Fan Algorithm, Huffman and Modified Huffman Coding, Run Length Coding.	8
IV	**EEG:** Neurological Signal Processing, EEG characteristic, linear prediction theory, Sleep EEG, Dynamics of Sleep/Wake transition. Study of pattern of brain waves, Epilepsy-Transition, detection and Estimation. EEG Analysis By Spectral Estimation: The Bt Method, Periodogram, Maximum Entropy Method & AR Method, Moving Average Method. The ARMA Methods, Maximum Likelihood Method.	8
V	**EP Estimation:** by Signal Averaging, Adaptive Filtering: - General Structures of Adaptive filters, LMS Adaptive Filter, Adaptive Noise Cancelling, Wavelet Detection: - Introduction, Detection by Structural features, Matched Filtering, Adaptive Wavelet Detection, Detection of Overlapping Wavelets.	8

Text Books:

1. Willis J. Tomkin, “Biomedical Digital Signal Processing”, PHI.
2. D. C. Reddy, “Biomedical Signal Processing”, McGraw Hill
3. Crommwell, Weibel and Pfeifer, “Biomedical Instrumentation and Measurement”, PHI

Reference Books:

1. Arnon Cohen, “Biomedical Signal Processing (volume-I)”, Licrc Press.
2. Rangaraj M. Rangayyan, “Biomedical Signal Analysis A Case Study Approach”, John Wiley and Sons Inc.
3. John G. Webster, “Medical instrumentation Application and Design”, John Wiley & Sons Inc.

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

1. To understand the basics of biomedical signals.
2. Analyses of ECG signals.
3. To Analyze the data reduction techniques.
4. Analyses of EEG signals.
5. To understand the advance techniques of signal processing

BEC -057	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 OpticalPropagation, 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.	8
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.	8
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.	8
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.	8
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.	8

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

BEC-058	CMOS ANALOG VLSI DESIGN	3L:0T:0P	3 CREDITS

Unit	Topics	Lectures
I	**Introduction to MOS**: MOS device models and short channel effects MOSFET level 1 and level 2 models, threshold voltage model, MOSFET basics, Single stage amplifiers, Basic concept, Common source stage: with resistive load, with diode connected load, with current-source load, with triode load, with source degeneration Source follower (common-drain) and common gate with various loads.	8
II	**Scheme and Implementation:** basic current mirrors, cascode current mirrors and active current mirrors with large and small signal analysis, CMOS amplifier Frequency response: Miller effect, common source (CS), common gate (CG), common drain (CD) stages.	8
III	**Noise:** types of noise, significance of flicker and thermal. Analysis and representation of noise in single stage amplifiers: CG, CS, CD (source follower) and cascode stage and noise in differential pairs. Feedback: Feedback topologies (voltage-voltage, current-voltage, voltage-current, current-voltage) and the noise and the loading effect analysis.	8
IV	**Design of the CMOS Operational Amplifiers:** One-stage opamps and two stage opamps, Gain boosting techniques, folded cascode, telescopic amplifier and common mode feedback (CMFB) amplifier, Design of high speed and high gain amplifiers.	8
V	**Stability and Frequency Compensation:** Specification analysis, multi-pole system, three stage opamp, phase margin Frequency compensation, pole-zero doublet analysis, Analog layout techniques, Design rule check (DRC), layout versus schematic (LVS) and antenna effects.	8

Text Book:

1. Design of Analog CMOS Integrated Circuits" by Behzad Razavi, McGraw Hill Education.
2. "CMOS Analog Circuit Design" by Phillip Allen and Douglas R. Holberg, OUP USA; Third Edition.

Reference Books:

1. "Operation and Modeling of the MOS Transistor" by Yannis Tsividis, Oxford University Press; 2nd edition.
2. "Microelectronic Circuits-Theory & Applications" by A.S. Sedra and K.C. Smith, Adapted by A.N. Chandorkar, 6th Edition, Oxford, 2013.

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

1. Analyze the basics concepts of MOSFET and modelling of single stage amplifiers.
2. Illustrate the various current mirror structures and layout techniques.
3. Analyze the different types of noise in MOSFET based amplifiers.
4. Illustrate designing of CMOS based operational amplifiers.
5. Analyze the stability analysis in MOSFET based amplifiers and oscillators.

BEC-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, antilogamplifiers 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.

BEC-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 subtractionof two Numbers. ***(Through Virtual Lab Link).***
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
3. ***(Through Virtual Lab Link).***
4. To perform multiplication and division of two 8 bit numbers using 8085. ***(Through Virtual Lab Link).***
5. To find the largest and smallest number in an array of data using 8085 instruction set.
6. To write a program using 8086 to arrange an array of data in ascending and descending order.
7. ***(Through Virtual Lab Link).***
8. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8086 instruction set.
9. To convert given Hexadecimal number into its equivalent BCD number and vice versa using 8086 instruction set.
10. To interface 8253 programmable interval timer and verify the operation of 8253 in six different modes.
11. To write a program to initiate 8251 and to check the transmission and reception of character.
12. Serial communication between two 8085 through RS-232 C port.
13. Write a program of Flashing LED connected to port 1 of the 8051 Micro Controller
14. Write a program to generate 10 kHz square wave using 8051.
15. Write a program to show the use of INT0 and INT1 of 8051.
16. 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.

BEC-553	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*: (Through Virtual Lab)***
    a) Study of Discrete Fourier Transform (DFT) and its inverse.
    b) Study of FIR filter design using window method: Lowpass and highpass filter.
    c) Study of FIR filter design using window method: Bandpass and Bandstop filter.
    d) Study of Infinite Impulse Response (IIR) filter.

Virtual Lab Link: http://vlabs.iitkgp.ernet.in/dsp/index.html#
http://vlabs.iitkgp.ernet.in/dsp/

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

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. 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

BEC-601	DIGITAL 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.	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.
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 in digital systems.

BEC-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 ofthe 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 modellingof 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 timedomain specifications.
4. Distinguish the concepts of absolute and relative stability for continuous data systems alongwith different methods.
5. Interpret the concept of frequency domain response analysis and their specifications.

BEC-603	ANTENNA & 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, Long-wire 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', 7th Ed, Oxford University Press, 2018.
2. John D Kraus, Ronald J Marhefka and Ahmad S. Khan, "Antennas and WavePropagation", 5th Edition, Tata McGraw Hill, 2017.
3. Das, Antennas and Wave Propagation, TMH 1st Edition.

Reference Books:

1. C. A. Balanis, "Antenna Theory Analysis and Design", John Wiley, 2016.
2. WH Hayt and JA Buck, "Engineering Electromagnetic", 7th Edition TMH, 2013.
3. (Schaums Outlines Series) Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Engineering Electromagnetic", 3rd Edition, TMH, Special Indian Edition, 2010.

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

1. Identify different coordinate systems and their applications in electromagnetic field theory to establish a relation between any two systems using the vector calculus.
2. Explain the concept of static electric field, current and properties of conductors.
3. Express the basic concepts of ground, space, sky wave propagation mechanism.
4. Demonstrate the knowledge of antenna fundamentals and radiation mechanism of the antenna.
5. Analyze and design different types of basic antennas.

BEC-061	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.

Reference Books:

1. Digital Satellite Communications/ Tri T. Ha./ McGraw-Hill, 2nd Edition
2. 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.

BEC-062	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.

BEC-063	CMOS DIGITAL DESIGN TECHNIQUES	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	VLSI design flow, VLSI design style, introduction to the basic fabrication processes (wafer preparation, oxidation, diffusion, etching, metallization and lithography, etc.), Fabrication process Flow: basic Steps, the CMOS n-well Process. Metal oxide semiconductor (MOS) structure, Types of MOSFET: Enhancement and Depletion. Structure and operation of MOS transistor.	8
II	Threshold voltage equation and energy band diagram of MOSFET, controlling of threshold voltage, MOSFET current – Voltage Characteristics. Transconductance, Drain conduction. Aspect ratio, process parameters, second order effects, MOS small signal and Large signal model, MOS capacitances. Stick diagram rules for nMOS and CMOS technology, lambda based and micron-based design rules. Layout design for CMOS inverter	8
III	Analysis of different types of inverter circuit, CMOS inverter, transfer characteristic, calculation of propagation delay, rise time, fall time, noise margin and power dissipation for CMOS Inverter. Effect of threshold voltage and supply voltage on Delay and power dissipation. Limitations of CMOS in NANO scale circuit design.	8
IV	CMOS logic, Complex Logic Circuits, pseudo NMOS logic, pass transistor logic, Transmission Gate logic and Dynamic logic circuit design. Designing of Combinational logic circuit using CMOS and analysis of various design parameters.	8
V	Sequential MOS Logic circuits, SR Latched circuits, clocked latch and Flip Flop Circuits, CMOS D latch and Edge Triggered Flip Flop, Design of the Schmitt trigger circuit, Dynamic random access and Static random access memory cell design and analysis, Sense amplifier and row and column decoder circuit.	8

Text Books:

1. Sung-mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuit analysis and Design, Tata McGraw-Hill, 3/e.
2. R. Jacob Baker, Harry W. Li and David E. Boyce, CMOS Circuit design, layout and Simulation, PHI, IEEE press, Series Edition,

Reference Books:

1. Yuan Taur and Tak H. Ning, Fundamentals of Modern VLSI Devices, Cambridge university Press, Special Edition, 1998
2. Neil H.E. Weste and Kamran Esharhian, Principal of CMOS VLSI design, PHI, 2/e
3. Jan M. Rabaey, Digital Integrated Circuit, PHI, 2/e

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

1. Understand the static and dynamic behavior of MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) and the secondary effects of the MOS transistor model.
2. To be aware about the trends in semiconductor technology, and how it impacts scaling and its effect on device density, speed and power consumption.
3. To understand MOS transistor as a switch and its capacitance.
4. Student will be able to design digital systems using MOS circuits (Static and Switching characteristics of inverters)
5. Understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.

BEC-064	MICROWAVE ENGINEERING	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Rectangular & Circular waveguides:** Introduction to microwave communication and EM spectrum **Rectangular wave guide:** Field Components, TE, TM Modes, Dominant TE10 mode, Field Distribution, Power, Attenuation. **Circular waveguides:** TE, TM modes. Wave velocities, Microstrip transmission line (TL), Coupled TL, Strip TL, Coupled strip line, Coplanar TL, Microwave cavities	8
II	**Passive microwave devices:** Scattering matrix, Passive microwave devices: Microwave hybrid circuits, Terminations, Attenuators, Phase Shifters **Directional couplers:** Two-hole directional couplers, S- Matrix of a directional coupler, Hybrid couplers, Microwave propagation in ferrites, Faraday rotation, Isolators, Circulators. S-parameter analysis of all components.	8
III	**Microwave tubes:** Limitations of conventional active devices at microwave frequency, Two cavity Klystron, Reflex Klystron, Magnetron, Traveling wave tube, Backward wave oscillators **Gyro Devices:** Their schematic, Principle of operation, Performance characteristic and their applications.	8
IV	**Solid state amplifiers and oscillators:** Transferred electron devices: Gunn effect diodes & modes of operation. Avalanche transit – time devices: IMPATT diode, TRAPPAT diode, BARITT diode.	8
V	**Microwave Measurements:** VSWR meter, Frequency meter, Spectrum analyser, Network analyser, Tunable detector, Slotted line carriage, Power meter, Microwave power measurement, Insertion loss and attenuation measurement, VSWR measurement, Return loss measurement by a reflectometer, Frequency measurement, measurement of cavity Q, Dielectric constant measurement of a solid, EM radiation & measurement.	**8**

Text Books:

1. G. S. Raghuvanshi, Microwave Engineering; Cengage
2. S.Y. Liao, Microwave Devices & Circuits; PHI 3rd Ed.

Reference Books:

1. A Das and S.K. Das, Microwave Engineering; McGraw Hill Education
2. S. Vasuki, D Margaret Helena, R Rajeswari, Microwave Engineering; MHE
3. M.I. Skolnik, Introduction to Radar Engineering; TMH
4. Om P. Gandhi, Microwave Engineering and Applications; Pergamon Press.

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

1. Analyze fundamentals of microwave communication and waveguides.
2. Analyze various passive microwave circuits and S parameters.
3. Determine the performance parameters of microwave junctions, directional coupler.
4. Analyze the characteristics of microwave tubes and gyro devices.
5. Measure the Frequency, Wavelength, VSWR and impedance of a microwave signal and load.

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

SUGGESTIVE LIST OF EXPERIMENTS:

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

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.

BEC-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, peakovershoot 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 ofk.
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 gainand 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.

BEC-653	ANTENNA AND WAVE PROPAGATION LAB	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

Part A

1. To study the variation of radiated field with distance from transmitting antenna.
2. To demonstrate the reciprocity theorem for transmitting and receiving radiation patterns of an antenna.
3. To plot the radiation pattern of an Omni directional antenna.
4. To plot radiation pattern of directional antenna.
5. To study Phenomena of Circular, Linear and Elliptical Polarization of antennas.
6. To study and plot the radiation pattern of the dipole/Folded dipole antennas in Azimuth & Elevation planes.
7. To study and plot the radiation pattern of the helical antenna.
8. To study and plot the radiation pattern of the parabolic reflector.
9. To study and plot the radiation pattern of the Log-Periodic antenna.
10. To study and plot the radiation pattern of the Broadside antennas and Measure its Gain, Bandwidth and Beam width.
11. To plot radiation pattern of $3\lambda/2$ dipole antenna and compare with $\lambda/2$ dipole antenna.
12. To plot the radiation pattern of a Slot antenna.
13. Design and simulate micro strip patch antenna in HFSS simulator.

Part B

1. Design an optimum log-periodic antenna to operate at frequencies from 100 to 500 MHz with 11 elements. Give a) length of longest element, b) length of shortest element, and c) gain
2. Design a right circularly polarized axial mode helical antenna with 15 dBi gain for operation at 1600 MHz with turn spacing $\frac{\lambda}{\pi}$. Find a) the number of turns, b) turn diameter and c) axial ratio.

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

1. Explain the radiation through antenna and identify different types of antennas.
2. Identify and measure the basic antenna parameters
3. Design and analyze wire and aperture antennas
4. Design and analyze matching and feeding networks for antennas
5. Design and analyze antenna arrays.