Course Structure for B. Tech (Electronics & Communication Engineering)
First Year (Common courses for all B. Tech Programme)

First Semester					
S. No.	**Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BAS-101	Applied Mathematics-I	3-1-0	4	**BAS**
2.	BAS-103	Applied Physics-I	2-1-2	4	**BAS**
3.	BAS-105	Applied Chemistry	2-1-2	4	**BAS**
4.	BMA-110/ BEC-110	Engineering Mechanics/ Basic Electrical Engineering	3-0-2	4	**OEC**
5.	BMA-120/ BMA-130	Workshop Practice/ Engineering Graphics	0-1-2	2	**OEC**
6.	HMC-110/ BCS-110	Humanities and Social Science/ Programming in C Language	3-1-0/ 3-0-2	4	**HMC/ OEC**
		Total		**22**	

Second Semester					
S. No.	**Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BAS-102	Applied Mathematics-II	3-1-0	4	**BAS**
2.	BAS-104	Applied Physics-II	2-1-2	4	**BAS**
3.	BAS-106	Environmental Science	2-1-2	4	**BAS**
4.	BEC-110/ BMA-110	Engineering Mechanics/ Basic Electrical Engineering	3-0-2	4	**OEC**
5.	BMA-130/ BMA-120	Workshop Practice/ Engineering Graphics	0-1-2	2	**OEC**
6.	BCS-110/ HMC-110	Programming in C Language / Humanities and Social Science	3-0-2/ 3-1-0	4	**HMC/ OEC**
		Total		**22**	

Second Year

Third Semester					
S. No.	**Course Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BEC-201	Analog Electronics	3-0-2	4	DCC
2.	BEC-203	Signals & Systems	3-1-0	4	DCC
3.	BEC-205	Network Analysis and Synthesis	3-0-2	4	DCC
4.	BEC-207	Digital Electronics	3-0-2	4	DCC
5.	GEC-201	Generic Open Elective*	0-2-0 0-0-4 2-0-0	2	GEC
6.	BEC-253	Industrial Training/Internship**	-	1	DCC
7.	BAS-201 BAS-203 BCS-201 BIT-201 BMA-211	Material Science & Engineering Numerical Methods Data Structures Database Management Systems Engineering Measurements and Metrology	3-0-2 3-0-2 3-1-0 3-0-2 3-1-0	4	OEC
		Total		**23**	

Fourth Semester					
S. No.	**Course Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BEC-202	Linear Integrated Circuits	3-0-2	4	**DCC**
2.	BEC-204	Digital System Design	3-0-2	4	**DCC**
3.	BEC-206	Electromagnetic Field Theory	3-0-2	4	**DCC**
4.	BEC-208	Communication Systems	3-0-2	4	**DCC**
5.	BCS-202 BIT-204 BMA-210 BAS-202 BAS-204 BAS-206	Computer Organization and Architecture Object Oriented Programming Operations Management Nano Structures & Materials in Engg. Optical Engineering Optimization Techniques	3-0-2 3-0-2 3-1-0 3-1-0 2-1-2 3-1-0	4	**OEC**
6.	HMC-202	Disaster Management	1-0-2	2	**HMC**
		Total		**22**	

Third Year

Fifth Semester					
S. No.	**Course Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BEC-301	Digital Communication Systems	3-0-2	4	**DCC**
2.	BAS-301	Modelling and Simulation	3-0-2	4	**BAS**
3.	BEC-303	Control Systems	3-0-2	4	**DCC**
4.	DEC-3xx	Departmental Elective Course - 1	3-1-0/ 3-0-2	4	**DEC**
5.	HMC-301	Professional Ethics and Human Values	3-0-0	3	**HMC**
6.	BEC-353	Industrial Training/Internship**	-	1	**DCC**
7.	GEC-301	Generic Open Elective*	0-2-0 0-0-4 2-0-0	2	**GEC**
		Total		**22**	

Sixth Semester					
S. No.	**Course Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BEC-302	Digital Signal Processing	**3-0-2**	4	**DCC**
2.	BEC-304	Information Theory & Coding	**3-0-2**	4	**DCC**
3.	BEC-306	VLSI Design	**3-0-2**	4	**DCC**
4.	BEC-308	Microprocessors & Microcontrollers	**3-0-2**	4	**DCC**
5.	DEC-3xx	Departmental Elective Course - 2	**3-1-0/ 3-0-2**	4	**DEC**
6.	HMC-302 HMC-304 HMC-306 HMC-308	Principles of Management Marketing Management Financial Management Human Resource Management	**2-0-0 2-0-0 2-0-0 2-0-0**	2	**HMC**
		Total		**22**	

Fourth Year

Seventh Semester					
S. No.	**Course Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BEC-401	Microwave Techniques	**3-0-2**	4	**DCC**
2.	BEC-403	Wireless and Mobile Communication	**3-0-2**	4	**DCC**
3.	DEC-4xx	Departmental Elective Course-3	**3-1-0** **3-0-2**	4	**DEC**
4.	DEC–4xx	Departmental Elective Course-4	**3-1-0/** **3-0-2**	4	**DEC**
5.	BEC-451	Minor Project	**0-0-8**	4	**DCC**
6.	BEC-453	Industrial Training/Internship*	**-**	1	**DCC**
		Total		**21**	

Eighth Semester					
S. No.	**Course Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BEC-402	Embedded Systems	**3-0-2**	4	**DCC**
2.	DEC-4xx	Departmental Elective Course-5	**3-0-2**	4	**DEC**
3.	DEC-4xx	Departmental Elective Course-6	**3-1-0** **3-0-2**	4	**DEC**
4.	BEC-452	Major Project	**0-0-16**	8	**DCC**
5.	GEC-402	Generic Open Elective	**0-2-0** **0-0-4** **2-0-0**	2	**GEC**
		Total		**22**	

* All Industrial Training/Internship will be done in summer break of previous academic session. The assessment for the same will be done within the first two weeks of opening of academic session by the Department.

List of Departmental Elective Courses

Category	Course Code	Subject	L-T-P
Departmental Elective Course-1	BIT-301	Data Communication and Computer Networks	3-0-2
	BEC-305	Electronics Measurement & Instrumentation	3-0-2
	BCS-301	Artificial Intelligence	3-0-2
	BEC-309	Random Signals & Processes	3-0-2
	BCS-307	Advanced Computer Architecture	3-0-2
Departmental Elective Course-2	BIT-310	Internet of Things	3-0-2
	BEC-312	Antenna Design	3-0-2
	BEC-314	FPGA & Verification	3-0-2
	BEC-316	Power Electronics	3-0-2
	BIT-304	Cloud Computing	3-0-2
Departmental Elective Course-3	BEC-405	Introduction to Robotics	3-0-2
	BIT-405	Soft Computing	3-0-2
	BIT-407	Big Data Analytics	3-0-2
	BEC-407	Digital Image Processing	3-0-2
	BEC-409	VLSI Technology	3-0-2
Departmental Elective Course-4	BCS-401	Machine Learning	3-1-0
	BEC-411	Introduction to Smart Grid	3-1-0
	BEC-413	Analog VLSI	3-1-0
	BEC-415	Radar Engineering	3-1-0
	BIT-419	Cyber Security and Forensics	3-0-2
Departmental Elective Course -5	BEC- 404	Bio-medical Signal Processing	3-1-0
	BEC-406	Optical Communication & Networks	3-0-2
	BEC-408	Satellite Communication	3-0-2
	BIT-406	Information Retrieval	3-0-2
	BEC-410	Artificial Neural Networks and Deep Learning	3-0-2
Departmental Elective Course-6	BEC-412	Non-Conventional Energy Resources	3-1-0
	BEC-414	Wireless Sensor Networks	3-1-0
	BEC-416	Data Analytics with Python	3-0-2
	BEC-418	Applied Optimization for Wireless, Machine Learning, Big Data	3-1-0
	BEC-420	Cryptography and Network Security	3-1-0

ANALOG ELECTRONICS	
Course Code: BEC-201 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 3

Introduction: It is a branch of electronics that deals with analog electronic circuits and electronic components. The course will introduce concepts of electronic devices such as p-n junction diode, BJT, and FET which form the basic building block of any electronic system.

Course Objective:

- To give an insight into fundamental concepts of semiconductor devices and the design of analog integrated circuits
- To give the broad spectrum of analog principles and design equations

Pre-requisite: Theory of semiconductor physics

Course Outcome: After completion of the course, students will be able to:

CO1: Understand the basic electronics components such as diodes and transistors.
CO2: Design and analyze transistor-based circuits and amplifiers.
CO3: Design and analyze various multi-stage amplifier and feedback amplifier circuits.
CO4: Design and analysis of FET amplifiers and their frequency response.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	12 Hours
Review of semiconductor physics, p-n junction diode, p-n diode characteristics, and its operation, p-n junction capacitances (depletion and diffusion), Breakdown in p-n diodes. Diode applications: Clipping and Clamping circuits, Rectifier circuits, Zener diode, Zener diode as regulators, Voltage multipliers, Switching behavior of p-n diode. Bipolar junction transistor: Introduction and types of transistors, Construction, BJT characteristics in CB, CE & CC mode, Operating point, ac/dc load line, Leakage current, Saturation and cut off mode of operations, Ebers-moll model. Bias stabilization: Need for stabilization, Various biasing schemes, Bias stability with respect to variations in Ico, V_{BE} & β, Stabilization factors, and Thermal stability.	
UNIT-II	**10 Hours**
Models: Low-frequency models for the transistor (h-parameter, Hybrid – Π, r_{Π}) BJT amplifiers: Analysis at low frequency (CB, CE, CC & CE with R_E), Comparison of various types of configurations, Cascaded Amplifiers, Darlington pair, Cascode amplifiers. High-frequency response of amplifier: Hybrid-Π Model at high frequency, CE short circuit current gain, Current gain with resistive load	
UNIT-III	**12 Hours**
Multistage Amplifiers: Methods of coupling, RC coupled amplifier, Frequency response analysis (Low, Mid & High), Calculation of gain bandwidth. Feedback Amplifiers: Feedback concept, Classification of Feedback amplifiers, Properties of negative feedback amplifiers, Overall gain using feedback, Impedance considerations in different configurations, Examples of analysis of feedback amplifiers. Special semiconductor devices: SCR (Operation, Characteristics & applications), Thyristors, TRIAC, DIAC, Unijunction Transistor (UJT), UJT Relaxation Oscillator	
UNIT-IV	**8 Hours**
Field Effect Transistor: Classification, JFET characteristics, Operating point, Various biasing techniques, Enhancement & depletion type MOSFETs, JFET Model, JFET amplifier analysis (CD, CS & CG), CMOS, MISFET, MESFET, VFET	

Text Books	
1	Millman and Halkias, “Electronic Devices and Circuits” TMH, 4^{th} Edition, 2015 (latest edition).
2	Salivahanan, Suresh Kumar, Vallavaraj, “Electronic Devices and Circuits” TMH, 4^{th} Edition 2016 (latest edition).
3	Boylestad & Nashelsky, “Electronic Devices & Circuit Theory” PHI – 5^{th} Edition, 2014 (latest edition).
Reference Books	
1	Balbir Kumar and S. B. Jain, “Electronic Devices and Circuits” PHI, 2012 (latest edition).
2	Sedra & Smith, “Micro Electronic Circuits” Oxford University Press, 6^{th} Edition, 2012 (latest edition).
3	J. Millman and Halkias, “Integrated Electronics, Analog & Digital Circuits & Systems” TMH –2017 (latest edition).

SIGNAL AND SYSTEMS	
Course Code: BEC-203 **Contact Hours**: L-3 T-1 P-0 **Course Category:** DCC	**Credits:** 4 **Semester:**4

Introduction: This course introduces the concept of analog and digital signal processing, which forms an integral part of engineering systems in many diverse areas, including seismic data processing, communications, speech processing, image processing, defense electronics, consumer electronics, and consumer products. The course presents and integrates the basic concepts for both continuous-time and discrete-time signals and systems. It addresses classifications of signals and systems, basic signal operations, linear time-invariant (LTI) systems, time-domain analysis of LTI systems, signal representation using Fourier series, continuous-time Fourier transform, discrete-time Fourier transform, and Laplace transform.

Course Objective:

- To provide a strong foundation on signals and systems, which is the foundation of communication and signal processing.
- To make the students learn about basic continuous time and discrete time signals and systems.
- To provide an understanding of the application of various transforms for analysis of signals and systems in both continuous time and discrete time domains.
- To create an understanding of the power and energy signals and spectrum.
- To create strong foundation of communication and signal processing to be covered in the subsequent semesters.

Pre-requisite: Inclination to learn mathematics, basic knowledge of differential equations, electrical circuits and networks.

Course Outcome: After successful completion of the course, students will be able to

CO1: Understand various types of signals, classify them, and perform various operation on them.
CO2: Understand about various types of systems, classify them, analyze them, and understand their response behavior.
CO3: Apply transforms in the analysis of signals and systems.
CO4: Analyze the effects of applying various properties and operations on signals and systems by carrying out simulation.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	**11 Hours**
Introduction: Continuous and Discrete - Time Signals & their Classification, Continuous & Discrete–Time system & their properties. Linear Time Invariant Systems, Properties of LTI systems, State variable description for LTI systems, Convolution for continuous time systems, Convolution for discrete time systems (DTS), Correlation of DTS.	
UNIT-II	**10 Hours**
Fourier analysis for CTS - Importance of frequency domain analysis, Response of LTI systems to exponential signals, Periodic signals and properties, Fourier Transform (FT) its properties, system analysis of LTI system using FT Fourier.	
UNIT-III	**11 Hours**
Discrete Time Fourier Series (DFS), Discrete Time Fourier transform (DTFT) & its properties, Analysis of LTI system using DFS, DTFT, Time and Frequency characterization of signals and	

systems, Magnitude phase representation of the fourier transform, Classification of linear and nonlinear phase, Phase delay and group delay. Min phase system, Max phase system, All pass system.	
UNIT-IV	**10 Hours**
Sampling theorem, Effect of under sampling, aliasing, Interpolation, Signal reconstruction using zero order hold system, Sample and Hold circuit, Z-Transform- Definitions and Properties, Significance and properties of ROC, Inversion of Z-Transform using partial fractions and residue theorem, Application of Z-transform for LTI system.	

Text Books

1.	Alan V. Oppenheim, Alan S. Wilsky and Nawab, "Signals and Systems", Prentice Hall, 2nd Edition, 2017 (latest edition).
2.	J.G.Proakis and D.G.Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson Education, 4th Edition, 2009 (latest edition).
3.	Simon Haykin and Bary Van Veen, "Signals and Systems", Wiley India Publications, 2nd Edition, 2007 (latest edition).

Reference Books

1.	Michal J. Roberts and Govind Sharma, "Signals and Systems", Tata Mc-Graw Hill Publications, 2nd Edition, 2017 (latest edition).
2.	B.P.Lathi, "Linear Systems and Signals", Oxford University Press, 3rd Edition, 2017 (latest edition).
3.	Ramesh Babu, "Signal & Systems", Scitech, 4th Edition, 2011 (latest edition).

NETWORK ANALYSIS AND SYSTEMS	
Course Code: BEC 205 **Contact Hours**: L-3 T-0 P-2 **Course Category**: DCC	**Credits**: 4 **Semester**: 3

Introduction: This course provides basics of electrical circuit concepts, circuit modelling and methods of circuit analysis in time domain and frequency domain. The individual will be able to solve simple and complex multi-dimensional circuits including direct current (DC) and alternating current (AC) circuits with the help of circuit theory and network theorems. The laboratory exercises will help to design, build, and implement basic AC and DC circuits. The aim of this course is to provide a thorough comprehension of the fundamental behavior of electrical and electronic circuits, understand concepts of graph theory, two port networks, and network synthesis.

Course Objective:

- To make the students capable of analyzing any given electrical network.
- To make the students learn how to synthesize an electrical network from a given impedance/admittance function.
- To analyze the behavior of the circuit's response in the time and frequency domain.
- To understand the significance of network functions.
- To understand the concept of graphical solutions to an electrical network.
- To learn techniques of solving circuits involving different active and passive elements.
- To learn a number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, theorems, source transformation, and several methods of simplifying networks.
- To analyze various types of filters, attenuators, and different types of a two-port network using network parameters, with different types of connections.

Pre-requisite: Basic course in Electrical Engineering.

Course Outcome: After successful completion of the course, student will be able to

CO1: Apply the fundamental concepts in solving and analyzing different electrical networks

CO2: Analyze the electrical network in different conditions by selecting relevant technique and apply mathematics in synthesizing the networks in time and frequency domain.

CO3: Evaluate the performance of a particular network from its analysis.

CO4: Understand the various laws and theorems related to electric networks.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	11 Hours
Voltage, Current, Power and Energy, Circuit Elements (R,L,C), Independent and Dependent Sources, Kirchhoff's Laws, Series and Parallel combinations of Elements, Voltage division and Current division, Node analysis, Mesh analysis, Three phase networks, Star/Delta connection, Superposition theorem, Thevenin's theorem, Norton's theorem, Source transformations, Maximum power transfer theorem Compensation theorem, Reciprocity theorem, Millman's theorem, Telegen's theorem.	
UNIT-II	**10 Hours**
Time domain response of First order RL and RC circuits, Time domain response of Second order	

linear circuits, Circuit Analysis by Laplace Transform, Graph theory and its application.		
UNIT-III		**10 Hours**
Two- port three terminal Networks, Equations of two-port networks, Z and Y parameters, Hybrid and transmission parameters, Inverse hybrid and inverse transmission parameters, Relationship between two-port parameters, Inter-connection of two-port networks– Lattice networks.		
UNIT-IV		**11 Hours**
Poles and Zeros, Network functions for the one port and two port, Poles and zeros of network functions, Restrictions on pole and zero locations for driving point functions and transfer functions, Time domain behavior from the pole zero plot, Positive real function and its properties, Properties of LC, RC and RL driving point functions - synthesis of LC, RC and RL driving point admittance functions using Foster and Cauer first and second forms.		
Text Books		
1	W. Hayt, J.E. Kemmerley and S. M. Durbin, "Engineering circuit Analysis", Tata McGraw-Hill, 8^{th} Edition, 2013 (latest edition).	
2	M.E.VanValkenburg, “Network Analysis”, Prentice-Hall, 3^{rd} Edition, 2006 (latest edition).	
3	V. K, Aatre, “Network Theory and Filter Design”, New Age International Publishers, 3^{rd} Edition, 2014 (latest edition).	
Reference Books		
1	J. A, Edminister, “Theory and Problems of Electric Circuits”, Schaum’s Outline Series, Tata McGraw Hill, 5^{th} Edition, 2017 (latest edition).	
2	R. C, Dorf & J. A, Svoboda, “Introduction to Electric Circuits”, John Wiley & Sons, 8^{th} Edition, 2010 (latest edition).	
3	Sudhakar. A and Shyammohan S.Palli, “Circuits and Networks Analysis and Synthesis”, Tata McGraw- Hill Publishing Company Limited, 5^{th} Edition, 2017 (latest edition).	

DIGITAL ELECTRONICS	
Course Code: BEC-207 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 3

Introduction: Digital circuits are the basic blocks of modern electronic devices like mobile phones, digital cameras, microprocessors and several other devices. This course emphasizes on the fundamentals of digital circuits and how to engineer the building blocks that go into digital subsystems. This will cover the basics of Boolean algebra and combinational logic followed by a thorough understanding of sequential circuits and state machines. The design and analysis of digital circuits will also be an integral part.

Course Objective:

- To understand number representation and conversion between different number system in digital electronic circuits.
- To analyze logic processes and implement logical operations using combinational logic circuits.
- To understand characteristics of memory and their classification.
- To understand concepts of sequential circuits and to analyze sequential systems in terms of state machines.
- To understand the concept of Programmable Devices, PLA, PAL, TTL, ECL, CMOS logic families.

Pre-requisite: Basic understanding of diode and transistor operation.

Course Outcome: After successful completion of the course student will be able to

CO1: Understand different semiconductor memories.

CO2: Analyze, design and implement combinational logic circuits.

CO3: Analyze the design and implement sequential logic circuits.

CO4: Design digital systems using PLA.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	11 Hours
Analog & Digital signals, AND, OR, NOT, NAND, NOR & XOR gates, Boolean algebra. Standard representation of Logical functions, K-map representation and simplification of logical functions, Don't care conditions, X-OR & X-NOR simplification of K-maps. Combinational circuits: Multiplexers, Demultiplexers, Decoders & Encoders, Adders & Subtractor, Code Converters, Comparators, Decoder/ drivers for display devices.	
UNIT-II	**10 Hours**
Flip Flops: S-R, J-K, D & T Flip-flops, Excitation table of a flip-flop, Race around condition. Sequential circuits: Shift registers, Ripple counter, Design of Synchronous counters and sequence detectors, Sequence generators.	
UNIT-III	**11 Hours**
A/D and D/A converters: ADC Performance Characteristics - Resolution, Sampling Rate, Dynamic Range, Binary-weighted DAC, R-2R Ladder type networks, Successive-approximation ADC, Linear ramp ADC, Dual-slope ADC. Logic Families: Characteristics, RTL and DTL circuits, TTL, ECL and CMOS Logic families. Comparison of all Logic Families.	

UNIT-IV		10 Hours
Logic Implementations using ROM, PAL & PLA. Semiconductor Memories: Memory organization & operation, Classification and characteristics of memories, RAM, ROM and Content Addressable Memory.		
Text Books		
1	R.P. Jain, “Modern Digital Electronics”, TMH, 4th Edition, 2014 (latest edition).	
2	Morris Mano, “Digital Design”, PHI, 5th Edition. 2014 (latest edition).	
3	Malvino and Leach, “Digital Principles and Applications”, TMH, 7th Edition, 2010 (latest edition).	
Reference Books		
1	R. J. Tocci, “Digital Systems”, 10th Edition, PHI, 2009 (latest edition).	
2	I. J. Nagrath, “Electronics, Analog & Digital”, 2nd Edition, PHI, 2013 (latest edition).	
3	J. M. Yarbrough, “Digital Logic-Application and Design”, 4th Edition, PWS Publishing, 2012 (latest edition).	

NUMERICAL METHODS	
Course Code: BAS-203 **Contact Hours:** L-3 T-1 P-0 **Course Category:** OEC	**Credits:** 4 **Semester:** 3

Introduction: Numerical Methods give insight into problems we cannot otherwise solve. These methods provide us the way to solve problem when exact methods fails or unable to produce the desirable results.

Course Objectives:

- To motivate the students to understand and learn various numerical techniques to solve mathematical problems representing various engineering, physical and real life problems.
- To provide constructive methods for obtaining answers to such problem for whichanalytical methods fails to find solutions.

Pre-requisites: Calculus, Differential equations, some exposure to linear algebra (matrices).

Course Outcomes: Upon completion of this course, the students will be able to:

CO1: Understand the errors, source of error and its effect on any numerical computations andalso analysis the efficiency of any numerical algorithms.

CO2: Learn how to obtain numerical solution of nonlinear equations using bisection, secant,Newton, and fixed-point iteration methods.

CO3: Solve system of linear equations numerically using direct and iterative methods.

CO4: Understand how to approximate the functions using interpolating polynomials.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Content

UNIT-I	10 Hours
Floating-Point Numbers: Floating-point representation, rounding, chopping, error analysis, -conditioning and stability. Non-Linear Equations: Bisection, secant, fixed-point iteration, Newton method for simple andmultiple roots, their convergence analysis and order of convergence.	

UNIT-II	11 Hours
Linear Systems and Eigen-Values: Gauss elimination method using pivoting strategies, LUdecomposition, Gauss-Seidel and successive-over-relaxation (SOR) iteration methods and their convergence, ill and well-conditioned systems, Rayleigh's power method for eigen-values and eigen-vectors.	
UNIT-III	**11 Hours**
Interpolation and Approximations: Finite differences, Newton's forward and backward interpolation, Lagrange and Newton's divided difference interpolation formulas with error analysis, least square approximations. Numerical Integration: Newton-Cotes quadrature formulae(Trapezoidal and Simpson's rules) and their error analysis, Gauss--Legendre quadrature formulae.	
UNIT-IV	**10 Hours**
Differential Equations: Solution of initial value problems using Picard, Taylor series, Euler's and Runge-Kutta methods (up to fourth-order), system of first-order differential equations.	

Text Books

1	Jain M.K., Iyengar, S.R.K., and Jain, R.K. Numerical Methods for Scientific andEngineering Computation, 6th Edition, New Age International Publication, 2012 (Latest edition).
2	Sastry S., Introductory Methods of Numerical Analysis, 5th Edition, Prentice Hall India Learning Private Limited; 2012.
3	Conte, S.D and Carl D. Boor, Elementry Numerical Analysis: An Algorithmic approach, SIAM-Society for Industrial and Applied Mathematics, 2017.
4	Grewal, B. S., "Higher Engineering Mathematics", 44thEdition, Khanna Publishers,2012.

Reference Books

1	Gerald C.F and Wheatley P.O., Applied Numerical Analysis, 8thEdition, Pearson Education, 2011.
2	Chappra S.C., Numerical Methods for Engineers, 7th Edition, McGraw-Hill Higher Education, 2014.

ANALOG & DIGITAL ELECTRONICS	
Course Code: BEC-209 **Contact Hours:** L-3 T-0 P-2 **Course Category:** OEC	**Credits:** 4 **Semester:** 3

Introduction: The course will introduce fundamental principles of analog and digital electronics. The course provides sufficient basic knowledge for the undergraduate to understand the design of diodes and transistor-based circuits, op-amps and their applications as well as the design of digital circuits.

Course Objective:

- Understand the design and analysis of various analog electronic circuits
- Understand the fundamental concepts and techniques used in digital electronics

Pre-requisite: Basic concept of circuit theory, Student should have the prior knowledge of semiconductor electronics, Basic concept of number system.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand basic electronic devices such as diodes, BJT & FET transistors
CO2: Understand various applications of Op-Amp
CO3: Analyze logic processes and implement logical operations using combinational logic circuits
CO4: Design sequential circuits

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	**12 Hours**
Semiconductor diodes, Characteristics and operation, Applications of p-n junction diode. Bipolar Junction Transistor: Construction and operation, Common base (CB) configuration, Transistor amplifying action, Common emitter (CE) and Common collector (CC) configurations, definition of α and β, saturation, regions of operation of transistor, biasing methods. Amplifiers: CE, CC, CE amplifier circuits and their comparisons, RC coupled amplifier, Frequency response, Gain-bandwidth, and Darlington pair, Class B push pull amplifier. Feedback: Concept of negative & positive feedback and their relative advantages & disadvantages, Sinusoidal oscillators.	
UNIT-II	**10 Hours**
Field Effect Transistor: Introduction, JFET characteristics, Depletion & enhancement MOSFET, CMOS. Operational amplifier: Characteristics of ideal Op-Amp, Inverting & non-inverting amplifier, Differential amplifier, Adder & Subtractor, Integrator, Differentiator, Instrumentation amplifier, Schmitt trigger, Astable multivibrator.	
UNIT-III	**10 Hours**
Digital electronics: Analog & digital signals, Logic gates, Boolean algebra. Standard representation of logical functions, K-map representation and simplification of logical functions, Don't care conditions, X-OR & X-NOR simplification of K-maps. Combinational circuits: Multiplexers, Demultiplexers, Decoders & Encoders, Adders & Subtractor, Code converters, Comparators, Decoder/drivers for display devices, A/D and D/A converters.	

UNIT-IV		**10 Hours**
Flip Flops: S-R, J-K, D & T Flip-flops, Excitation table of a flip-flop, Race around condition Sequential circuits: Shift registers, Ripple counter, Design of synchronous counters and Sequence detectors, Sequence generators.		
Text Books		
1	Morris Mano, “Digital Design”, PHI, 5th edition, 2013 (latest edition).	
2	Millman and Halkias, “Electronic Devices and Circuits” TMH, 4th Edition, 2015 (latest edition).	
3	Salivahanan, Suresh Kumar, Vallavaraj, “Electronic Devices and Circuits” TMH, 4th Edition, 2016 (latest edition).	
Reference Books		
1	Balbir Kumar and S. B. Jain, “Electronic Devices and Circuits” PHI, 2nd Edition 2014 (latest edition).	
2	R.P. Jain, “Modern Digital Electronics”, TMH, 4th Edition, 2010 (latest edition).	
3	Roy Choudhury and Jain, “Linear Integrated Circuits”, New Age Publishers, 4th Edition, 2017 (latest edition).	

LINEAR INTEGRATED CIRCUITS	
Course Code: BEC-202 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 4

Introduction: This is a course on the design and analysis of Operational Amplifiers (Op-Amps) and Op-Amp based circuits which have varied applications in mathematical operations. This vastly covers the study of linear and non-linear applications of Op-Amp. The course also deals in power amplifiers and waveform generators.

Course Objective:

- To study the basic principles, configuration and characteristics of Op-Amp.
- To understand various mathematical applications of Op-Amp.
- To design and understand filters, waveform generators etc which are used in electronic systems

Pre-requisite: Basic knowledge of electronic devices, circuit analysis and phasor algebra

Course Outcome: After completion of the course, student will be able to:

CO1: Understand the concept, working principles and applications of Op-Amp
CO2: Analyze linear and non-linear Op-Amp circuits
CO3: Apply Op-Amp to solve a variety of application problems
CO4: Remember the concepts of Op-Amps and its practical applications

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction to Op-Amp, Op-Amp models (Ideal & Practical), Analysis of internal circuit of Op-Amp, Inverting & non-inverting amplifier, Differential amplifier, Transfer characteristics, A_{DM}, A_{CM}, CMRR, Current mirror, Active load, Level Shifter, Output Stages, IC 741 Op-Amp. Op-Amp Characteristics, DC/AC characteristics, Compensating techniques, Slew rate, Op- Amp Data Sheet.	
UNIT-II	**12 Hours**
Op-Amp Applications, Adder, Subtractor, Integrator, Differentiator, Voltage-to-Current converter, Current-to-Voltage converter, Current amplifier, Instrument amplifier. Linear & Non-Linear Applications: Sine wave generation (Barkhausen criterion, Phase shift, Wein bridge, Hartley, Colpitts, LC, RC & Crystal oscillators), Comparator, Schmitt trigger, Astable, Monostable, Triangular, Ramp generator, Log/antilog circuits using Op-Amp, Precision rectifier.	
UNIT-III	**10 Hours**
OTA & its applications, Basic structure and functioning, OTA as Differentiator, Integrator, (OTA)-C filter, (OTA)-C oscillator, OTA as Voltage amplifier, Programmable resistor & OTA as a filter. Power amplifiers, Classification of amplifier, Analysis of class A, B and AB amplifiers, Push pull amplifier, Complementary symmetry amplifiers, Conversion efficiency, Cross over distortion, Power distortion, Heat sinks, Tuned amplifiers, Power BJT, IC power amplifiers, MOS power transistors.	

UNIT-IV		10 Hours
Active RC filters, Idealistic & realistic response of filters (LP, BP, and HP), Butterworth & Chebyshev approximation filter functions, All pass, Notch filter, Quadrature filter. IC PLL - Operating principle, Monolithic PLL ICs, PLL applications. IC 555 Timer - Internal operation and its applications as Astable and Monostable multivibrator		
Text Books		
1	R. A. Gayakward, “Op-Amps and Linear Integrated Circuit” PHI (latest edition).	
2	D. Roychaudhary, and S. B. Jain, “Linear Integrated Circuits” New Age International – 2018 (latest edition).	
3	Albert Malvino, David J. Bates, “Electronic principles”, 8th Edition, 2015 (latest edition).	
Reference Books		
1	Sedra and Smith, “Microelectronic Circuits”, 7th Edition, Oxford University Press, 2010 (latest edition).	
2	J. B. Gupta, “Electronic Devices & Circuits” S. K. Kataria, 2013 (latest edition).	

DIGITAL SYSTEM DESIGN	
Course Code: BEC-204 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:**4

Introduction: The objective of this course is to introduce a hardware description language (HDL) for the specification, simulation, synthesis, and implementation of digital logic systems. The students will have design practice sessions and implement digital logic systems with electronic design and automation (EDA) tools.

Course Objective:

- To implement digital logic circuits on FPGA and a CPLD
- To synthesize complex digital circuits at several levels of abstraction
- To simulate and debug digital systems described in VHDL
- To learn the Hardware Description Language
- Demonstrate the use and application of Boolean algebra in the areas of digital circuit reduction, expansion, and factoring.

Pre-requisite: Digital Electronics

Course Outcome: After completion of the course, the students will be able to:

CO1: Apply Boolean algebra in reduction, expansion, factoring
CO2: Synthesize and analyze digital circuits through Verilog/VHDL
CO3: Create complex digital circuits at several levels of abstraction
CO4: Understand and analyze logic on an FPGA and a CPLD

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	12 Hours
Introduction to VHDL, Modelling concepts, Data types and operations, Basic modelling constructs, Entity, architecture, Signal, variable, Concurrent statements, Sequential statements, Signal drivers, Resolved signals, Delay mechanisms, Dataflow, Behavioral and Structural models, Subprograms, Configurations, Package and test bench, High level description of standard combinational and sequential modules.	
UNIT-II	**10 Hours**
Introduction to Finite State Machine, Pulse and fundamental mode of operation, Realization of state table from verbal description, State diagram & Transition matrix, Mealy and Moore machine, Reduction of flow tables of completely and incompletely specified sequential machines, Concept of secondary state assignment.	
UNIT-III	**10 Hours**
Realization of circuits of FSM, Decomposition of FSM & composite machine, Equivalence between Mealy and Moore model machine, Capabilities and limitations of FSM, Simplification of incompletely specified machines, Analysis of asynchronous FSM, Race and Hazard problems with asynchronous sequential machine.	
UNIT-IV	**10 Hours**
Introduction to EDA tools, Simulation, Event driven simulation, RTL synthesis, Behavioural synthesis, and Synthesis for FPGAs, Testing digital systems, Design for testability. Introduction to programmable logic devices: ROM, PLA, PAL, GAL based circuit. FPGA, CPLD, Architecture and Programming of FPGA/CPLD and hardware implementation.	
Text Books	
1	Mark Zwolinski, “Digital System Design with VHDL”, 2nd Edition, 2003 (latest edition).

2	Z. Kohavi, “Switching And Finite Automata Theory”, TMH, 3^{rd} Edition, 2010 (latest edition).
3	Peter J. Ashenden, “The student’s guide to VHDL”, Morgan Kaufmann publishers, 3^{rd} Edition, 2008 (latest edition).
Reference Books	
1	Charles. H. Roth, “Digital System Design using VHDL”, PWS, 2012 (latest edition).
2	Roth, “Fundamental of Logic Design”, Cengage learning, 7^{th} Edition, 2015 (latest edition).
3	Navabi Z., “VHDL-Analysis & Modelling of Digital Systems”, McGraw Hill, 2^{nd} Edition, 1998 (latest edition).

ELECTROMAGNETIC FIELD THEORY	
Course Code: BEC-206 **Contact Hours:** L-3 T-1 P-0 **Course Category:** DCC	**Credits:** 4 **Semester:** 3

Introduction: Electromagnetic field theory is the most fundamental subject in the curriculum of electrical engineering education. Electromagnetic field theory defines capacitors, inductors and resistors in terms of its primary electric and magnetic quantities like electric charge, electric potential, electric current, electric and magnetic flux. Electromagnetics explains universal concepts in three- dimension real world, i.e., electro-magnetic wave propagation in free-space.

Course Objective:

- To list Maxwell's equations and solve them for specific regular geometries.
- To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.
- To impart knowledge on the concepts of Faraday‘s law, induced emf and Maxwell‘s equations.
- Understand general electromagnetic wave propagation and its applications to engineering problems.

Pre-requisite: The basic ideas of Coulomb's law and Ohm's law.

Course Outcome: At the end of the course, student will be able to

CO1: Understand the concepts of Electrostatic and Magneto statics field.

CO2: Analyze and formulate fields and electromagnetic waves propagation problems in a multi-disciplinary frame individually or as a member of a group.

CO3: Remember the different concepts of electrostatic, magnetostatic and time varying electromagnetic systems.

CO4: Understand and remember the different coordinate systems.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	11 Hours
Introduction: Addition, subtraction and multiplications, Cartesian, Cylindrical, Spherical transformation, scalar and vector field, Dot and Cross products, Differential length, area and volume, Line surface and volume integrals, Divergence and curl, Transformation of vectors in different co-ordinate systems, Dirac-delta function, Stokes's theorem.	
UNIT-II	**10 Hours**
Electrostatic fields: Electric field due to point-charges, Line charges and surface charges, Electrostatic potential, Gausses' Law - Maxwell's equation, Solution of Laplace and Poisson's equation in one dimension, Electric flux density, Boundary conditions, Capacitance - calculation of capacitance for simple rectangular, Cylindrical and spherical geometries, Electrostatic energy.	
UNIT-III	**11 Hours**
Magnetostatics - Magneto-static fields, Biot - Savart's Law, Ampere's circuit law, Magnetic Induction and Faraday's Law, Magnetic Flux Density, Permeability, Energy Stored in a Magnetic Field, Ampere's Law for a Current Element, Volume Distribution of Current, Maxwell's Equations - Maxwell's equation for static fields, Magnetic scalar and vector potential.	
UNIT-IV	**10 Hours**
Electromagnetic Waves - Continuity equations, Displacement current, Maxwell's equation, Boundary conditions, Plane wave equation and its solution in conducting and non-conducting media, Phase and	

Group velocity, Depth of penetration, Conductors and dielectrics, Impedance of conducting medium. Polarization, Reflection and refraction of plane waves at plane boundaries, Poynting vectors, and Poynting theorem, Introduction to Transmission Lines and equations, Characteristic impendence, Input impendence of a lossless line, Open and Short-circuited lines, Standing wave and reflection losses, Impedance matching.		
Text Books		
1	Matthew N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 7th Edition, 2018 (latest edition).	
2	E. C. Jordon, and K. G. Balman, "Electromagnetic Waves & Radiation System" PHI, 2nd Edition, 2015 (latest edition).	
3	John R. Reitz, "Foundations of Electromagnetic Theory", Pearson, 4th Edition, 2008 (latest edition).	
Reference Books		
1	William H. Hayt, "Engineering Electromagnetics", TMH 6th Edition, 2017 (latest edition).	
2	David K. Cheng, "Field and Wave Electromagnetic", 5th Edition, Pearson Education Asia, 2014 (latest edition).	
3	J.D. Kraus, "Electromagnetics", TMH, 2017 (latest edition).	

COMMUNICATION SYSTEMS	
Course Code: BEC-208 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 4

Introduction: To introduce the concepts of analog communication systems, and to equip students with various issues related to analog communication such as modulation, demodulation, transmitters and receivers and noise performance.

Course Objective:

- To provide basic understanding of the random signals and stochastic processes.
- To provide understanding of analog modulation techniques along with its applications in various fields.
- To understand various types of noise, their source and their effect on the different modulation techniques.
- To understand applications of communication in allied fields of Electronics, Computers and Industrial control.

Pre-requisite: Signals and Systems, Probability theory and stochastic process

Course Outcome: After successful completion of the course student will be able to

CO1: Understand the use of communication in electronic systems, computers, automation and control system.

CO2: Analyze and apply different modulation techniques as per the design requirements.

CO3: Analyze different parameters of analog communication techniques.

CO4: Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction to Pobability theory, Conditional probabilities, Random variables, Cumulative distribution function (cdf), probability mass function, probability density functions and properties, Bayes' rule for continuous and mixed random variables, Sum of two independent random variables, Expectation- mean, variance and moments of a random variable, Joint moments, Covariance and Correlation, Uniform, Gaussian and Rayleigh distributions, Binomial, and Poisson distributions, Multivariate Gaussian distribution. Random process, Discrete and continuous time processes, Mean, Autocorrelation and Autocovariance functions, Stationarity, Strict-sense stationary (SSS) and Wide-sense stationary (WSS) processes, Autocorrelation function of a real WSS process and its properties, Cross-correlation function, Ergodicity and its importance, Cross-power spectral density and properties, Spectral factorization theorem, Gaussian process, Poisson process, Markov Process.	
UNIT-II	**11 Hours**
Introduction to Communication systems, Source of information, Communication channels, Base band pass band signals, Representation of signals and systems, Probabilistic considerations, Modulation process, Primary communication resources, Analog versus digital communication, Applications of communications systems. Linear modulation: Time and frequency domain expression of AM (including intensity modulation of light), DSB, SSB and VSB, Generation of linearly modulated signals, Coherent demodulation and envelope detection.	

UNIT-III	11 Hours
Angle modulation: Instantaneous frequency; phase and frequency modulation. Single tone FM and its spectral analysis. NBFM and WBFM. Bandwidth requirements of angle modulated signals. Demodulation of angle modulated signal. Radio and Television broadcasting: AM radio broadcasting and FM radio and TV broad casting. Frequency division multiplexing, radio transmitters and receivers.	
UNIT-IV	**10 Hours**
Noise in Communication systems: Thermal noise, shot noise and white noise. Noise equivalent bandwidth, noise figure and noise temperature. Time domain representation of narrowband noise. Properties of narrowband noise. Noise in CW modulation systems. Figure of merit: Noise performance of linear and exponential modulation. Pre-emphasis and de-emphasis in FM. Comparison of the noise performance of CW modulation schemes.	

Text Books

1.	Simon Haykin, "Communication System", John Wiley & sons., 4th Edition, 2006 (latest edition)
2.	Taub & Schilling, "Principles of Communication System", McGraw hill, 4th Edition, 2017 (latest edition)
3.	John G. Proakis, "Communication Systems", McGraw Hill, 5th Edition, 2014 (latest edition).

Reference Books

1.	B. P. Lathi, "Linear Systems and Signals", Oxford Publication, 3rd Edition, 2017 (latest edition).
2.	Leon W. Couch, "Analog and Digital Communication", Pearson Education, 8th Edition, 2012 (latest edition).
3.	George Kennedy, "Electronic Communication Systems", Tata McGraw Hill, 6th Edition, 2017 (latest edition).

DATA STRUCTURES	
Course Code: BCS -201 **Contact Hours**: L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 3

Introduction: This course introduces about data structures and their useful applications in Computer Science & Engineering. It deals with all aspects of Data structures like static anddynamic data structure. How to choose a particular data structure for any specific problem.

Course Objective:
- To study different kinds of data structures with their respective applications.
- To learn applications of data structures
- To apply data structures in various programs
- Learn to use data structures for different programs

Pre-requisite: Fundamentals of Programming

Course Outcome:
- Knowledge of different kinds of data structures with their respective applications.
- Devise data structures for programs
- Differentiate between static and dynamic data structures
- Develop programs using different types of data structures

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction: Introduction to Algorithmic, Complexity- Time-Space Trade off. Introduction to abstract data types, design, implementation and applications. Introduction to List data structure. **Arrays and Strings:** Representation of Arrays in Memory: one dimensional, Two dimensional and Multidimensional, Accessing of elements of array, performing operations like Insertion, Deletion and Searching. Sortingelements of arrays. Strings and String Operations.	
UNIT-II	**10 Hours**
Stacks and Queues: Introduction to data structures like Stacks and Queues. Operationson Stacks and Queues, Array representation of Stacks, Applications of Stacks: recursion, Polish expression and their compilation conversion of infix expression toprefix and postfix expression, Operations of Queues, Representations of Queues	

Applications of Queues, Priority queues. **Linked Lists:** Singly linked lists, Representation of linked list, Operations of Linked list such as Traversing, Insertion and Deletion, Searching, Applications of Linked List.Concepts of Circular linked list and Doubly linked list and their Applications. Stacks and Queues as linked list.		
UNIT-III		**12 Hours**
Trees: Basic Terminology, Binary Trees and their representation, binary search trees, various operations on Binary search trees like traversing, searching, Insertion and Deletion, Applications of Binary search Trees, Complete Binary trees, Extended binary trees. General trees, AVL trees, Threaded trees, B- trees. **Searching and Sorting:** Linear Search, Binary search, Interpolation Search, InsertionSort, Quick sort, Merge sort, Heap sort, sorting on different keys, External sorting.		
UNIT-IV		**10 Hours**
Graphs: Terminology and Representations, Graphs & Multi-graphs, Directed Graphs, Representation of graphs and their Transversal, Spanning trees, shortest path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths. **File Structure:** File Organization, Indexing & Hashing, Hash Functions, Collision Resolution Techniques.		
Text Books		
1	Horowitz and Sahni, “Fundamentals of Data structures”, Galgotia publications, 1983 (Latest edition).	
2	Tannenbaum, “Data Structures”, PHI, 2007 Fifth Impression, (Latest edition).	
3	An introduction to data structures and application by Jean Paul Tremblay & Pal G. Sorenson (McGraw Hill) (Latest edition).	
Reference Books		
1	R.L. Kruse, B.P. Leary, C.L. Tondo, “Data structure and program design in C”, PHI, 2009 (Fourth Impression)	
2	Seymour Lipschutz Saucham’s series, data Structures, Mc, Graw Hill Publication, 2018 (Latest edition).	
3.	Nitin Upadhaya, Data Structures using C, S K Kataria Publicatrions, 2015 (Latest edition).	

ELEMENTS OF INFORMATION THEORY	
Course Code: BEC-210 **Contact Hours:** L-3 T-1 P-0 **Course Category:** OEC	**Credits:** 4 **Semester:** 4

Introduction: Information theory deals with the study and solving the problems of communication or transmission of signals over channels. It is an essential component to decide upon the coding technique to be used for a particular application and measurement of the channel capacity. The concepts of information theory are widely used in research.

Course Objective:

- To introduce the principles and applications of information theory.
- To understand how information is measured in terms of probability and entropy, and the relationships among conditional and joint entropies.
- To calculate the capacity of a communication channel, with and without noise.
- To introduce coding schemes, including error correcting codes.
- To study efficient coding of audio-visual information, data compression.

Pre-requisite: Advanced courses of analog and digital communication**.**

Course Outcome: At the end of the course students should be able to

CO1: Analyze the information content of a random variable from its probability distribution.

CO2: Understand and relate the joint, conditional, and marginal entropies of variables in terms of their coupled probabilities.

CO3: Understand channel capacities and properties using Shannon's Theorems.

CO4: Evaluate efficient codes for data on imperfect communication channels.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	**12 Hours**
Information theory: Information rate, Entropy, Joint and conditional entropies, Kraft McMillan inequality, Mutual information - Discrete memory less channels – BSC, BEC – Channel capacity, Shannon limit, Source coding theorem, Shannon-Fano coding.	
UNIT-II	**10 Hours**
Huffman coding, Extended Huffman coding, Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm Channel, Linear Predictive coding, Introduction to Audio coding, Perceptual coding, Masking Techniques, Introduction to Speech Coding, Channel Vocoder.	
UNIT-III	**10 Hours**
Error control coding, Block codes-Definitions and Principles, Hamming weight, Hamming distance, Minimum distance decoding, Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation.	
UNIT IV	**10 Hours**
Convolution codes, Code tree, Trellis, State diagram, Error control coding, Turbo coding - Principle of Turbo coding, Video Compression - Principles I,B,P frames, Motion Estimation, Motion Compensation.	

Text Books	
1	R Bose, "Information Theory, Coding and Cryptography," McGraw hill Education, 3rd Edition, 2016 (latest edition).
2	Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards," Pearson Education Asia, 4th Edition, 2009 (latest edition).

3	K. Sayood, "Introduction to Data Compression," Elsevier, 5th Edition, 2017 (latest edition).
Reference Books	
1	S Gravano, "Introduction to Error Control Codes," Oxford University Press, 2007 (latest edition).
2	Amitabha Bhattacharya, "Digital Communication," Tata McGraw Hill,1st Edition, 2017 (latest edition).
3	Cover and Thomas, "Elements of Information Theory," Wiley Series in Telecommunication and Signal Processing, 2nd Edition, 2006 (latest edition).

Digital Communication Systems	
Course Code: BEC-301 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 5

Introduction: The course will introduce fundamental principles of digital communication. The course provides sufficient basic knowledge for the undergraduate to understand the design of digital modulator and demodulator and their real time applications.

Course Objective:

- Solve various types of problems on digital communications.
- To prepare mathematical background for communication signal analysis.
- To understand concept of spread spectrum communication system.
- Develop skill on advanced communication system design.

Pre-requisite: Random variable and random process, signal and system, Fourier transform.

Course Outcome: After completion of the course, student will be able to:

CO1: Understanding basic theories of digital communication and solve various types problems.

CO2: Analyze the properties of basic Modulation techniques and apply them to Digital Communication.

CO3: Apply theory for analyzing a practical problem related to modern communication systems.

CO4: Describe and analyze the digital communication system with spread spectrum modulation.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Signal space representation, Gram-Schmit organization, Characterization of band limited Channels Pulse code modulation, Channel noise and error probability, Quantization noise and signal-to-noise ratio, robust quantization, Companding, Linear prediction, DPCM, Delta Modulation, Quantization error and SNR calculations, Channel Capacity theorem, Design of MP/ADM, ADPCM, Binary data formats, Inter symbol interference, Nyquist criterion for distortion less baseband binary transmission, Correlative coding –duo –binary and modified duo-binary signalling and precoder, Eye pattern, Introduction to Equalization techniques, zero forcing, mean squared error linear equalizer, Decision feedback equalizer.	
UNIT-II	**10 Hours**
State space/Constellation Diagram based design of Coherent and non-coherent Digital Receivers with BPSK, DPSK, DEPSK, BFSK, QPSK, QAM, MSK, GMSK transmitter and receiver implementation, Probability of error calculations, Bandwidth Efficiency, Carrier synchronization methods by calculating probability of miss-of probability of false detection., Optimum design of transmit and receive filters, Conceptual Receiver Design using MF & Maximum likelihood Algorithm.	
UNIT-III	**10 Hours**
Pseudo-Noise Sequences and Spread Spectrum, Model of a Spread Spectrum Communications Systems, Direct Sequence Spread Spectrum Signals, frequency –hopping and time –hopping spread spectrum systems, correlation functions, spreading sequences maximal- length sequences, gold codes, Walsh orthogonal codes, properties and generation of sequence like Rake Receivers, Multi-user Detection, Frequency Hopped Spread Spectrum Signals, Other	

types of spread spectrum signals, Spread Spectrum in multipath channels, Multichannel Digital Communications in AWGN.		
UNIT-IV		**10 Hours**
OFDM Basics: Multi-carrier transmission; OFDM modulation & demodulation, BER; coded-OFDM; Orthogonal frequency-division multiple-access (OFDMA). OFDM Synchronization: Effect/estimation of symbol-time offset (STO); Effect/estimation of carrier-frequency offset (CFO); Effect/compensation of sampling-clock offset (SCO). Peak-to-Average Power Ratio Reduction (PAPRR): Distribution of OFDM-signal amplitude; PAPR & oversampling; Mitigation methods: clipping & filtering, selective mapping (SLM), partial transmit sequence (PTS), tone reservation (TR), tone injection (TI), etc. Multiple-Input (i.e., Multiple-Transmitter) Multiple- Output (i.e., Multiple-Receiver) (MIMO) Channel Models: Small-scale vs. Large- scale fading; time-dispersive vs Frequency-dispersive fading; Spatial correlation. Antennas Diversity: Receive- antenna diversity; Transmit-antenna diversity. Space-time Coding.		
Text Books		
1	J. G. Proakis, Masoud Salehi, "Digital Communications", McGraw Hill, 5th Edition, 2010 (latest edition).	
2	B.Sklar, "Digital Communications, Fundamentals and Applications", Pearson, 2nd Edition, 2010 (latest edition).	
Reference Books		
1	L. Glover, "Digital Communication", Pearson, 2007 (latest edition).	
2	J. G. Proakis, M.Salehi, "Fundamental of Communication System", Pearson, 1st Edition, 2007 (latest edition).	
3	H. Taub, "Principles of Communication Systems", Tata McGraw-Hill Education, 2008 (latest edition).	
3	S. Haykins, "Digital Communication", John Wiley and Sons, 2010 (latest edition).	

Modeling and Simulation	
Course Code: BAS 301 **Contact Hours:** L-3 T-0 P-2 **Course Category:** BAS	**Credits:** 4 **Semester:** 5

Introduction: Modeling and simulation are the indispensable tools that allow us to analyze the systems efficiently. They help us to analyze the behavior of the system before the system is actually built. Due to the advancement in this field, they have now become popular in all disciplines of engineering and sciences. The course will provide groundwork to the engineers to understand the underlying basis of modeling and simulation techniques.

Course Objectives: The objective of this course is to impart a basic understanding of system and their modeling. Students will be introduced to mathematical modeling and their applications with simulation techniques. Also, the use of MATLAB/R/Mathematica will help the students to simulate the various mathematical models.
Pre-requisite: Determining the system of units of your model, adding coordinate systems, adding datum features.

Course Outcomes: Having successfully completed this course, the student will be able to

- **CO1:** Understand the procedure of modeling of various systems using appropriate modeling techniques.
- **CO2:** Learn about various models such as Monte Carlo simulation models, queuing models, and mathematical models.
- **CO3:** Formulate and solve the mathematical models for the systems.
- **CO4:** Apply the simulation code in MATLAB/R/Mathematica for gaining quick and useful insights into real-world systems.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT I	10 hours
Concept of system and environment: Classification of Systems; Need of System Modeling; Modeling Methods for Complex Systems; Classification of Models: Physical vs. Abstract Model, Mathematical vs. Descriptive Model, Static vs. Dynamic Model, Steady State vs. Transient Model, Open vs. Feedback Model, Deterministic vs. Stochastic Models, Continuous vs. Discrete Models; Steps in the Modeling process; Mathematical Modeling: Concept, Importance, Advantages and Limitations.	
UNIT II	**10 hours**
Introduction to Simulation: Need and Advantages; Mathematical Modeling and Approaches to Simulation; Discrete system simulation: Monte Carlo method, Random Number Generation. Applications of Modeling and Simulation; Numerical Methods for Simulation: Trapezoidal and Tangent Formulae, Simpson’s Rule, One-Step Euler’s Method, Runge–Kutta Methods of Integration, Runge–Kutta Fourth-Order Method; Errors during Simulation with Numerical Methods.	

UNIT III	12 hours
Difference equations: Introduction to Discrete Models; Linear Models: Population Model Involving Growth, Drug Delivery Problem, Linear Prey-Predator Problem; Introduction to Continuous Models; Mathematical Model of Influenza Infection (within host), Epidemic Models (SI, SIR, SIRS), Numerical solution of the models.	
UNIT IV	**10 hours**
Fitting a Mathematical Function to Data: Fitting of Linear Model, Linear Model with Multiple Predictors, Non-Linear Model Estimation. Queuing Theory: Introduction, notation and assumption. Simulation of queuing system, Simulation of a single server queue.	

Text Books	
1	D.K. Chaturvedi, "Modeling and Simulation of Systems using MATLAB and Simulink", CRC press, 2017 (latest edition).
2	S.I. Gordon, B. Guilfoos, "Introduction to Modeling and Simulation with MATLAB® and Python", CRC Press, 2017 (latest edition).
4	A. M. Law, "Simulation Modeling and Analysis", McGraw-Hill, 2014 (latest edition).
Reference Books	
1	J. Narain, "Mathematical modeling", New Age International, 1988 (latest edition).
2	B. Barnes, G. Fulford, "Mathematical Modelling with Case Studies, Using Maple and MATLAB", CRC Press, 2016 (latest edition).
3	K. Velten "Mathematical Modeling and Simulation: Introduction for Scientists and Engineers", John Wiley & Sons, 2009 (latest edition).
4	S. Banerjee, "Mathematical Modeling: Models, Analysis and Applications", CRC Press, 2014 (latest edition).

Control Systems	
Course Code: BEC-303 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 5

Introduction: The course will introduce fundamental principles of open loop and closed loop control system. The course provides sufficient basic knowledge for the undergraduate to understand the feedback control system, frequency response analysis, stability analysis, basics of state space analysis, transducers, circuits of control system and their applications as well as the design of feedback control system.

Course Objective:

- To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
- To employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system
- Formulate different types of analysis in frequency domain to explain the nature of stability of the system.

Pre-requisite: Linear Differential Equations, Laplace Transform, Rotational Motion, Network Theory.

Course Outcome: After completion of the course, students will be able to:

CO1: Understand different types of systems and identify a set of algebraic equations to represent and model a complicated system into a more simplified form.

CO2: Apply different physical and mechanical systems in terms of the electrical system to construct equivalent electrical models for analysis.

CO3: Apply time and frequency domain analysis to predict and diagnose transient performance parameters of the system for standard input functions.

CO4: Evaluate different types of controllers and compensators to ascertain the required dynamic response from the system.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations, and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	**12 Hours**
Definitions of Control Systems, Closed Loop and Open Loop Control, Examples of Control Systems, Laplace Transformation and Solution of Differential Equations, Concept of Mathematical model, Linear and Non-Linear Systems, Transfer Function with Simple Examples, Transfer function of physical systems (Mechanical Translational Systems), Armature controlled and field controlled DC servomotors, AC servomotors and deriving their transfer functions, Block Diagram representation, Block Diagram Reduction Technique.	
UNIT-II	**10 Hours**
Signal Flow graph, Mason gain formula, Basic Control Actions, Proportional, integral and Derivative controllers, effect of feedback on control system, Transient and steady state response of first order system, Second order system, Transient, Static error coefficients, position, velocity and acceleration error coefficients.	
UNIT-III	**10 Hours**
Stability of Control System, Routh's Stability criterion, relative stability analysis, Root Locus Techniques, Bode Plot, Determination of Transfer function from Bode Plot, Polar Plots, Nyquist Stability Criterion.	
UNIT-IV	**10 Hours**

Definitions of state, state variables, state space, representation of systems, Solution of time invariant, homogeneous state equation, state transition matrix and its properties, Z transform and solution of difference equation, Transducers, Stepper Motor, Rotating Amplifiers and Magnetic Amplifiers.

Text Books	
1	I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 6th Edition 2018 (latest edition).
2	K. Ogata, "Modern Control Engineering", 5thEdition, 2015 (latest edition).
Reference Books	
1	K. Kuo, "Automatic Control Systems", PHI, 7th Edition, 2013 (latest edition).
2	N. K. Jain, "Automatic Control System Engineering", Dhanpat Rai, 2nd Edition, 2011 (latest edition).

Information Theory & Coding	
Course Code: BEC-304 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:**6

Introduction: The course will introduce fundamental principles of information theory and various coding techniques used in digital communication. The course provides sufficient basic knowledge for the undergraduates to understand the coding theory that is major tool to find explicit techniques to enhance error free data propagation with increased efficiency pattern associated to advancement of different digital technologies.

Course Objective:

- Understand the various mathematical models developed for coding schemes utilized in data communication.
- Understand the fundamental concepts and application of coding theory.
- Implement and analyze basic coding and compression algorithms.

Pre-requisite: Basic concept of Communication Systems, Student should have the prior knowledge of Digital Communication Techniques, Basic knowledge of Probability Theory.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand and apply fundamental concepts in information theory such as probability, entropy, information content and their inter-relationships.

CO2: Understand the coding theory thoroughly.

CO3: Understand various applications associated with research

CO4: Analyze logical aspects of model development for digital data communication processes.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations, and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	**12 Hours**
Information Theory: Information- Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information- Discrete memory less channels - BSC, BEC - Channel capacity, Shannon limit.	
UNIT-II	**10 Hours**
Source coding: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm Channel, Linear Predictive coding, Introduction to Audio coding, Perceptual coding, Masking Techniques, Introduction to Speech Coding, Channel Vocoder.	
UNIT-III	10 Hours
Error control coding: block codes: Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder - CRC, Convolution codes - code tree, trellis, state diagram - Encoding - Decoding: Sequential search and	

Viterbi algorithm.		
UNIT-IV		10 Hours
Error control coding: convolution codes: Principle of Turbo coding Video Compression - Principles I,B,P frames, Motion Estimation, Motion Compensation. Random process: Definition and examples, first order, second order, strictly stationary, wide sense stationary, Ergodic process and Markov process - Binomial, Poisson and Normal processes, sine wave processes, random telegraph process.		
Text Books		
1	R. Bose, “Information Theory, Coding and Cryptography,” TMH, 3rd Edition 2016 (latest edition).	
2	F. Halsall, “Multimedia Communications: Applications, Networks, Protocols and Standards,” Pearson Education Asia, 2002 (latest edition).	
Reference Books		
1	S.Gravano, “Introduction to Error Control Codes,” Oxford University Press2007 (latest edition).	
2	A. Bhattacharya, “Digital Communication,” TMH, 2017 (latest edition).	
3	T. M. Cover and J. A. Thomas, “Elements of Information Theory,” Wiley Series in Telecommunication and Signal Processing, 2nd Edition, 2006 (latest edition).	
4	K.Sayood, “Introduction to Data Compression,” Elsevier, 5rd Edition, 2017 (latest edition).	

Data Communications and Computer Networks	
Course Code: BIT 301 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 5

Introduction: Data communications refers to the transmission of digital data between two or more computers, whereas, a computer network or data network is a telecommunication network that allows computers to exchange data. The physical connection between networked computing devices is established using either wired or wireless media. The best-known computer network is the Internet.

Course Objective:

- The students should understand the layered structure of networking devices.
- They should be familiar with a few networking protocols.
- They should study the different types of networks and topologies of networks.

Pre-requisite: Basic knowledge of networking.

Course Outcome: Upon successful completion of this course, students will be able to:

CO1: Understand the basics of data communication, networking, internet and their importance.
CO2: Understand the functionalities of each networking layer and standards.
CO3: Analyze the services and features of various protocol layers in data networks.
CO4: Identify the basic security threats of a network.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT I	10 hours
Introduction: Goals and Applications of Networks, Layering Concept, OSI Reference Model, TCP/IP Protocol Suite, Networks Topology, Physical Layer: Signals, Digital Transmission – Analog to Digital & Digital to Digital, Analog Transmission – Digital to Analog & Analog to Analog, Multiplexing – FDM & TDM, Media – Guided and Unguided, switching – Packet based & Circuit based, Shannon Capacity; Network Topologies, Connecting Devices.	
UNIT II	**10 hours**
Data Link Layer: Addressing, Error Detection & Correction, Checksum & CRC; Medium Access – ALOHA, CSMA, CSMA/CD & CA; Protocols – Ethernet, ARP & RARP; Switching Techniques. Network Layer: Need for internetworking, IP Addressing, Subnetting, Super-netting, Basic Routing (or Forwarding) Mechanism; IPv4 frame format and functions; Key features of IPv6, ICMP, IGMP, Routing protocols – RIP, OSPF & BGP and algorithms – Distance Vector and Link State. Linux Network Commands: arp, route, if config, netstat, traceroute, ping.	
UNIT III	**10 hours**
Transport Layer: Port Addresses; ARQ - Simple, Stop and Wait, Go Back-N, Selective Repeat; UDP – Services & Applications; TCP – header format, connection setup & termination, state transition diagram, flow control, error control, Congestion Control: causes for congestion, effects of congestion, various open-loop and close-loop congestion control techniques: The leaky bucket algorithm, The token bucket algorithm	
UNIT IV	**10 hours**
Application Layer: Web & HTTP, FTP, Email, Telnet, DNS, RPC. Network Security Basic concepts: Cryptographic Protocols, PGP, IPSEC, SSL, SSH, Firewalls, IDS, IPS. Advanced	

Protocols: SNMP, RTP, SIP, BitTorrent.	
Text Books	
1	B. Forouzan, “Data Communications and Networking”, McGraw Hill Education, 5th Edition, 2017 (latest edition).
2	A. S. Tanenbaum and D. J. Wetherall, “Computer Networks”, Pearson Education India, 5th Edition, 2013 (latest edition).
Reference Books	
1	L. L. Peterson and B. S. Davie, “Computer Networks: A Systems Approach”, 5th Edition, Elsevier, 2011 (latest edition).
2	W. Stallings, “Data and Computer Communications”, 5th Edition, Pearson, 2014 (latest edition).
3	V. Pallapamanvi, “Data Communications and Computer Networks”, 2nd Edition, Prentice Hall, 2014 (latest edition).
4	K. James, “Computer Networking: A Top-down Approach”, 6thh Edition, Pearson, 2017 (latest edition).

Electronic Measurement and Instrumentation	
Course Code: BEC-305 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 5

Introduction: The course will introduce fundamental working principles of electronic and electrical instruments in laboratory and industry too. The course provides sufficient basic knowledge for the undergraduates to understand the elementary measuring circuits and their elaborated application in working industry.

Course Objective:

- Understand the concept of measurement and analysis of various electronic circuits
- Understand the fundamental concepts and techniques used in electrical and electronic measuring instrument

Pre-requisite: Basic concept of Electrical Science, Student should have the prior knowledge of electronics and electrical circuits, Basic concept of measurement system.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand significance of measurement in various laboratories.
CO2: Understand different and intense applications of electronic and electrical circuit.
CO3: Analyze implementation of circuits and does synthesis using various working principle.
CO4: Apply the complete knowledge of various electronics instruments/transducers to measure the physical quantities in the field of science, engineering and technology.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Role of Measurement Systems, General Principles of Measurements, Standards of Measurement, Units and Dimensions, Errors in Measurement, Classification & its statistical Analysis, Moving Coil Instruments, Moving Iron Instruments, Dynamo Meter Instruments, Induction Instruments, Extension of Ranges, Shunts and Multipliers.	
UNIT-II	**10 Hours**
Measurement of Current, Voltage and Power, Measurement of Resistance, Wheatstone Bridge, Kelvin Double Bridge, Megger, Measurement of Inductance, Maxwell's Bridge, Hay's bridge, Anderson's Bridge, Desauty's Bridge, Measurement of Capacitance, Schering Bridge, Measurement of Frequency, Wien's Bridge.	
UNIT-III	**10 Hours**
Multirange Ammeters, RF Ammeter, Multirange Voltmeter, Transistor Voltmeter (TVM), Differential Voltmeter, AC voltmeters using Half Wave and Full Wave Rectifiers, True RMS Voltmeter, Ohmmeter, Series and Shunt, LCR bridge, Q- meter. AF Sine and Square Wave Generator, Basic Wave Analyzer, Heterodyne Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer.	
UNIT-IV	**10 Hours**
Digital Measurements, Digital Voltmeter, Voltage to frequency converter, Digital Multimeter, A/D and D/A converters, Ramp Type, Dual Slope Integration Type, Successive approximation Type 1 3 2 Digit. Transducers, Classification and Selection, Displacement Transducers, Linear Variable Differential Transformer, Photoelectric Transducers, Piezoelectric Transducers, Thermo- Electric Transducers.	

Text Books	
1	E.W. Golding, “Electrical Measurements & Measuring Instruments”, Wheeler Pub., 1999 (latest edition).
2	W. D. Cooper, “Modern Electronics Instrumentation”, Prentice Hall of India, 2007 (latest edition).
Reference Books	
1	B. Oliver, J. Cage, “Electronic Measurements & Instrumentation”, McGraw Hill, 2013 (latest edition).
2	J B Gupta, “Electronics & Electrical Measurements and Instrumentation”, Katson Publication, 2013 (latest edition).
3	A. K. Sawhney, “Electrical and Electronic Measurements and Instrumentation”, Dhanpatrai and Sons, 2012 (latest edition).

Artificial Intelligence	
Course Code: BCS 301 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 5

Introduction: This course is an introduction to the basic Knowledge representation, problem solving and learning methods of artificial intelligence. After learning this course, the student should be able to understand the basic concepts of problem-solving and learning in intelligent system engineering.

Course Objective: Introduce the basic concepts of artificial intelligence, problem solving, knowledge representation and reasoning.

Pre-requisite: Discrete Mathematics, Programming Concepts.

Course Outcome: The students will be able to

- **CO1:** Apply the concepts of artificial intelligence for real world problem solving.
- **CO2:** Understand the fundamentals of artificial intelligence (AI) and expert systems.
- **CO3:** Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
- **CO4:** Apply the concepts of handling uncertainty in various applications

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT I	10 hours
Introduction to AI: Brief introduction about Intelligent agents and Problem Solving. Uninformed Search Strategies, Informed Search Strategies, Heuristics. Solving problems by searching, BFS, DFS, Issues in design of Intelligent Search Algorithms.	
UNIT II	**10 hours**
Knowledge Representation: Knowledge Representation using predicate logic, Rule Based Systems, Ontology, WordNet and Concept Net as Knowledge representation tools. Programming with Prolog/Lisp, Relationship of languages with knowledge representation and inferences.	
UNIT III	**12 hours**
Decision Making in Uncertainty: Handling Uncertainty, Probabilistic Reasoning, Fuzzy Logic, Learning by induction, Introduction to Neural Network Genetic Algorithms basics. Rough Sets. Case Studies of Applications of Uncertainty.	
UNIT IV	**10 hours**
Real World Applications of AI: Expert System Architecture, Case Studies: MYCIN, Applications in NLP, Medical Sciences, Social Network Analysis, Information Retrieval from Search Engines and Metasearch Engines, IoT Applications & Big Data Analytics Applications.	

Text Books	
1	E. Rich and K. Knight, “Artificial Intelligence”, McGraw Hill Education; 3rd edition, 2017 (latest edition).
2	P.H. Winston, “Artificial Intelligence”, Pearson Education, 3rd Edition, 2002 (latest edition).
Reference Books	
1	S. J. Russell and P. Norvig, “Artificial Intelligence- A Modern Approach”, Pearson 3rd Edition, 2010 (latest edition).
2	N.J. Nilsson, “Principles of Artificial Intelligence”, Narosa Publ. House, 2002 (latest edition).
3	L. Luger,“Artificial Intelligence : Structures and Strategies for Complex Problem Solving”, Pearson Education, 5th Edition, 2008 (latest edition).
4	E. Kumar, “Artificial Intelligence”, Dreamtech Press, 2020 (latest edition).

VLSI Design	
Course Code: BEC-306 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:**6

Introduction: The course will introduce the fundamental principles of analog and digital electronics. The course provides sufficient basic knowledge for the undergraduate to understand the design of diodes transistor-based circuits, op-amps and their applications as well as the design of digital circuits.

Course Objective:

- Study the fundamentals of MOSFET circuits and its characteristics.
- Learn the design and realization of combinational & sequential digital circuits using MOSFET.

Pre-requisite: Basic concept of transistor and logic, Student should have the prior knowledge of semiconductor electronics.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand basics of MOSFET family devices.
CO2: Understand and apply various applications of MOSFET.
CO3: Analyze logic processes and implement logical operations using MOS/CMOS combinational logic circuits.
CO4: Design circuits for VLSI projects.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Evolution of VLSI technology trends in VLSI, MOS transistor theory, MOS structure, enhancement & depletion transistor, threshold voltage, MOS device design equations, MOSFET scaling and small geometry effects, MOSFET capacitances, transconductance, figure of merit. MOSFE Transistors SPICE MODEL, Level 1, 2 and 3. Fabrication of MOSFET, CMOS fabrication process steps, isolation, latchup, twin well process, triple well process.	
UNIT-II	**10 Hours**
MOS inverter, resistive and active load, CMOS inverter design, DC characteristics, switching characteristics, rise time, fall time delays, noise margin, CMOS Inverter design with delay constraints, Interconnect parasitics and Delay, static & dynamic power dissipation in CMOS inverters. Combinational MOS/CMOS logic implementation, pass transistor and transmission gate designs, tristate buffers, cascaded inverters and super buffers.	
UNIT-III	**10 Hours**
Sequential MOS/CMOS logic circuits: SR latch, clocked latch and flip flop circuits, CMOS D latch and edge triggered flip flop, dynamic logic circuits; basic principle, synchronous dynamic circuit techniques, shift register, domino CMOS logic, high performance dynamic CMOS circuits, clocking issues, clock distribution. Introduction to Semiconductor memories.	

UNIT-IV	10 Hours
Introduction to BiCMOS Logic circuits, Static Behavior, Switching in BiCMOS Logic Circuits, BiCMOS Applications.CMOS chip design, design strategies, design flow, design Hierarchy, concept of regularity, modularity & locality, Chip design using programmable logic, testing. Introduction to Layout and design rules. CMOS and SOI Technology.	

Text Books	
1	S. M. Kang, Y. Lebiebici, “CMOS digital integrated circuits analysis & design” Tata McGraw Hill 4th Edition, 2019 (latest edition).
2	N. Weste and D. Harris, "CMOS VLSI Design: A Circuits and Systems Perspective - 4th Edition", Pearson Education, India, 2011 (latest edition).
3	P.A. Douglas, E. Kamran, “Basic VLSI Design”, PHI Learning Pvt. Limited,2013/latest edition.
Reference Books	
1	K. Martin, “Digital Integrated Circuit Design”, Oxford University Press, Indian Edition 2014 (latest edition).
2	J. M. Rabaey, “Digital Integrated Circuits” PHI Learning Pvt Limited, India, 2nd Edition 2016 (latest edition).
3	J. P. Uyemura, “Introduction to VLSI Circuits and Systems”, John Wiley & Sons, Inc., New York, NY, 2010 (latest edition).

Microprocessors & Microcontrollers	
Course Code: BEC-308 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 6

Introduction: Microprocessors are used extensively in the design of any computing facility. It contains units to carry out arithmetic and logic calculations, fast storage in terms of registers and associated control logic to get instructions from memory and execute them. A number of devices can be interfaced with them to develop a complete system application. On the other hand, microcontrollers are single chip computers, integrating processor, memory and other peripheral modules into a single System-on-Chip (SoC). Apart from input-output ports, the peripherals often include timers, data converters, communication modules, and so on. The single chip solution makes the footprint of the computational element small in the overall system package, eliminating the necessity of additional chips on board. However, there exists a large range of such products. This course will also introduce advanced microcontrollers and advanced microprocessors.

Course Objective:

- To understand the Architecture of 8086 microprocessor.
- To learn the design aspects of I/O and Memory Interfacing circuits.
- To interface microprocessors with supporting chips.
- To study the architecture of 8051 microcontroller as well as advance processors.
- To design a microcontroller-based system

Pre-requisite: Basic concept Digital design, Digital Logic.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand and execute programs based on 8086 microprocessors.
CO2: Design Memory Interfacing circuits.
CO3: Design and interface I/O circuits.
CO4: Design and implement 8051 microcontroller-based systems.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction to microprocessor, Basic of 8-bit microprocessor (8085): Architecture, Instruction set, Addressing modes. Introduction to 8086 Microprocessor and its architecture, **8086 System Bus Architecture,** memory organization.	

UNIT-II	10 Hours
Addressing modes, Instruction set and assembler directives, Interrupts and interrupt service routines, Byte and String Manipulation, System design using 8086, I/O programming. Introduction to Multiprogramming, System Bus Structure, Multiprocessor configurations, Coprocessor, Closely coupled and loosely Coupled configurations.	
UNIT-III	**12 Hours**
Introduction to 8051, Addressing Modes, Instruction Set, Assembly Language Programming and C Programming, Peripheral devices: Parallel Peripheral Interface (8255), A/D & D/A Interface, Timer / Counter (8253), Keyboard and Display Controller (8279), Serial data transfer (USART 8251), Interrupt Controller (8259), DMA Controller (8237), DAC and ADC interfacing and applications, Alphanumeric displays, LCD, Graphic Displays, Communication Bus protocols: RS 232, RS 485.	
UNIT-IV	**10 Hours**
Introduction to 80186/80286, Introduction to Advanced microcontrollers: High performance CISC architecture: Pentium CPU architecture. High Performance RISC architecture: ARM Core & Architectures. PIC microcontroller: CPU Architecture, Interrupts, Timers, I2C Interfacing.	

Text Books	
1	R. Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", Prentice Hall, 2014 (latest edition).
2	M.A. Mazidi, R.D. McKinlay, J.G. Mazidi, "The 8051 Microcontroller: A Systems Approach", Pearson, 2013 (latest edition).
Reference Books	
1	M.Bates, "PIC Microcontrollers", Newnes, 2011 (latest edition).
2	W.A. Smith, "ARM Microcontroller Interfacing: Hardware and Software, Eketor, 2010 (latest edition).
3	B. B. Brey, "The Intel Microprocessor 8086/8088. 80186, 80286, 80386 and 80486 Architecture Programming and Interfacing", PHI 2009 (latest edition).

Random Signals & Processes	
Course Code: BEC-309 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 5

Introduction: The course will introduce fundamentals and principles of random signals and stochastic processes. Students are able to apply the tools needed to analyze systems involving random signal and be able to improve their skills in analyzing random phenomena which occur in Electronics and Communication Engineering application.

Course Objective:

- To introduce student to the fundamentals and principles of random signals and stochastic processes.
- To provide students the tools needed to analyze systems involving random signals.
- To improve their skills in analyzing random phenomena which occur in Electronics and Communication Engineering application.

Pre-requisite: Introduction to Probability: Sets and set operations, probability space, conditional probability and Bayes theorem, combinatorial probability and sampling models.

Course Outcomes: After completion of the course, student will be able to:

CO1: Understand the axiomatic formulation of modern Probability Theory and think of random variables as an intrinsic need for the analysis of random phenomena.
CO2: Evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits.
CO3: Understand the concept of random processes and determine covariance and spectral density of stationary random processes.
CO4: Demonstrate the specific applications to Poisson and Gaussian processes and representation of low pass and band pass noise models.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Definition of a random variable (discrete and continuous), distribution of a random variable (cdf and pdf), commonly used random variables, Joint density of two or more random variables and their properties, random vectors, Conditional distribution/density, Bayes' rule for pdfs, chain rule	

for densities, Independence of random variables, Functions of random variables. Two functions of two random variables (and deriving their joint density), Order statistics, Mean, variance and other moments. Conditional Mean. Covariance, correlation coefficient, Markov inequality, Chebyshev inequality, and Chernoff bound, Joint moments, covariance matrices. Characteristic function, Moment Generating Function, Probability Generating Function.	
UNIT-II	**10 Hours**
Convergence of random variables (almost surely, rth mean, in probability, in distribution), Law of large numbers (Weak and Strong) and Central Limit Theorem, Convergence of Binomial Distribution to Poisson, Bivariate Normal random variables, Multivariate Normal Random Variables, PDF, Covariance Matrix, Characteristic Function, and properties, Transformation of Correlated Random variables into Uncorrelated ones. Discrete-time Markov Chains, definitions, examples: Time-homegenous Markov Chains, Transition probability matrix. Recurrence time, transient and recurrent states, classification of states (open, closed).	
UNIT-III	**10 Hours**
Random processes, definitions, mean, auto-correlation, and auto-covariance function. First and higher order density of random processes, Independent and Stationary Increments Property. Gaussian random process, Brownian motion, Counting processes and Poisson Process. Strict Sense Stationarity, Wide Sense Stationarity, Ergodic random process, Cross-correlation and cross-covariance, Cyclo-stationary processes.	
UNIT-IV	**10 Hours**
Random processes in linear systems. WSS processes in LTI systems, Power Spectral Density, Properties, Discrete Random Processes in LTI systems. Ergodicity, mean ergodicity, ergodicity with respect to the first and second order density function, Wiener Filtering, and its general solution. Statement of the causal linear Wiener Filtering Problem, Wiener –Hopf equations. Causal functions and spectral factorization, Spectral factorization cont'd. Multiplicative decomposition. Solution of the causal Wiener Filtering problem for rational PSD's.	

Text Books	
1	A Papoulis, S. U. Pillai, "Probability, Random Variables and Stochastic Processes", McGraw Hill, 2017 (latest edition).
2	H. Stark, J. W. Woods, "Probability and Random Processes with applications to Signal Processing", Pearson Education, 2002 (latest edition).
Reference Books	
1	R.Gallager, "Stochastic Processes:Theory for Applications",Cambridge University Press, 2013 (latest edition).
2	A. L. Garcia, "Probability and Random Processes for Electrical Engineering", Prentice Hall, 3rd Edition, 2008 (latest edition).
3	C.W.Helstrom, "Probability and Stochastic Processes for Engineers",Prentice Hall, 3rd Edition, 2004 (latest edition).
4	V. Veerarajan, "Probability, Statistics and Random Processes", Tata McGraw-Hill Education, 2008 (latest edition).

Advanced Computer Architecture	
Course Code: BCS 307 **Contact Hours:** L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:** 5

Introduction: This course provides the complete description about the advancements in Computer Architecture. After exploiting the full capacity of execution of uniprocessor system, the speed is enhanced with using multiprocessor and other concepts like pipelining. The algorithms also need to be parallelized for achieving highest speed. This course aims at teaching the complete concepts about the changes in bus system, , memory, placements and interconnection of different processors etc.

Course Objective:

- To make students know about the Parallelism concepts in Programming.
- To give the students an elaborate idea about the different memory systems and buses.
- To introduce the advanced processor architectures to the students.
- To make the students know about the importance of multiprocessor and multi computers.
- To study about data flow computer architectures

Pre-requisite: A course on computer organization, microprocessor, and computer architecture

Course Outcomes: The students will be able to

CO1: Understand the concept of highest achievable computing speed in uniprocessor system
CO2: Acknowledge the concept of pipelining, parallelism etc for achieving higher speed.
CO3: Understand different architectures of multiprocessor systems.
CO4: Understand the concepts of parallel algorithms and parallel programming

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Introduction & Fundamentals: The concept of computer Architecture: Interpretation of concept of computer architecture at different level abstraction, Multi-level hierarchical frame work, description of computer architecture, Introduction to parallel processing: Basic concept, types of level of parallelism, classification of parallel architecture, Basic parallel techniques, relationship between language and parallel architecture. Principles of scalable performance: Performance Metrics and Measures, Speedup Performance Law, Scalability Analysis & approaches, Processor and memory hierarchy: Design Space of Processor, ISA, CISC & RISC, Memory Hierarchy Technology, Virtual Memory Technology.	
UNIT-II	**10 Hours**

Instruction Level Parallel Processor (Parallelism): Pipelined Processors: Basic concept, ILP: Basics, Exploiting ILP, Limits on ILP, design space of pipelines, performance of pipeline, reservation table, And DLX Case Study. VLIW architecture, Superscalar Processor: Super Scalar and super-pipeline Design, A case study of ARM 64-bit processor.		
UNIT-III		**12 Hours**
Data parallel Architecture and MIMD architectures: SIMD Architecture: Design space, fine grain SIMD architecture, coarse grain SIMD architecture, Associative and Neural Architecture, Systolic Architecture, Vector Architectures: Word length, vectorization, pipelining, and vector instruction format. **Thread and Process Level Parallel Architecture (MIMD Architecture)** Multi-threaded Architecture: Design space, computational model, Data flow architecture, hybrid multi shared architecture Distributed memory MIMD, Architecture: Design space, interconnection networks, topology, fine grain system, medium grain system, coarse grain system, Cache Coherence and synchronization Mechanism Shared memory MIMD Architecture.		
UNIT-IV		10 Hours
Parallel Algorithm and Programming: MPI: Basics of MPI Open MP: Open MP Implementation in 'C', Directives: Conditional Compilation, Internal Control Variables, Parallel Construct, Work Sharing Constructs, Combined Parallel Work-Sharing constructs, Master and Synchronization Constructs POSIX thread: IEEE POSIX Threads: Creating and Exiting Threads, Simultaneous Execution of threads.		
Text Books		
1	D. SIma, T. Fountain, P. Karsuk , "Advanced Computer Architectures: A Design Space Approach", Pearson Education India; 1st edition, 2002 (latest edition).	
2	K. Hwang, N. Jotwani , "Advance Computer Architecture : Parallelism, Scalability, Programmability", McGraw Hill Education; 3rd edition, 2017 (latest edition).	
Reference Books		
1.	Quinn, "Parallel Programming in C with MPI and Open MP", McGraw Hill Education; 1st edition, 2017 (latest edition).	
2.	J. P. Hayes, "Computer Architecture and Organization", McGraw Hill Education; 3rd edition, 2017 (latest edition).	
3.	J. L. Hennessy and D. A. Patterson, "Computer Architecture: A Quantitative Approach", Elsevier; Fifth edition, 2012 (latest edition).	

Internet of Things	
Course Code: BIT 310 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 6

Introduction: Internet of Things (IoT) is the next big idea in technology and has gained prominence with the ever- increasing connected devices, sensor systems and capability of computing resources. This course is designed to initiate the widest possible group of students to the field of IoT and will be comprehensive in its scope. This course supplies in-depth content that puts the theory into practice. The course will start with a basic introduction to IoT and take the students through an IoT solution case study.

Course Objective:

- To impart an understanding of various building blocks and working of state-of-the-art IoT systems.
- To learn the basic issues, policy and challenges in the Internet and understand the cloud and internet environment.
- To design and program own IoT devices by using real IoT communication protocols.
- To analyze the data generated from the IoT devices.

Pre-requisite: Design and Analysis of Algorithms, Data Structures and Algorithms and Computer Networks.

Course Outcomes:

CO1: Develop smart IoT Applications using smart sensor devices and cloud systems.
CO2: Analyze the protocol Stack for IoT in order to address the issues related to heterogeneous devices and networks.
CO3: Design IoT system specific secure protocols.
CO4: Understand uses and risks related to IoT devices.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based resources as well as flipped class room teaching will be adopted.

Contents

UNIT I	10 hours
Introduction: Definition, Functional requirements, Characteristics, Foundations, architectures, challenges and issues, Physical design of IoT, Logical design of IoT, Web 3.0 of IoT, IoT World Forum (IoTWF) and Alternative IoT models, IoT Communication Models, IoT in Global Context, Real world scenarios, Different Areas, Examples Trends in the Adaption of the IoT (Cloud Computing, Big Data Analytics, Concepts of Web of Things, Concept of Cloud of Things with emphasis on Mobile Cloud Computing, Smart Objects).	
UNIT II	**10 hours**
Components in IoT: Control Units, Sensors, Communication modules, Power Sources, Communication Technologies, RFID, Bluetooth, Zigbee, Wi-fi, RF links, Mobile Internet, Wired Communication**; IoT Protocol and Technology:** RFID, NFC, Wireless Networks, WSN, RTLS, GPS, Agents, Multi – Agent Systems, IoT Protocols: M2M, BacNet, ModBus, Bluetooth, Wi-Fi,	

ZigBee; **Web of Things (WoT):** WoT vs. IoT, Architecture; **Cloud of Things (CoT):** Grid/SOA and Cloud Computing, Standards, Cloud Providers and Systems, Architecture.		
UNIT III		**10 hours**
Data Analytics for IoT: Introduction, Machine Learning, Big Data Analytics Tools and Technology, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Apache Kafka, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, Using Apache Storm for Real-time Data Analysis, Structural Health Monitoring Case Study, **Tools for IoT**: Chef, Chef Case Studies, Puppet, Puppet Case Study – Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator.		
UNIT IV		**10 hours**
Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Smart Homes, Ambient Assisted Living, Intelligent Transport, Other IoT application: Use-Case Examples; **Developing IoT solutions**: Introduction to Python, Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi Implementation of IoT with Arduino and Raspberry, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.		
Text Books		
1	A. Bahga, V. Madisetti, "Internet of Things: A Hands-on Approach", 1st Edition, Universities Press, 2015 (latest edition).	
2	R. Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education private limited, 2017 (latest edition).	
Reference Material		
1	D. Uckelmann, M. Harrison, "Architecting the Internet of Things", 1st Edition, Springer, 2011 (latest edition).	
2	O. Hersent, D. Boswarthick, O. Elloumi, "The Internet of Things – Key applications and Protocols", 2nd Edition, Wiley, 2012 (latest edition).	
3	Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", 1st Edition, CRC Press, 2015 (latest edition).	
4	Edureka, Internet of Things - IoT Tutorial for Beginners. 2021. [video] Youtube. Available : https://www.youtube.com/watch?v=LlhmzVL5bm8&list=PL9ooVrP1hQOGccfBbP5tJWZ1hv5sIUWJl	

ANTENNA DESIGN	
Course Code: BEC-312 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:**6

Introduction: The course will introduce the basic essentials of antenna and apply them in the analysis and design basics of antennas. Starting from the basic antenna parameters, the course will discuss various types of antennas such as array antennas, loop antenna, horn antenna and Micro strip Antennas etc. It also covers the fundamentals of wave propagation.

Course Objective:

- To familiarize with the fundamental principles of antenna theory
- To develop understanding of antenna concepts and practical antenna design for various applications
- To develop underlying concepts of wave propagation

Pre-requisite: Basic concepts of electromagnetic field theory, Knowledge of differential and integral calculus

Course Outcome: After completion of the course, student will be able to:

CO1: Understand antenna fundamentals and basic concepts of radiation mechanism of an antenna
CO2: Design different types of basic antennas.
CO3: To apply the different feeding technique.
CO4: Analyze the concept of wave propagation mechanism

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Antenna fundamental: Introduction, field & power pattern, Near field and far field radiation pattern, beam area, radiation intensity, beam efficiency, directivity and gain, antenna aperture, effective height, radiation resistance, antenna impedance, antenna temperature, signal to noise ratio, from oscillating dipole, Far Field due to an alternating current element, Power radiated by a current element.	
UNIT-II	**10 Hours**
Antenna Design: Point Source, Power Theorem and its Application to an Isotropic Source, Electric dipoles, The short electric dipole, Fields of a short dipole, Radiation resistance of short electric dipole, Thin linear antenna, Radiation resistance of λ/2 antenna, Half wave dipole, quarter wave monopole, Array Antenna, Array of two driven λ/2 elements: Broadside case and end-fire case.	
UNIT-III	**10 Hours**
Yagi-Uda antenna design: Design and its Characteristic Properties, Applications, Field pattern Loop Antennas: Design and its Characteristic Properties, Applications, Horn Antennas, Helical Antennas, The Log-Periodic Antenna, Micro strip Antennas, Long wire antennas, Folded dipole antennas.	

UNIT-IV		10 Hours
Wave Propagation: Ground Wave Propagation: Plane Earth Reflection, Space Wave and Surface Wave Space Wave Propagation: Introduction, Field Strength Relation, Effects of Imperfect Earth Sky wave Propagation: Introduction structural details of the ionosphere, Wave Propagation Mechanism, Refraction and Reflection of Sky Waves by ionosphere, Critical Frequency, MUF, LUF, OF, Virtual Height and Skip Distance, Relation Between MUF and the Skip Distance, Multi-Hop Propagation.		
Text Books		
1	J. D. Kraus, R. J Marhefka, A. S. Khan, “Antennas and Wave Propagation”, Vth Edition, Tata McGraw Hill, 2019 (latest edition).	
2	C. A. Balanis, "Antenna Theory Analysis and Design", IVth Edition, John Wiley, 2016 (latest edition).	
Reference Books		
1	M. Sadiku, “Elements of Electromagnetic’, VIIth Edition, Oxford University Press, 2020 (latest edition).	
2	W.H. Hayt, J.A. Buck and M.Jaleel Akhtar, “Engineering Electromagnetic”, IXth Edition, McGraw- Hill Education, 2013 (latest edition).	
3	A. R. Harish, M. Sachidananda, “Antennas and Wave Propagation”, Oxford University Press, 2007 (latest edition).	
4	R.L. Yadava, Electromagnetic Waves, Khanna Publishing House, Delhi, 2018 (latest edition).	
5	K.D. Prasad, “Antennas and Wave Propagation”, Satya Prakashan, Tech India Publications, New Delhi-2019 (latest edition).	

FPGA & VERIFICATION	
Course Code: BEC-314 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 6

Introduction: This course covers the systematic design of advanced digital systems using Field-Programmable Gate Arrays (FPGAs). The emphasis is on top-down design starting with a software application, and translating it to high-level models using a hardware description language (such as VHDL or Verilog). The course will focus on design for high-performance computing applications using streaming architectures. The basic building blocks of FPGA programming are discussed followed by review of architecture, design methodologies, best design practices, and optimization techniques for performance (frequency, latency, area, power, etc). Finally, simulation for bit-true design verification, SoC Design Flow and demonstration of hardware by different acceleration and emulation techniques has been covered.

Course Objective:

- To know FPGA architecture, technologies and FPGA's implementation methodologies.
- To understand configuring and implementing digital embedded system, microcontrollers, microprocessors, DSP algorithm on FPGA.
- To utilize techniques and technology for efficient circuit verification.
- To introduce the concepts of Verification techniques, UML and considerations
  To demonstrate the hardware acceleration and emulation techniques

Pre-requisite: Concepts of digital system design and behavior modelling of a system, Basics of Verilog and VHDL, FPGA architecture and its technologies, Knowledge of sequential and combinational circuits.

Course Outcome: After completion of the course, student will be able to:

CO1: Demonstrate VLSI tool-flow and appreciate FPGA architecture

CO2: Understand the basics of system on chip and on chip communication architectures.

CO3: Understand the issues involved in ASIC design, including technology choice, design management, tool flow.

CO4: Able to verify digital circuits for design errors.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
FPGA Design Environment: Introduction, Scripting Environment, Interaction with Version Control Software, A Regression Test System, Common Tools in the FPGA Design Environment, challenges that FPGAs Create for Board Design, Engineering Roles and Responsibilities, FPGA Engineers, Design Flows for Creating the FPGA Pinout, Board Design Check List for a Successful	

FPGA Pin-Out. Power Analysis and RTL Design: Introduction, Power Basic, Key Factors in Accurate Power Estimation, Power Estimation Early in the Design Cycle, Simulation Based Power Estimation, Best Practices for Power Estimation, Recommendations for Engineers with an ASIC Design Background, Writing Effective HDL, Analyzing the RTL Design.	
UNIT-II	**10 Hours**
Design and Verification Languages: Introduction, History, Design Languages, Verification Languages. Digital Simulation: Introduction, Event vs Process-Oriented Simulation, Logic Simulation Methods and Algorithms, Impact of Languages on Logic simulation, Logic Simulation Techniques, Impact of HVLs on simulation, Summary.	
UNIT-III	**10 Hours**
Using Transactional-Level Models in a SoC Design Flow: Introduction, Overview of the System-to-RTL Design Flow, TLM —View for the Design Flow, TLM Modeling Application Programming Interface, Example of a Multimedia Platform, Design Flow Automation, Conclusion.	
UNIT-IV	**10 Hours**
Hardware Acceleration and Emulation: Introduction, Emulator Architecture Overview, Design Modeling, Debugging, Use Models, The Value of In-Circuit Emulation, Considerations for Successful Emulation	

Text Books	
1.	D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, “Embedded System Design: Modeling, Synthesis and Verification”, Springer, 2009 (latest edition).
2.	G. De Micheli, “Synthesis and Optimization of Digital Circuits”, McGraw Inc (latest edition).

Reference Books	
1.	L.Scheffer, L.Lavagno, G. Martin, “EDA for IC System Design, Verification, and Testing”, Taylor & Francis, 2006 (latest edition).
2.	E. Seligman, T. Schubert, “Formal Verification: An Essential Toolkit for Modern VLSI Design”, Elsevier Inc., 2015 (latest edition).
3.	M. Fujita, I. Ghosh, and M. Prasad, and Morgan Kaufman, “Verification Tec/latest edition. Techniques for System-Level Design”, Published in The Morgan Kaufmann series, 2008 (latest edition)

Power Electronics	
Course Code: BEC-316 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 5

Introduction: The course will introduce fundamental principles, concept of power electronics, application of power electronics, uncontrolled converters, advantages and disadvantages of power electronics converters, power electronics systems, power diodes, power transistors, power MOSFETS, IGBT and GTO. The course provides sufficient basic knowledge for the undergraduate to understand the design of converters, AC controllers, Thyristors and their applications.

Course Objective:

- To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.
- To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
- To provide strong foundation for further study of power electronic circuits and systems.

Pre-requisite: Basic Electronics, Student should have the prior knowledge of semiconductor electronics Circuit Theory.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand the basic semiconductor physics to properties of power devices, and combine circuit mathematics and characteristics of linear and non-linear devices.
CO2: Understand basic operation and compare performance of various power semiconductor devices, passive components and switching circuits
CO3: Design and Analyze power converter circuits and learn to select suitable power electronic devices by assessing the requirements of application fields.
CO4: Recognize the role power electronics play in the improvement of energy usage efficiency and the applications of power electronics in emerging areas.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	**12 Hours**
Power Electronic Devices: Construction, Principle of operation, Static and dynamic characteristics of Power diodes, SCR, TRIAC, GTO, power BJT, power MOSFET and IGBT, Safe operating Area, Protection circuits- series and parallel connections.	
UNIT-II	**10 Hours**

AC TO DC Converters: Single phase and three phase-controlled rectifiers (half and full converters) with R, RL and RLE load, Estimation of RMS load voltage, RMS load current and input power factor, effect of source inductance and firing circuits, Single phase and three phase dual converters.		
	UNIT-III	**11 Hours**
DC TO DC Converters: Principle of step up and stepdown operation, single quadrant DC chopper with R, RL and RLE load, Time ratio control, Estimation of average load voltage and load current for continuous current operation- two quadrant and four quadrant DC choppers, Voltage, current and load-commutated choppers.		
	UNIT-IV	**11 Hours**
DC TO AC Converters & AC TO AC Converters: Inverters- Types- Voltage source and current source inverters, single phase bridge inverters, three phase bridge inverters, PWM inverters, Series inverter control of AC output voltage, Harmonic reduction, AC voltage regulator, step up and step down cycloconverter, three phase to single phase cyclo convertor and three phase to three phase cyclo convertor.		

Text Books	
1	M. H. Rashid, “Power Electronics - Circuits Devices and Applications,” 4th Edition, Pearson Education, 2014 (latest edition).
2	P. C. Sen, “Power Electronics,” Tata Mc Graw Hill Education, 12th Edition, 2011/latest edition.
Reference Books	
1	M. D. Singh and K. Kanchandani, “Power Electronics,” Tata McGraw-Hill & Hill Publication Company Ltd, 2008 (latest edition).
2	J.Vithayathil, “Power Electronics,” McGraw Hill series in Electrical and Computer Engineering, USA, 1995 (latest edition).
3	U. Loganathan, “Power Electronics,” Wiley India Pvt. Limited, 2009 (latest edition).
3	P. S. Bhimbra, “Power Electronics,” Khanna publishers, 2018 (latest edition).

Cloud Computing	
Course Code: BIT 304 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 6

Introduction: Cloud computing is a scalable services provider platform that provides on-demand and pay per use computing service for various types of shared pool of resources such as memory, servers, storage, networking, software, database, applications designing etc., with the help of the internet. This course will introduce various aspects of cloud computing including fundamentals of cloud computing, load balancing techniques, security challenges, case studies and industrial applications of cloud computing. This will help students to use and explore the cloud computing platforms.

Course Objective:

- To learn how to use Cloud Services and Cloud Deployment models.
- To learn how to use the concept of virtualization in cloud computing.
- To learn resource management and load balancing algorithms.
- To provide basic concepts of security attacks and their provisions at various levels of cloud computing.

Pre-requisite: Basic understanding of Operating System, Internet, Parallel and Distributed Computing.

Course Outcome: Upon successful completion of this course, students will be able to:

CO1: Understand the key dimensions of Cloud Computing.
CO2: Analyze the trade-off between deploying applications in the cloud and over the local infrastructure.
CO3: Compare the advantages and disadvantages of various cloud computing platforms.
CO4: Identify security and privacy issues in cloud computing.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT I	10 hours
Cloud Computing Fundamentals: Introduction of cloud computing, History of cloud computing, Trends in Computing, Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Fog Computing, NIST definition of cloud computing, properties and characteristics of cloud computing, Cloud as green and smart, Cloud as IaaS, PaaS, SaaS, BPaaS, HaaS, SPI framework, SPI vs. traditional IT Model, Cloud Deployment models, Benefits and Challenges.	
UNIT II	**10 hours**
Virtualization and Cloud Architecture: Virtualization concept, Resource Virtualization, Server virtualization, Storage virtualization, Network virtualization, Storage models, Storage Network Design: Architecture of storage, Analysis and planning, Cloud Optimized Storage, Virtual Box and Microsoft Hyper-V.	
UNIT III	**10 hours**
Cloud Security: Web services, Web 2.0, Web OS, Security challenges and approaches (Infrastructure security, Network level security, Host level security, Application-level security), Resource	

management in cloud computing, Static and dynamic load balancing in cloud computing, Identity access management and Trust in cloud computing, Thin client, Security models in cloud.		
UNIT IV		**10 hours**
Cloud providers and case studies: Amazon EC2, Amazon EC service level agreement, Recent developments, Benefits, GoGrid, Salesforce.com, Force.com, Google App Engine, Rackspace, Government of India Cloud, IBM cloud, eucalyptus cloud, How to decide if the cloud is right for your requirements, Analysis of Case Studies when deciding to adopt cloud computing architecture.		
Text Books		
1	B. Sosinsky, "Cloud Computing Bible", 1st Edition, Wiley-India, 2011 (latest edition).	
2	R. Buyya, C. Vecchiola, and S. T. Selvi, "Mastering cloud computing: foundations and applications programming",1st Edition, Newnes, 2013 (latest edition).	
Reference Material		
1	A.Shawish and M. Salama, "Cloud computing: paradigms and technologies." In Inter-cooperative collective intelligence: Techniques and applications, pp. 39-67. Springer, Berlin, Heidelberg, 2014 (latest edition).	
2	M. Miller, "Cloud Computing: Web-Based Applications That Change the Way YouWork and Collaborate Online", 1st Edition, Pearson Education India , 2008 (latest edition).	
3	https://swayam.gov.in/course/4413-cloud-computing	
4	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs20/	

PRINCIPLES OF MANAGEMENT	
Course Code: HMC-302 **Contact Hours:** L-2 T-0 P-0 **Course Category:** HMC	**Credits:** 2 **Semester:** 6

Introduction: To give a preview of basics of management to engineering students, this course discusses about the basic nature of management and describes the functions of management, the specific roles of contemporary management, and different approaches to designing organizational structures. This will help the students to understand the role of personality, learning and emotions at work, discover and understand the concept of motivation, leadership, power and conflict, understand the foundations of group behavior and the framework for organizational change and development.

Course Objectives:

- To acquaint the students with the fundamentals of managing business
- To make them understand individual and group behavior at workplace so as to improve the effectiveness of an organization.
- The course will use and focus on Indian experiences, approaches and cases.

Pre-requisite: Self-paced course.

Course Outcomes: After completion of the course, the students should be able to:

CO1: Understand the nature of management and describe the functions of management·

CO2: Understand the role of personality, learning and emotions at work.

CO3: Understand the foundations of group behavior and the framework for organizational change and development.

CO4: Develop an understanding of different approaches to designing organizational structures.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	7 Hours
Introduction: Concept, Nature, Process and Significance of Management; Managerial levels, Development of Management Thought: Classical, Neo-Classical, Behavioral, Systems and Contingency Approaches.	
UNIT-II	7 Hours
Planning: Nature, Scope and Objectives of Planning; Types of plans; Planning Process; Organizing: Nature, Process and Significance; Principles of an Organization; Span of Control; Types of an Organization.	
UNIT-III	7 Hours
Staffing: Concept, Nature and Importance of Staffing. Motivating and Leading: Nature and Importance of Motivation; Types of Motivation; Leadership: Meaning and Importance; Traits of a	

leader.		
UNIT IV		7 Hours
Controlling: Nature and Scope of Control; Types of Control; Control Process; Control Techniques– Traditional and Modern; Effective Control System.		
Text Books		
1	S.P. Robbins, "Fundamentals Management: Essentials Concepts Applications", Pearson Education, 2014 (latest edition).	
2	Gilbert, J.A.F. Stoner and R.E. Freeman, "Management", Pearson Education, 2014. H. Koontz, "Essentials of Management", McGraw Hill Education, 2012 (latest edition).	
3	C. B. Gupta, "Management Concepts and Practices", Sultan, latest edition.	
Reference Books		
1	W. Ghillyer, "Management- A Real World Approach", McGraw Hill Education, 2010 (latest edition).	
2	K. Mukherjee, "Principles of Management", McGraw Hill Education, 2012 (latest edition).	

MARKETING MANAGEMENT	
Course Code: HMC-304 **Contact Hours:** L-2 T-0 P-0 **Course Category:** HMC	**Credits:** 2 **Semester:** 6

Introduction - This course will build the basic concept of marketing and related concepts for the engineering students. It will provide an in-depth understanding to various elements of marketing mix for effective functioning of an organization. Students will learn some of the tools and techniques of marketing with focus on Indian experiences, approaches and cases.

Course Objectives:

- To familiarize students with the marketing function in organizations.
- To equip the students with understanding of the Marketing Mix elements and sensitize them to certain emerging issues in Marketing.

Pre-requisite: None

Course Outcomes: After completion of the course, the students should be able to

CO1: Understand the concept of marketing and related concepts.
CO2: An in-depth understanding to various elements marketing mix for effective functioning of an organization.
CO3: Understand the tools and techniques of marketing with focus on Indian experiences, approaches and cases.
CO4: To analyze and examine the implementation of marketing concepts and strategy to firms.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	7 Hours
Introduction to Marketing: Nature, Scope and Importance of Marketing, Basic concepts, Marketing Environment.	
UNIT-II	7 Hours
Product: Product Levels, Product Mix, Product Strategy, Product Development, Product Lifecycle and Product Mix Pricing Decisions.	
UNIT-III	7 Hours
Place: Meaning & importance, Types of Channels, Channels Strategies, Designing and Managing Marketing Channel.	
UNIT IV	7 Hours
Promotion: Promotion Mix, Push vs. Pull Strategy; Promotional Objectives, Advertising-Meaning and Importance, Types, Media Decisions, Promotion Mix, Personal Selling-Nature, Importance and	

Process.	
Text Books	
1	P. Kotler, P.Y. Agnihotri and E.U. Haque, “Principles of Marketing- A South Asian Perspective”, Pearson Education, 2012 (latest edition).
2	T. Ramaswamy and S. Namkumar, “Marketing Management Global Perspective: Indian Context”, McMillan, Delhi, 2013 (latest edition).
Reference Books	
1	R. Saxena, “Marketing Management”, (5th ed.) McGraw Hill Education, 2017 (latest edition).
2	C.W. Lamb, J.F. Hair, C. McDaniel, D. Sharma, “MKTG: a South Asian Perspective with Coursemate”,1/e edition Cengage Learning, 2016 (latest edition).
3	R. Winer, “Marketing Management” 4th edition Pearson Education, 2012 (latest edition).

FINANCIAL MANAGEMENT	
Course Code: HMC-306 **Contact Hours:** L-2 T-0 P-0 **Course Category:** HMC	**Credits:** 2 **Semester:** 6

Introduction: Efficient Management of a business enterprise is closely linked with the efficient management of its finances. Accordingly, the objective of the course is to familiarize the engineering students with the basic fundamentals, principles and practices of financial decision-making in a business unit in the context of a changing, challenging and competitive global economic environment. The purpose of the course is to offer the students relevant, systematic, efficient and actual knowledge of financial management that can be applied in practice while making financial decisions and resolving financial problems.

Course Objectives: The objective of the course is to acquaint the students with the overall framework of financial decision-making in a business unit.

- To acquaint the students with the fundamentals of Financial Management
- To make them understand Decisions to be taken as a Finance Manager.
- The course will use and focus on Indian experiences, approaches and cases.

Pre-requisite: None

Course Outcomes: Upon successful completion of the course, students will be able to:

CO1: Understand the overall role and importance of the finance function for decision-making.

CO2: Understand appropriate investment criteria and projecting cash flows associated with corporate project evaluation.

CO3: Analyze the complexities associated with management of cost of funds in the capital structure.

CO4: Apply the concepts of financial management to contemporary financial events.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	7 Hours
Financial Management Definition scope, objectives of Financial Management, Functions of a finance manager, Time value of money. Sources of Finance for different Organizations.	
UNIT-II	7 Hours
Capital Structure: Meaning of Capital Structure: Factors Determining Capital Structure. Cost of Capital: Concept, Importance and Classification.	
UNIT-III	7 Hours
Capital Budgeting: Concept, Importance and Appraisal Methods: Pay Back Period, Accounting, Rate	

of Return, Net Present Value Method (NPV), Profitability Index, and IRR. Capital Rationing.		
UNIT IV		7 Hours
Working Capital Management: Operating cycle, Working Capital Estimation, Inventory Management: EOQ Problem.		
Text Books		
1	M.Y. Khan and P.K. Jain, “Financial Management”, McGraw Hill Education, 8^{th} Edition, 2018 (latest edition).	
2	I. M. Pandey, “Financial Management”, Vikas Publishing House, 2015 (latest edition).	
Reference Books		
1	S. Kapil, “Financial Management”, Pearson Education, 2012 (latest edition).	
2	C. Prasanna, “Financial Management: Theory and Practice”, McGraw Hill,10th Ed. 2019 (latest edition).	
3	S.N. Maheshwari, “Financial Management: Principles and Practice”, Sultan Chand, LN, 2019 (latest edition).	

HUMAN RESOURCE MANAGEMENT	
Course Code: HMC-308 **Contact Hours**: L-2 T-0 P-0 **Course Category:** HMC	**Credits:** 2 **Semester:** 6

Introduction: This course focuses on issues and strategies required to select and develop manpower resources. The main objective of this course is to help the students to acquire and develop skill to design rational decisions in the discipline of human resource management.

Course Objective: The objective of this course is to make students familiar with the basic concepts of human resource management and people related issues.

- To enable the students to understand the HR Management and system at various levels in general and in certain specific industries or organizations.
- To help the students focus on and analyze the issues and strategies required to select and develop manpower resources.
- To develop relevant skills necessary for application in HR related issues.
- To enable the students to integrate the understanding of various HR concepts along with the domain concept in order to take correct business decisions.

Pre-requisite: Basic management knowledge

Course Outcomes: After completion of the course, the students should be able to:

CO1: Develop an understanding of the concept of human resource management and to understand its relevance in organizations.
CO2: Develop necessary skill set for application of various HR issues.
CO3: Analyze the strategic issues and strategies required to select and develop manpower resources.
CO4: Integrate the knowledge of HR concepts to take correct business decisions.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	7 Hours
Human Resource Management: Introduction to Concept and Functions of HRM, Role, Status and Competencies of HR Manager, HR Policies, Evolution of HRM. Emerging Challenges of Human Resource Management.	
UNIT-II	7 Hours
Human Resource Planning: Human Resource Planning- Quantitative and Qualitative dimensions; Recruitment – Concept and sources; (E-recruitment, recruitment process outsourcing etc.); Selection – Concept and process; test and interview; placement induction. Job analysis – job description and job specification.	
UNIT-III	7 Hours
Training and Development: Concept and Importance; Identifying Training and Development Needs; Designing Training Programs; Role Specific and Competency Based Training;	

Evaluating Training Effectiveness; Performance appraisal: nature and objectives; Modern Techniques of performance appraisal.		
UNIT IV		7 Hours
Human Resource Development: Orientation Program; Requisite of an effective Program, Evaluation of Orientation Program. Strategic HRM: HRD audit, ethics and CSR		
Text Books		
1	G. Dessler. “A Framework for Human Resource Management”, Pearson Education, 2017, 15th Edition (latest edition).	
2	D. A. Decenzo, S. P. Robbins, S. L. Verhulst, “Human Resource Management”, Wiley India Private Limited, 2015 (latest edition).	
Reference Books		
1	Bohlendar and Snell, “Principles of Human Resource Management”, Cengage Learning, 2013 (latest edition).	

PROFESSIONAL ETHICS AND HUMAN VALUES	
Course Code: HMC-301 **Contact Hours:** L-3 T-0 P-0 **Course Category:** HMC	**Credits:** 3 **Semester:** 5

Introduction: Values and Ethics are very relevant in today's environment of conflicts and stress in every profession, with obligations to be met by one person in many directions. A formal study will certainly improve one's ability and judgment and refine one's behavior, decisions, and actions in performing the duty to the family, organization, and to the society.

Course Objectives:

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and Loyalty
- To appreciate the rights of others.
- To create awareness on assessment of safety and risk

Pre-requisite: Basic ethics knowledge

Course Outcomes: After completion of the course, the students should be able to:

CO1: Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field Students turn themselves into champions of their lives.

CO2: Understand the multiple ethical interests at stake in a real-world situation or practice.

CO3: Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human.

CO4: Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	10 Hours
Human Values Morals, Values and Ethics, Integrity, Work Ethic, Respect for Others, Living Peacefully, Caring, Sharing, Honesty, Valuing Time, Co-operation, Commitment, Empathy, Self-Confidence, Character, Spirituality. Indian values (on the conceptual framework of Vedas): Purusharth, Niskama karma, Religion and Human Values, Towards a World Religion, Ethical Living and Harmony in Life.	
UNIT-II	11 Hours
Profession and Professionalism, Ethical Theories: Kohlberg's Theory, Gilligan's Theory, Feminist Consequentialism, Moral Dilemmas, Types of Enquiries, Uses of Ethical Theories, Engineering Profession, Engineering Professionals- Training, Skill Set, Life Skills, Engineering Ethics: Making Senses and Issues, Ethical Obligations of Engineers, Ethical Codes for Engineers.	

UNIT-III	10 Hours
Engineering as a Social Experimentation, Safety Responsibility and Rights: Engineering as experimentation, Engineers as responsible Experimenters, Concept of Safety and Risk, Engineer's Responsibility for Safety, Risk – Benefit Analysis, Case Studies: The challenger case study, The Three Mile Island, Fukushima Nuclear Disaster, Bhopal Gas Tragedy. Disaster Management, Professional Rights, Employee Rights, Intellectual Property Rights (IPRs), Human Rights and Human Responsibilities. Major Ethical Issues.	
UNIT IV	11 Hours
Ethics and Global Issues: Ethics in Global Scenario, Multinational corporations, Environmental ethics, computer ethics, Business Ethics. Corporate Social responsibility, Weapons Development, Research Ethics.	

Text Books	
1	M. Govindarajan, S. Natarajan, V.S. Senthil, "Engineering Ethics", Prentice Hall, New Delhi, 2004 (latest edition).
2	R. Subramaniam, "Professional Ethics", Oxford University Press, New Delhi, 2013 (Latest Edition).

Reference Books	
1	B.P. Banerjee, "Foundation of Ethics and Management", (2nd ed.) Excel Books, 2005 (latest edition).
2	C. Fleddermann, "Engineering Ethics", 4th Edition, Pearson Education. 2004 (latest edition).
3	C. Harris et al., "Engineering Ethics- Concepts and Cases", 4th Edition, Thompson Learning, 2008 (latest edition).
4	J.R. Boatright, "Ethics and the Conduct of Business", 8th Edition, Pearson Education, New Delhi, 2018 (latest edition).

Industrial Training/ Internship	
Course Code: BEC-353 **Contact Hours:** L-1 T-0 P-0 **Course Category:** DCC	**Credits:** 1 **Semester:** 5

Course Objectives: Students will carry on the industrial training for six weeks making them capable of handling the implementation of their theoretical knowledge in the practical field. To facilitate the development of a holistic perspective among students towards life, industry experts teach advanced technologies. Through Industrial training, students get familiarize with the environment of an organization and a company. Students get a certificate which validates their skills and helps them in getting a job quickly.

General Elective Course	
Course Code: GEC-301 **Contact Hours**: L-0 T-0 P-4 **Course Category**: GEC	**Credits:** 2 **Semester:** 5

Introduction: A Generic Elective (GE) course is an inter-disciplinary course provided to the students chosen generally from an unrelated discipline/subject and allowing them a chance at comprehensive education. Generic Electives (GE) are introduced as part of the CBCS. The students can choose their preference from a pool of papers from various disciplines/subjects. Elective courses do much more than filling in the gaps to fulfill the high school graduation requirements. It gives a chance to explore new options, allowing students to study more about the subject they are passionate about, and enables them to 'test drive' new activities. They provide students with the necessary skills to improve creativity that they might not find in the classroom. The main purpose of the Elective course is to seek exposure to a new discipline/subject and to provide the students with an alternative option for desired fields.

Course objective:

- Students will have exposure to a new discipline/subject.
- Prepare students to look for inter-disciplinary research.
- GE can fulfill the limitation to pursue master's study in desired field.
- Help discover new things that never existed and might change the course of student's life.

Pre-requisite: Basic knowledge of the selected domain of elective course

Course Outcome: After completion of the elective course, the students will be able to:

CO1: To investigate future careers.
CO2: Allow diligent students to improve their knowledge and area of weakness.
CO3: Help students build a strong resume that shows students willingness and curiosities to the officials and employers.
CO4: Electives take students into the real world that doesn't require academic papers or research. They not only learn to work independently, but they attain self-motivation, discipline, and confidence to achieve their goals.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

MICROWAVE TECHNIQUES	
Course Code: BEC-401 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:**7

Introduction: This Course explains various fundamentals and applications of microwave techniques.

Course Objective:

- To build up the concept from basics of microwave communications to modern applications
- Understand the fundamental concepts of microwave techniques.

Pre-requisite: Electronic Devices

Course Outcome: On completing this subject the student should be able to:

CO1: Qualitatively and quantitatively analyze microwave networks and measure their measurements parameters.

CO2: Identify the modern-day applications of microwaves

CO3: Analyze the radiation pattern of antenna

CO4: Analyze microwave transmission modes and transmission lines.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based sources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	**12 Hours**
History, Introduction and Applications of Microwaves, Review of Electromagnetic waves and Maxwell's Equations, Rectangular and Cylinder waveguides, Construction and wave propagation, Solution of wave equation, Modes in waveguide, Excitation of Modes, field patterns, propagation properties, Power transmission and Power losses, Components & Elements, S-parameters, Cavity resonators (Cylindrical and rectangular), Waveguide tees, Magic Tree, Hybrid tees, Hybrid couplers, waveguide corners, Joint, bends and twists, Irise and screws, short circuit, Attenuator, Directional couplers, Circulators, Isolators, Faraday's rotation, Phase shifter.	
UNIT-II	**10 Hours**
Klystron Amplifier, Reflex Klystron, Magnetron (cylindrical), Overview of TWT, CFA, M/W Solid state Device & MICS, M/W Bipolar Transistor, M/W FET, Varactor and Step Recovery Diodes, pin Diode, Schottky Diode, Parametric Amplifiers, Tunnel Diode, Gunn Diode, Read Diode, Impatt, Trapatt.	
UNIT-III	**10 Hours**
Introduction to MIC, Stripline and Microstrips, Introduction to fabrication of MICs, Introduction to Microwave Detectors, Mixers, Switches, Microwave Measurements, Measurements of frequency, power, attenuation, phase shift, VSWR, impedance, Introduction to Microwave filters.	
UNIT-IV	**10 Hours**
Single-section and multi-section Quarter wave transformer designs. Periodic structures filter design by the image parameter and insertion loss methods. Filter transformations, Richard's transformation, kuroda's identities, impedance and admittance inverters, step impedance low pass filters, coupled line band pass filter and its design. Introduction to Microwave application in various fields.	
Text Books	
1	S.Y. Liao, "Microwave Devices" Pearson, 3rd Edition, 1990 (Latest Edition).
2	Rizzi, "Microwave Engg. Passive Circuits", PHI, 2001 (Latest Edition).
3	David, M. Pozar, Microwave Engineering, Wiley India, (2012) (Latest Edition).
Reference Books	

1	Rao, “Microwave and Radar Engg.”, Pearson, 1st Edition, 2014 (Latest Edition).
2	Kulkarni, “Microwave & Radar Engg.” Umesh Publications, 2nd Edition. 2010 (Latest Edition).
3	Collin, R.E., Foundations for Microwave Engineering, IEEE Press (Latest Edition).

WIRELSS AND MOBILE COMMUNICATION	
Course Code: BEC-403 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:**7

Introduction: This Course explains various fundamentals and applications of wireless communication networks. A detailed discussion of channel design and case studies are also provided.

Course Objective:

- Understand the design and analysis of wireless Communication Links.
- Understand the fundamental concepts and techniques used in Advanced Mobile communication Networks.

Pre-requisite: Digital Communication

Course Outcome: On completing this subject the student should be able to:

CO1: Qualitatively and quantitatively analyze and evaluate mobile communication systems

CO2: Understand the new trends in mobile/wireless communications networks.

CO3: Analyze various routing algorithms used in mobile/wireless networks

CO4: Apply software tools to analyze, design and evaluate wireless communication systems

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	12 Hours
Evolution of mobile radio communication fundamentals. General Model of Wireless Communication Link, Types of Signals, Cellular Infrastructure, Cellular System Components, Antennas for Cellular Systems, Operation of Cellular Systems, Channel Assignment, Frequency reuse, Channel Assignment strategies, Handoff Strategies Cellular Interferences, Sectorization; Wireless Channel and Radio Communication, Free Space Propagation Model, Channel Noise and Losses, Fading in Land Mobile Systems, Multipath Fading, Fading Effects on Signal and Frequency, Shadowing; Wireless Channel Modelling: AWGN Channel, Rayleigh Channel, Rician Fading Channel, Nakagami Fading Channel, Okumura and Hata Path Loss Model; Channel Modelling: Stochastic, Flat Fading, Wideband Time- Dispersive Channel Modelling.	
UNIT-II	**10 Hours**
GSM system for mobile Telecommunication, General Packet Radio Service, Edge Technology; CDMA Based Standards: IS 95 to CDMA 2000, Wireless Local Loop, IMT 2000 and UMTS, Long Term Evolution (LTE), Mobile Satellite Communication. Equalization Techniques: Transversal Filters, Adaptive Equalizers, Zero Forcing Equalizers, Decision Feedback Equalizers, and related algorithms.	
UNIT-III	**10 Hours**
Multiplexing and Multiple Access: FDMA, TDMA, CDMA, OFDMA, SCFDMA, IDMA Schemes and Hybrid Method of Multiple Access Schemes, RAKE Receiver; Multiple Access for Radio Packet Systems: Pure ALOHA, Slotted ALOHA, CSMA and their versions; Packet and Pooling Reservation Based Multiple Access Schemes.	
UNIT-IV	**10 Hours**
Introduction to Mobile Adhoc Networks, Bluetooth, Wi-Fi Standards, WiMax Standards, Li-Fi communication, Ultra-Wideband Communication, Mobile data networks, Wireless Standards IMT 2000, Introduction to 4G, 5G and concept of NGN.	

Text Books	
1	T.S. Rappaport, “Wireless Communication-Principles and practice”, Pearson Publications, Second Edition, 2010 (Latest Edition).
2	Andrea Goldsmith, “Wireless Communications”, Cambridge University Press (Latest Edition).

3	S. Haykin& M. Moher, “Modern wireless communication”, Pearson, 2005 (Latest Edition).
Reference Books	
1	Upena Dalal, “Wireless Communication and Networks”, Oxford Press Publications (Latest Edition).
2	T L Singhal,“Wireless Communications ”, McGraw Hill Publications (Latest Edition).
3	Robert W. Heath Jr,,“Introduction to Wireless Digital Communication: A Signal Processing Perspective”, Prentice Hall, First Edition, 2017 (Latest Edition).

INTRODUCTION TO ROBOTICS	
Course Code: BEC-405 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 7

Introduction: Robotics engineering provides an overview of robot mechanisms, kinematics, dynamics, and intelligent controls

Course Objective: Research simple machines and the history of robotics;

- Students are able to analyze Robot motions.
- Students learn Offline and online Robot Programming;
- The students are to be provided hands on practical exposure on topics covered in the course

Pre-requisite: None

Course Outcome: On successful completion of the course, the students will be able to

CO1: Analyze the kinematics of robots using DH representation.
CO2: Understand the mechanism of the robot and its grippers.
CO3: Analyze the differential motion and velocities of a robot using jacobian.
CO4: Design a robot mechanism to meet kinematics requirements and to write simple programs.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based sources as well as flipped classroom teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction: Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.	
UNIT-II	**10 Hours**
Kinematics of Robots: Transformation Matrices, Inverse transformation matrices, Forward and Inverse kinematic equation for position and orientation, Denavit-Hartenberg representation of robot, inverse kinematic solution for articulated robot, Numericals. Differential Motions and velocities: Jacobian, Differential motions of a frame, Differential motion between frames, Calculation of the Jacobian, Inverse Jacobian, Numericals.	
UNIT-III	**11 Hours**
Dynamic analysis of Force: Lagrangian and Newtonian mechanics, Dynamic equations form multiple – DOF Robots, Static force analysis of Robots, Transformation of forces and moments between coordinate frames, Numerical. Trajectory Planning: Basics of Trajectory planning, Joint space trajectory planning, Cartesian Space trajectories, Numerical	
UNIT IV	**10 Hours**
Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages. Off-	

line programming systems: Introduction, central issues in on-line and off-line programming. Programming examples.	
Text Books	
1	Saha S K, “Introduction to Robotics”, TMH Publication, 2008 (Latest Edition).
2	Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, 2003 (Latest Edition).
3	Fu. K.S, Gonzalez, R.C., Lee, C.S.G, “Robotics, control, sensing, Vision and Intelligence”, McGraw Hill International, 1987 (Latest Edition).
4	Saeed B. Niku, “Introduction to Robotics analysis, Systems & Applications”, Pearson Education Singapore P. Ltd., 2002 (Latest Edition).
Reference Books	
1	Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and sons, 2008 (Latest Edition).
2	Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia (Latest Edition)
3	Kavraki and Sebastian Thurn, “Principles of Robot Motion: Theory, Algorithms, and implementations”, Prentice Hall of India, 2005 (Latest Edition).

Soft Computing	
Course Code: BIT 405 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 7

Introduction: This course aims at introducing the fundamental theory and concepts of computational intelligence methods, in particular neural networks, fuzzy systems, genetic algorithms and their applications in the area of machine intelligence.

Course Objectives:

- To provide an introduction to the basic principles, techniques, and applications of soft computing.
- To provide an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.
- To provide the mathematical background for carrying out the optimization associated with neural network learning.
- To develop some familiarity with current research problems and research methods in Soft Computing by working on a research or design project.

Prerequisite: Artificial Intelligence, Data Structures and Algorithms, Programming languages.

Course Outcomes: After completion of the course the students will be able to:

CO1: Apply Fuzzy Logic, approximate reasoning and fuzzy inference systems to various application domains such as user's behavioral modelling, decision making systems, etc.

CO2: Explain the fundamental concepts and various learning algorithms of supervised, unsupervised and associative memory networks in Artificial Neural Networks.

CO3: Apply evolutionary algorithms such as Genetic algorithms for solving optimization, path finding problems, etc.

CO4: Design and implement new variants of existing Heuristic and Metaheuristic algorithms through demonstration projects on real world problems.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Course Details

Unit 1	10 Hours
Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques. Differential Evolution Hill Climbing, Tabu Search, Cuckoo Search, Harmony Search, PSO, ACO, Bat algorithm, Artificial Bee Colony optimization, meta heuristic algorithms: applications to solve complex problems.	
Unit 2	**10 Hours**
Fuzzy Set Theory: Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, introduction & features of membership functions, Extension Principle, Fuzzy If-Then Rules, Fuzzy Inference Systems, Sugeno Fuzzy Models, Fuzzification, Defuzzification, Applications, Fuzzy clustering, cluster validity measures.	
Unit 3	**10 Hours**
Genetic Algorithm: Difference between Traditional Algorithms and GA, The basic operators, Schema theorem, convergence analysis, stochastic models, applications in search and optimization. Encoding, Fitness Function, Reproduction, Cross Over, Mutation.	
Unit 4	**10 Hours**
Bayesian Networks, Probabilistic reasoning, Neural Networks: NN vs ANN, Learning networks of ANN – Perceptron's - Adaline – Back Propagation, Multilayer Perceptron, Unsupervised Learning Neural Networks.	

Text Books
1. S. N. Sivanandam and S. N. Deepa, “Principles of Soft Computing”, 2nd Edition (Latest Edition), Wiley - India, 2011.
2. S. Rajasekaran, “Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications”, 2nd Edition (Latest Edition), PHI Learning, 2017.
3. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective” — CRC Press-2012
Reference Books
1. N. P. Padhy and S.P. Simon, “Soft Computing techniques with MATLAB programming”, UK Edition/ Latest edition, Oxford University Press, 2015 (Latest Edition).
2. X. Wang, X. Z. Gao and K. Zenger, “An introduction to harmony search optimization method”, Springer International Publishing, 2015(Latest Edition).

Big Data Analytics	
Course Code: BIT 407 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 7

Introduction: Our ability to handle Big Data has increased the strategic value of data. Companies employ Big Data technologies for a wide range of analytics, descriptive, predictive and prescriptive, based on their data assets. Collection, storage and retrieval of data assets and processing them in reasonable response time is crucial today. This course deals with volume, variety and velocity aspects of Big Data. It exposes students to basic techniques for managing and processing such data.

Course Objectives: At the end of the course students should demonstrate the ability to manage big data and process it.

Pre-Requisites: Essential: Distributed Systems, Data warehouse Desirable: NoSQL Databases

Course Outcomes:

CO1: Understand Big Data and its analytics in the real world.
CO2: Analyze the Big Data framework like Hadoop and NOSQL to efficiently store and process Big Data to generate analytics.
CO3: Design and Implementation of Big Data Analytics using pig and spark to solve data intensive problems and to generate analytics.
CO4: Implement Big Data Activities using Hive.

Pedagogy: The course will be delivered in workshop mode with lecture material and problem-solving exercises suitably interspersed during lecture contact hours. Tutorial work shall be pen and paper problem solving as well as coding exercises. Take homework shall be oriented to use of tools based on lecture content. Students shall install and learn to use these independently. There shall be about 5 hours per week of take-home work.

Contents

Unit 1	**8 Hours**
Introduction: Need for Big Data, Structured and unstructured Big Data, Limitations of conventional data management and processing techniques for handling Big Data. Data Streams: Real time stream Data; Issues with streams of data, Data Stream Management Systems, Concept of Windows: Time based windows, Tuple count based windows, Movement of windows- fixed, sliding, Tumbling, Hoping; Event streaming: architecture, events, producers, consumers. Use in website activity tracking, stream processing, stream query processing.	
Unit 2	**16 Hours**
Data Warehouse for Big Data: Review of dimensional modeling, bus, hub and spoke architecture, ETL for real time DW, Big Data clusters; Cloud Warehousing: Cloud versus on-prem storage, setting up 'Infrastructure as code' Data Lakes. Data Lakes versus Data Warehouse, Lambda and Kappa Architectures, Meta data management, Curating, designing and deriving value from data lakes, Data pipelines: ETL versus ELT, streaming data pipelines, scheduling batch data pipelines, automated data pipelines. Data governance.	
Unit 3	**8 Hours**
Data Virtualization: Need for data virtualization, architecture, abstraction, views and services, design principles, defining specifications for transformations.	
Unit 4	**8 Hours**
Map Reduce Framework: Distributed Processing with Hadoop Framework; Architecture; Basic Programs on Read and Write.	

The architecture of a MR job, Mapper, Reducer, Combiner, Partitioner Interfaces; Use of distributed relational Store: HIVE architecture and features; different types of tables and implications; data types; basic queries Societal Issues with Big Data, Data rights, policy and regulation; data and ethics, data and communication. Data as a strategic resource.
Text Books
1. Gorelik A., “The Enterprise Big Data Lake: Delivering the Promise of Big Data and Data Science”, O’Reilly, 2019 (Latest Edition).
2. Marz N. and Warren J., Big Data: Principles and best practices of scalable real-time data systems, Manning Publications, 2015 (Latest Edition).
3. Erl T. Khattak W., Buhler P., “Big Data Fundamentals: Concepts, Drivers & Techniques”, The Pearson Service Technology Series from Thomas ERL, 2016 (Latest Edition).
Reference Books
1. DT Editorial Services, “Big Data, Black Book”, Dream Tech Press, 2016 (Latest Edition)
2. The instructor shall select research papers for supplementary reading.

DIGITAL IMAGE PROCESSING	
Course Code: BEC-407 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 7

Introduction: The course will introduce fundamental principles of digital image processing. The course provides sufficient basic knowledge for the undergraduate to understand the design of digital image processing techniques such as image enhancement, restoration, segmentation, and morphological filtering.

Course Objective:

- Understand the design and analysis of various digital image processing techniques
- Understand the fundamental concepts and techniques used in digital image processing

Pre-requisite: Basics of engineering mathematics and signal and systems

Course Outcome: After completion of the course, student will be able to:

CO1: Understand basic image processing algorithms.
CO2: Analyze images in the frequency domain using various transforms.
CO3: Understand various applications of digital image processing.
CO4: Design and analyze image enhancement, restoration, segmentation techniques for real time applications.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	**12 Hours**
Introduction: Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, Image Sensing and Acquisition, sampling and quantization, Basic Relationships between Pixels. Image Enhancement: Gray level transformation, Histogram Processing, Enhancement using arithmetic and logical operator, Spatial filtering, contrast intensification, smoothing and sharpening spatial filters, spatial filter enhancements.	
UNIT-II	**10 Hours**
Filtering in the Frequency domain: Introduction to Hotelling Transform, Fourier Transforms and properties, FFT (Decimation in Frequency and Decimation in Time Techniques), Convolution, Correlation, 2-D sampling, Frequency domain filtering, correspondence between filtering in spatial and frequency domain, smoothing and sharpening frequency domain filters, Homomorphic filtering. Image Restoration: Basic Framework, Interactive Restoration, Image deformation and geometric transformations, Image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Constrained Least Squares Filtering, Geometric Mean Filter, Geometric Transformations, Restoration by Singular value Decomposition.	
UNIT-III	**10 Hours**
Image Compression: Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon’s 1st Theorem, Introduction to different codings - Huffman Coding, Arithmetic Coding, LZW coding, Transform Coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length coding, Symbol-based coding, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation, Introduction to Wavelet based Image Compression.	
UNIT-IV	**10 Hours**

Image Segmentation: Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, contour detection, local and regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation. Morphological Image Processing: Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Erosion, Reconstruction by dilation & erosion.	
Text Books	
1	Rafael C Gonzalez and Richard E Woods, "Digital Image Processing," Pearson Education, 3rd Edition, 2007 (Latest Edition).
2	Anil K Jain, "Fundamentals of Digital Image Processing," PHI, 1989 (Latest Edition).
3	Kenneth R. Castleman, "Digital Image Processing," Pearson Education, 2015 (Latest Edition).
Reference Books	
1	B. Chanda and D. Dutta Majumder, "Digital Image Processing and Analysis," PHI, 2nd Edition, 2013 (Latest Edition).
2	Chris Solomon and Toby Breckon, "Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab," Wiley Blackwell, 1st Edition, 2010 (Latest Edition).
3	Maria Petrou, and Costas Petrou, "Image Processing: The Fundamentals," Wiley Publications, 2nd Edition, 2010 (Latest Edition).

VLSI TECHNOLOGY	
Course Code: BEC-409 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC-3	**Credits:** 4 **Semester:**7

Introduction: The course will introduce fundamental principles of VLSI technology. The course provides sufficient basic knowledge for the undergraduate to understand the basics of crystal growth, wafer preparation along with fabrication of MOS transistors and Integrated Circuits.

Course Objective:

- Understand and analyze the basics of crystal growth and wafer preparation
- Understand the fundamental concepts and various techniques used in fabrication process

Pre-requisite: Basic concept of MOS transistor, Student should have the prior knowledge of semiconductor electronics.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand modern manufacturing practice
CO2: Understand how electronic grade silicon is obtained for fabrication
CO3: Simulate and verify a design.
CO4: Learn the basic process involved in IC packaging

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	**12 Hours**
Introduction to VLSI Technology: Classification of ICs, Scale of integration, semiconductor and hybrid ICs Features of ICs, CRYSTAL GROWTH: monolithic and hybrid ICs, crystal growth, Czochralski technique of crystal growth, wafer preparation and specifications, testing, measurements of parameters of crystals, Fabrication steps, OXIDATION: Theory of growth of Silicon di oxide layer, calculation of SiO_2 thickness and oxidation kinetics, Dry wet and high pressure oxidation, plasma oxidation, properties of oxidation, defects induced due to oxidation.	
UNIT-II	**10 Hours**
EPITAXIAL PROCESS: Epitaxy and its concept, Growth kinetics of epitaxy, epitaxial growth, Low temperature epitaxy, Si-epitaxy- growth chemistry of Si epitaxial layer, auto-doping apparatus for epitaxial layer, apparatus for epitaxy, MBE system DIFFUSION PROCESS: Diffusion models of solid, Fick's theory of diffusion, Solution of Fick`s law, diffusion parameters measurements schemes, ION IMPLANTATION: Scattering phenomenon, range theory, channeling, implantation damage, ion implantation systems, Annealing	
UNIT-III	**10 Hours**
LITHOGRAPHY: photolithography and pattern transfer, Optical and non-optical lithography, electron, X-ray and ion-beam lithography, contact/proximity and projection printers, alignment. Photoresist and ETCHING: Types of photoresist, polymer and materials, Etching- Dry & Wet etching, basic regimes of plasma etching, reactive ion etching and its damages, lift-off, and sputter etching. METALLIZATION: Applications and choices, physical vapor deposition, patterning, problem areas.	
UNIT-IV	**10 Hours**

VLSI PROCESS INTEGRATION: PMOS, NMOS and CMOS IC technology, MOS memory IC technology, bipolar IC fabrication. ASSEMBLY TECHNIQUE AND PACKAGING: Package types, packaging design consideration, VLSI assembly technologies. YIELD AND RELIABILITY: Yield loss in VLSI, yield loss modeling, reliability requirements, accelerated testing	
Text Books	
1	J. D. Plummer, M. D. Deal and Peter B. Griffin, “Silicon VLSI Technology: Fundamentals, Practice and Modeling", 1st Edition, Pearson Education Publication, 2016 (Latest Edition)
2	S. M. Sze, "VLSI Technology", McGraw Hill Publication, 2014 (Latest Edition)
Reference Books	
1	S.K. Ghandhi, "VLSI Fabrication Principles", 2nd Edition, Willy-India Pvt. Ltd, 2012 (Latest Edition)
2	Richard C. Jaeger, “Introduction to Microelectronic Fabrication”, 1st Edition PHI, 2002 (Latest Edition)

MACHINE LEARNING	
Course Code: BCS 401 **Contact Hours**: L-3 T-1 P-0 **Course Category:** DCC	**Credits:**4 **Semester:**

Introduction: Machine learning (ML) is the science of getting computers to act without being explicitly programmed. Many researchers also think it is the best way to make progress towards human-level AI. This course provides a broad introduction to machine learning, data mining, and statistical pattern recognition.

Course Objectives:

- To provide an introduction to the basic principles, techniques, and applications of ML.
- To explain the strengths and weaknesses of different machine learning algorithms relative to the characteristics of the application domain)
- To be able to adapt or combine some of the key elements of existing machine learning algorithms to design new algorithms as needed.

Pre-requisites: Knowledge of programming, basic probability theory and statistics

Course Outcomes: After completion of the course, student will be able to:

CO1: Understand the mathematical and statistical prospectives of machine learning algorithms through python programming.
CO2: Evaluate the machine learning models pre-processed through various feature engineering algorithms by python programming.
CO3: Design and apply various reinforcement algorithms to solve real time complex problems.
CO4: Understand the basic concepts of deep neural network model and design the same.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT-I	**12 Hours**
Introduction to Machine Learning, Well Posed Problems, Machine Learning Process, Designing a Learning System, Types of Machine Learning, Applications of Machine Learning, Feature Selection and Visualization, Testing ML Algorithms (Overfitting, Training, Testing, And Validation Sets, Confusion Matrix, Accuracy Metrics, ROC Curve, Unbalanced Datasets, Precision), Gradient Descent Algorithm, Univariate and Multivariate Linear Regression,and Logistic regression. Case studies on Linear and logistic regression.	
UNIT-II	**10 Hours**

The Brain and The Neuron, Neural Networks, The Perceptron, Linear Separability, The Multi- Layer Perceptron, Forward and Back-error propagation, The Curse of Dimensionality, Dimensionality Reduction, Principal Component Analysis. Case studies on Neural Networks.	
UNIT-III	**10 Hours**
Learning With Decision Tree, ID3, CART, Ensemble Learning, Boosting, AdaBoost, Bagging, Random Forest. k-Nearest Neighbor Classification, Support Vector Machines, Naive Bayes classifiers, Case studies on various classifiers.	
UNIT-IV	**10 Hours**
Unsupervised Learning, Clustering, K-Means Clustering, Hierarchical Clustering, Partitioning methods, Distribution based clustering, Density based clustering, fuzzy clustering, Evaluation Parameters for Unsupervised Learning. Case studies on various clustering techniques.	

Text Books	
1	Stephen Marsland, Machine Learning: An Algorithmic Perspective, Chapman and Hall/CRC; 2nd edition (8 October 2014) (Latest Edition)
2	Bishop, C.M., ,Pattern recognition and machine learning. Springer; 1st ed. 2006. Corr. 2nd printing 2011 edition (15 February 2010) (Latest Edition)
3	Tom Mitchell, Machine Learning, McGraw Hill Education; First edition (1 July 2017) (Latest Edition)
Reference Books	
1	T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, Springer; 2nd ed. 2009, Corr. 9th printing 2017 edition (19 April 2017) (Latest Edition)
2	Han, Jiawei, Jian Pei, and Micheline Kamber. Data mining: concepts and techniques. Morgan Kaufmann; 3rd edition (2011) (Latest Edition)

INTRODUCTION TO SMART GRID	
Course Code: BEC – 411 **Contact Hours:** L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:** 7

Introduction: This course mainly focuses on background and fundamental building blocks of smart grid with stringent emphasis on practical applications in the existing power system network. This also emphasizes on renewable energy source integration in present grid as well as in microgrid as a part of the course and explores its issues in protection, operation, control and monitoring. In addition to it, this further provides utility level analysis in terms of energy management, network analysis and operation of renewable based smart grid.

Course Objective: The aim of this course is to prepare the students to develop the ability of solving real world problems in the field of power system and smart grid, going beyond of what they have studied during their graduation. The curriculum is so designed that the student will get an in-depth knowledge of everyday systems and phenomena surrounding them.

Pre-requisite: Basic concept of power systems, Student should have the prior knowledge of power electronics, Basic concept of electric circuits.

Course Outcomes: Having successfully completed this course, the student will be able to

CO1: Understand issues, opportunities & challenges in Smart grid.
CO2: Understand Power distribution sector framework in India and its comparison globally.
CO3: Analysis of AC/DC Smart grid.
CO4: Understand Power distribution sector framework in India and its comparison globally.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Introduction to Smart Grid, Introduction to DC Smart Grid, Architecture of smart grid, Smart grid standards and policies, smart grid control layer and elements, Distributed generation resources, Smart grid components control elements	
UNIT-II	**10 Hours**
Smart grid Technologies, Plug-in-Hybrid Vehicles (PHEV) , State Estimation for low voltage networks , Smart grid Monitoring, Phasor measurement units, Phasor estimation, Dynamic Phasor estimation, Islanding detection ,Islanding relays, Fault Detection, Isolation, and Service Restoration, Digital relays for smart grid protections; relay co-ordination	
UNIT-III	**10 Hours**
Modelling of AC smart grid components , Modelling of DC smart grid components, Modelling of storage device, Operation and control of AC smart grid, Operation and control of DC smart grid, Simulation and case study of AC microgrid ,Simulation and case study of DC microgrid ,Operation and control of hybrid smart grid ,System analysis of AC/DC smart grid .	

UNIT-IV		10 Hours
Simulation and case study of hybrid microgrid, Demand side management. of smart grid, Demand response analysis of smart grid ,Energy management ,Design of smart grid and practical smart grid case study, Conclusions		
Text Books		
1	James Momoh, “Smart Grid Fundamentals of Design and Analysis”, Wiley IEEE Press, Ed (2012) (Latest Edition).	
2	Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkins, “Smart Grid Technology and Applications”, Wiley Press, Ed (2012) (Latest Edition).	
Reference Books		
1	Aranya Chakraborthy, “Control and Optimization Methods for Electric Smart Grids”, Marija D llic Editor, Springer Publications (Latest Edition).	

ANALOG VLSI	
Course Code: BEC-413 **Contact Hours:**L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:**7

Introduction: The course will introduce fundamental principles of analog VLSI with sufficient basic knowledge for the undergraduate to understand the different designing concept, basics and layout of analog CMOS blocks.

Course Objective:

- Understand, design, and model the CMOS analog circuits.
- Understand the fundamental concepts and techniques used in Analog VLSI
- Understand the present hierarchical approach of sub-blocks, blocks, circuits, and systems.

Pre-requisite: Analog Electronics, Linear Integrated Circuits

Course Outcome: After completion of the course, student will be able to:

CO1: Apply knowledge of mathematics, science, and engineering to design and analyze analog CMOS integrated circuits like current sources and voltage references for given specifications.
CO2: Understand chip level issues and need of testability.
CO3: Identify, formulate, and solve engineering problems in the area of analog integrated circuits.
CO4: Analyze and design single stage MOS Amplifiers.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	**10 Hours**
Introduction to MOSFET device structure and operation, MOS as an amplifier, Biasing in MOS amplifier circuits, Small signal equivalent circuit model, Single stage MOS amplifiers, Characterizing amplifiers, MOS internal capacitance and High frequency model.	
UNIT-II	**10 Hours**
IC biasing-current sources, Current mirrors and current-steering circuits, Cascode and Wilson current mirror, Common Source, Common gate and Common drain IC amplifiers, Low frequency and High frequency response.	
UNIT-III	**10 Hours**
MOS differential pair, Small signal operation, Differential gain, Common mode gain, Common mode rejection ration, Non ideal characteristics, Active loaded differential amplifier, Frequency response.Noise Spectrum - sources, types, Thermal and Flicker noise, Representation in circuits, Noise bandwidth, Noise figure.	
UNIT-IV	**10 Hours**
General feedback structure, Negative feedback, Four basic topologies, Loop gain, Stability, Effect of feedback on amplifier poles, Single pole response, Two pole response, Frequency compensation, Compensation Techniques, Pole splitting.	

Text Books	
1	P.E. Allen and D.R.Holberg, CMOS Analog Circuit Design, Oxford University Press , 2013 (Latest Edition)
2	B. Razavi, Design of Analog CMOS Integrated Circuits, Tata McGraw-Hill , 2017 (Latest Edition).
3	Gray, P.R., Hurst, P. J., Lewis, S.H., Meyer, R.G., “Analysis and Design of Analog Integrated

	Circuits", 4th Ed., John Wiley and Sons (Latest Edition)
Reference Books	
1	Sedra and Smith, "Microelectronic circuits", 7thEdition, Oxford University Press, 2017 (Latest Edition).
2	Kenneth R. Laker and Willy M.C. Sansen, "Design of Analog Integrated Circuits and systems", McGraw-Hill, 2014 (Latest Edition)

RADAR ENGINEERING	
Course Code: BEC-415 **Contact Hours:** L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:**7

Introduction: The course will introduce the basic functioning of a radar system. It will help in providing basic knowledge for the undergraduate to understand this by taking a specific example of Moving target indicator and pulse doppler radar. The course will also give better insight into the concepts of tracking radar and receivers used in radar.

Course Objective:

- To develop an understanding of fundamental concepts on radar system design and its terminologies
- To develop an understanding on radar engineering and its applications
- To develop an understanding of MTI and pulse doppler radar
- To develop an understanding of object tracking by radar

Pre-requisite: Student should have the prior knowledge of electromagnetic fields and waves

Course Outcome: After completion of the course, student will be able to:

CO1: Understand the basic building blocks of a radar system
CO2: Apply the knowledge acquired in this course in real time applications
CO3: Understand the working of a Moving target Indicator (MTI) on the basis of Doppler shift
CO4: Demonstrate an understanding on Radar Receiver

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction to radar, radar block diagram and operation, radar frequencies, Applications of radar. The Radar Equation: Detection of signals in noise, Receiver noise and the signal to noise ratio, Probabilities of detection and false alarm, Integration of Radar Pulses, Radar cross section of targets, Radar cross section fluctuations, Transmitter Power, Pulse Reception Frequency, Antenna Parameters, System Losses.	
UNIT-II	**12 Hours**
MTI and Pulse Doppler Radar: Introduction to Doppler and MTI Radar, Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line cancellers, Filter Characteristics, Blind Speeds, Double Cancellation, Staggered Pulse Reception Frequencies, Doppler Filter Banks,MTI Radar Parameters, Digital MTI Processing, Moving Target Detector, Limitations to MTI Performance.	
UNIT-III	**10 Hours**
Tracking Radar: sequential lobing, conical scan, monopulse Tracking, low angle tracking, tracking in range, Pulse compression. Phase Comparison Mono pulse, Tracking in Range, Acquisition and Scanning Patterns, Comparison of Trackers. Block Diagrams of Synthetic Aperture Radar (SAR),	

Phased array Radars, MST Radar, ECM, ECCM.		
UNIT-IV		**10 Hours**
Radar Receiver, amplifiers, Mixers, Radar Displays, Radar Coordinate systems, Radar antenna, Noise figure, radar resolution, receiver protectors. Principles of Direction Finders, Aircraft Homing and ILS, Radio Altimeter, LORAN, DECCA, OMEGA, Inland Shipping Aids.		
Text Books		
1	Merrill I. Skolnik, "Introduction to Radar Systems", McGraw Hill Education, 2nd Edition, 2017 (Latest Edition)	
2	Peebles, Peyton Z. "Radar principles", Wiley India Edition, John Wiley & Sons, 2007 (Latest Edition)	
Reference Books		
1	G S N Raju, Radar Engineering and Fundamentals of Navigational Aids, IK International Publishers, 2008 (Latest Edition)	
2	Toomay, J.C., "Principles of Radar", PHI, 2nd edition, 2004 (Latest Edition)	

CYBER SECURITY AND FORENSICS	
Course Code: BIT 419 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 7

Introduction:

Cyber Security and Forensics is the application of investigation and analysis techniques to gather and preserve evidence from a particular computing device in a way that is suitable for presentation in a court of law. This course provides for a broad introduction of cyber security and forensics concepts, industry best practices for information security and key security concepts that will protect an organization against fraud, data breaches and other vulnerabilities. It enables the students to gain in-depth knowledge in the field of Computer forensics & Cyber Crime.

Course Objectives:

- To maintain an appropriate level of awareness, knowledge and skill to allow students to minimize the occurrence and severity of information security incidents.
- To learn techniques used to detect, respond and prevent network intrusions.
- To identify and apply appropriate forensics tools to acquire, preserve and analyse system image.
- To protect information and information systems from unauthorized access, use, disclosure, disruption, modification or destruction in order to provide confidentiality, integrity and availability.
- Identify sources of evidentiary value in various evidence sources including network logs, network traffic, volatile data.

Pre-requisites: Knowledge of Computer Networking, Linux, UNIX, Understanding of Web Application Architecture and HTTP/HTTPS communication.

Course Outcomes: After completion of the course the students will be able to:

CO1: Understand the fundamentals of Cyber Security and comprehend the incident response process
CO2: Demonstrate the difference between data acquisition techniques
CO3: Apply forensic analysis tools to recover important evidence for identifying cyber-crime.
CO4: Apply investigation tools and techniques for analysis of data to identify evidence related to cyber-crime and use available digital forensics tools.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects presentations and quizzes. Students would be encouraged to develop an understanding of the existing real life cyber security issues and how they are solved. Emphasis would be given on assignments where students will be given numerical/ programming assignments based on topics studied in previous lectures. Course will have a blend of theory and practice for the benefit of students. Use of ICT, web-based sources as well as blackboard teaching will be adopted.

UNIT-I	12 hours
Cyber Security Concepts, Security Goals, Security Services, Types of Cybercrime, Cyber Attack Process, Introduction to Incident Response Process, Computer Security Incident, Goals of Incident response, Who is involved in Incident response, Incidence Response Methodology, Pre Incident preparation, Detection of Incidents, Initial response, Formulate a response strategy, Investigate the incident, Reporting and Resolution	
UNIT-II	**10 Hours**
Computer Forensics Fundamentals, Data Acquisition of digital evidence from electronic media, Acquisition tools, Evidence collection and preservation, Windows Forensics, Live data collection from Windows systems, Live data Collection from Unix systems	
UNIT-III	**10 Hours**
Sources of Digital/Electronic Evidence, Computer Forensic Analysis and Validating Forensics Data, System Forensics, Network Forensics, Database Forensics, Fighting against Macro Threats, Information Warfare Arsenal, Tactics of the Military	
UNIT-IV	**10 Hours**
Malware forensics, Mobile Device Forensics, Google Forensics, Internet Forensics, Email Forensics, Messenger Analysis, Web Forensics, Current Computer Forensics Tools: Software/Hardware Tools. An Indian perspective on digital forensics: Indian IT act, Cyber laws.	
Text Books	
1. K Mandla, C. Prosise , Matt Pepe, " Incident Response and Computer Forensics", McGraw Hill, 2nd Edition, 2003/Latest Edition	
2. Chad Steel, "Windows Forensics", Wiley India, 1st Edition, 2006/Latest Edition	
3. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations, Thomson Course Technology, 4th Edition, 2009/Latest Edition	
Reference Books	
1. Keith J. Jones, Richard Bejtiich, Curtis W. Rose, Real Digital Forensics, Pearson Education, 1st Edition, 2005/Latest Edition	
2. Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi/Latest Edition	

EMBEDDED SYSTEMS	
Course Code:BEC-402 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 8

Introduction: Embedded system design needs knowledge of hardware as well as software concepts. This course will pay attention to introduce some of the basic concepts of hardware and software designing of embedded systems with a well-motivated perspective. The course will cover embedded hardware architecture, design process and approaches, interfacing techniques and real time operating systems.

Course Objective: The course will enable the students to understand the basics of an embedded system and program an embedded system. The student will also learn the method of designing an Embedded System for any type of applications and understand operating systems concepts, types and RTOS.

Pre-requisite: Microprocessors & Microcontrollers

Course Outcome: On successful completion of the course, the students will be able to

CO1: To design, implement and test an embedded system.
CO2: The student will be able to understand and design embedded systems.
CO3: The student will learn basic of OS and RTOS,
CO4: understand types of communications and interacting to external world

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	10 Hours
Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Fundamentals of embedded system hardware and firmware design, Processor in the System, Embedded processor selection, Definition and Classification – Overview of Processors.	
UNIT-II	**10 Hours**
Typical Embedded Systems: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off- The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators.	
UNIT-III	**11Hours**
Real-time operating systems (RTOS): Required RTOS services/capabilities (in contrast with traditional OS), RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling . Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.	
UNIT IV	**10 Hours**
Communication and Interfacing: Synchronous and asynchronous communications from serial devices - UART and HDLC - Parallel Port Devices, 8051 connections to RS-232, its intra-inter	

process communication and synchronization of processes using on-chip timers/counters, interrupt sources, serial communication, Interfacing using Programmable Peripheral Interface, Programmable Interrupt Controller, Programmable Timer.

Text Books	
1	W. Wolf, Computers as Components: Principles of Embedded Computing System Design, 2nd Edition, Burlington, 2008.
2	Steve Heath, "Embedded System Design", Elsevier, 2nd Edition, 2004
3	Frank Vahid and Tony Gwargie, "Embedded System Design", Student Edition, John Wiley & sons, 2006.
Reference Books	
1	David. E. Simon, "An Embedded Software Primer", 1st Edition, Pearson Education, 2002 (Latest Edition).
2	Tim Wilmshurst, ``An Introduction to the Design of Small Scale Embedded Systems,'' Pal grave Publisher (Latest Edition)
3	T Noergaard, Embedded Systems Architecture: A comprehensive Guide for Engineers and Prgrammers,2 nd Edition, Newness, 2013 (Latest Edition).

BIO-MEDICAL SIGNAL PROCESSING	
Course Code: BEC-404 **Contact Hours:**L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:** 8

Introduction: The course will introduce fundamental principles of biomedical signal processing. The course provides sufficient basic knowledge for the undergraduate to understand the design of filters, noise, and artefact analysis, and bio-signals like ECG, EMG, PCG and EEG.

Course Objective:

- Understand the theoretical background underlying the use of digital signal processing and statistical techniques for biomedical applications.
- Identify the best solution for specific problems by considering the benefits and limitations of various digital signal and biomedical processing approaches.
- Implement appropriate biomedical signal processing algorithms for practical problems involving biomedical signals and systems.

Pre-requisite: Basic concept of signals and system, Student should have the prior knowledge of engineering mathematics.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand basics of biomedical signal processing.
CO2: Understand various applications of biomedical signals.
CO3: Apply knowledge of mathematics, natural science with relevant to life science and multidisciplinary context of engineering science.
CO4: Design filters for application w.r.t biomedical systems.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Fundamentals of Signal Processing: Sampling and aliasing, Signal reconstruction, Signal conversion systems, Linear time invariant stable casual discrete time systems, Circular convolution Correlation- Autocorrelation – Cross correlation, FFT-decimation in time algorithm, Decimation in Frequency algorithm.	
UNIT-II	**10 Hours**
Digital and Biomedical Filter Design: Basics of filter, Design of IR filter-impulse invariant method – Bilinear Transformation Method, Warping and pre-warping effect, Frequency transformation, Characteristics of FIR filter, FIR filter design using windowing techniques- Rectangular window – Hamming window – Hanning window, case-study/ applications.	
UNIT-III	**12 Hours**
Analysis of Bio-signals: Origin, application and analysis of ECG, EMG, PCG and EEG signals. Heart Rate variability, QRS analysis. PCG envelopes. Analysis of brain waves in time domain.	
UNIT-IV	**08 Hours**
Artefacts and noise: Introduction to noise and artefacts. Types of artefacts, noise in biomedical system, noise cancellation methods, artefact removal.	

Text Books	
1	John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, PHI of India Ltd., New Delhi, 4th Edition, 2007 (Latest Edition).
2	D. C Reddy, “Biomedical Signal Processing, Principles and Techniques”, Tata McGraw Hill Publishing Company Limited, First Edition, 2005 (Latest Edition).
3	Willis J Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall India Private Limited, First Edition, 2006 (Latest Edition).
Reference Books	
1	Rangaraj M. Rangayyan, Biomedical Signal Analysis (IEEE Press Series on Biomedical Engineering Book 33) 2nd Edition, 2015 (Latest Edition).
2	Willis J. Tompkins, Biomedical digital signal processing: C-language examples and laboratory experiments for the IBM PC, Prentice-Hall, Inc.Division of Simon and Schuster One Lake Street Upper Saddle River, NJ United States, 1993 (Latest Edition).

OPTICAL COMMUNICATION & NETWORKS	
Course Code: BEC-406 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 8

Introduction: The course will introduce fundamental principles of optical fiber communication. The course provides sufficient basic knowledge for the undergraduate to understand the design of transmitter and receiver of optical communication system.

Course Objective:

- To discuss technology developments in Optical Communication system.
- To provide an in-depth knowledge on various types of fibers and their transmission characteristics, the construction, working principle and characteristics of transmitters, receivers and various optical amplifiers used in long distance communication.
- To describe the concepts of Wavelength Division Multiplexing technique, components used and the estimation of rise-time and power budget for digital transmission system.
- To introduce SONET/SDH, OTN and PON Technologies.

Pre-requisite: Having an ability to apply mathematics and science in engineering applications, Having a clear understanding of the subject Digital Communication Systems concepts and their contemporary issues, Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand the concept of optical communication.

CO2: Understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors. Establish optical communication systems for multichannel systems using multiplexing techniques.

CO3: Understand and classify various types of optical Networks and their applications.

CO4: Design, analyze and evaluate optical communication systems.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	**12 Hours**
Spectral bands and windows-Key elements of optical fiber system, Optical Spectral Band with Operating Windows, Optical Communication System with its advantages-Modelling and simulation	

Tools. Optical Fiber Waveguides: Ray Theory of Transmission with TIR, Acceptance Angle, Numerical Aperture and Skew Rays, Evanescent Field, Goos-Haenchen Shift, Optical fibers: Types - SM-SI; MM-SI, MM-GI; specialty fibers Geometrical-Optics Description, Wave Propagation, Attenuation, Material Absorption Losses(Intrinsic and Extrinsic absorption), types of Linear and Non-Linear Scattering Losses, Fiber Bending Losses, Kerr Effect. Chromatic Dispersion, Polarization Mode Dispersion, Dispersion-Induced Limitations, Fiber Birefringence, Fiber Losses, Nonlinear Optical Effects (SRS,SBS,SPM,CPM,FWM).	
UNIT-II	**10 Hours**
Optical transmitter and Receivers-Sources: LED, LASER, Modulators, Transmitter Design, Mach-Zehnder and Electro-absorption Modulators. Photo detector, Receiver Design, Receiver Noise, Bit Error rate, Receiver Sensitivity, Sensitivity Degradation, Receiver Performance Optical Amplifiers-Semiconductor Optical Amplifiers, Raman Amplifiers , Erbium-Doped Fiber Amplifiers, System Applications.	
UNIT-III	**10 Hours**
Light wave transmission system- Intensity Modulation - Direct Detection Systems, Homodyne and heterodyne detection, Optical time division multiplexing (bit-interleaved, packet interleaved)Wavelength-division multiplexing, Sub carrier multiplexing, Polarization multiplexing. Digital links: Point-to-Point links-System consideration-Link power budget-Rise time budget, System performance. Multichannel system-WDM Light wave Systems and Components, Operational principles of WDM- Passive opticalcoupler:2x2 Fiber coupler-Wave guide coupler-Star couplers-MZI Multiplexers , Isolators and Circulators – Fiber Bragg Grating-FBG Applications, WDM System Performance Issues.	
UNIT-IV	**10 Hours**
Optical Networks-Network concepts-Topologies SONET/SDH -The Optical Transport Network -Introduction -OTN Network Layers - FEC in OTN - OTN Frame The Optical Channel - Optical Channel Carrier and Optical Channel Group - Optical Networks Access(existing PON Technologies; CWDM- PON, TDM-PON, Hybrid TDM-WDM –PON) and Metro Networks Long-Haul Networks, optical OFDM. Contemporary Issues.	

Text Books	
1	Gerd Keiser, Optical Fiber Communications, 2013, McGraw Hill, 5th Edition (Latest Edition).
2	J. M. Senior, Optical Fiber Communications: Principles and Practice, 2011, Pearson (Latest Edition).
3	B.Mukerjee, Optical WDM Networks (Optical Networks), 2006, Springer edition (Latest Edition)
Reference Books	
1	Cvijetic, M., Djordjevic. I. B.: Advanced Optical Communication Systems and Networks, 2012, Artech House (Latest Edition)
2	R. Ramaswami& K.N. Sivarajan, Morgan Kaufmann, Optical Networks A practical perspective, 2010, 2nd Edition, Pearson Education (Latest Edition)
3	G. P. Agrawal, Nonlinear Fiber Optics, 2008, 2nd Edition, Academic Press (Latest Edition).

SATELLITE COMMUNICATION SYSTEMS	
Course Code: BEC-408 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 8

Introduction: The course will introduce fundamental principles of satellite communication. The course provides sufficient basic knowledge for the undergraduate to understand the design of transmitter and receiver of satellite communication system.

Course Objective:

- To have a conceptual knowledge of communication through satellites.
- To have a detailed understanding of navigation - both inertial and by navigation satellites.
- To analyze typical challenges of satellite-based systems.

Pre-requisite: Having an ability to apply mathematics and science in engineering applications, Digital Communication Systems concepts and their contemporary issues, use techniques, skills and modern engineering tools necessary for engineering practice.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand the concept of orbits, launch vehicles and satellites.

CO2: Analyze the satellite orbits and link design for transmission & reception of signals.

CO3: Understand the impact of diverse parameters on satellite link design.

CO4: Able to study the design of Earth station and tracking of the satellites.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Elements of Orbital Mechanics-Overview of satellite communication - Orbital mechanics - Equations of the orbit – Kepler’s laws of planetary motion - Orbital elements - Look angle determination - Orbital perturbation and determination Orbital Launchers: Launches and launch vehicles- Launch vehicle selection factors - Satellite positioning into geostationary orbit - Orbital effects in communication systems performance – Doppler shift -Range variations - Solar eclipse and sun transit outage	
UNIT-II	**10 Hours**
Elements of Communication Satellite Design: Satellite subsystems - Attitude and orbit control electronics - Telemetry and tracking – Power subsystems - Communication subsystems - Satellite antennas - Reliability and redundancy Frequency modulation techniques. Digital Transmission Basics-Multiple access techniques – FDMA, TDMA, CDMA, SDMA, ALOHA	

and its types – Onboard processing- Satellite switched TDMA – Spread spectrum transmission and reception for satellite networks.		
UNIT-III		**10 Hours**
Satellite Link Design - Basic transmission theory – System noise temperature and G/T Ratio- Noise figure and noise temperature- Calculation of system noise temperature – G/T ratio for earth stations - Link budgets- Uplink and downlink budget calculations - Error control for digital satellite links - Prediction of rain attenuation and propagation impairment counter measures. VSAT Systems-Overview of VSAT systems - Network architectures – One way implementation – Split IP implementation – Two way implementation – Access control protocols – Delay considerations -VSAT earth station engineering - System design procedure and calculation of link margins for VSAT network.		
UNIT-IV		**10 Hours**
Direct Broadcast Satellite Television systems and GPS-DBS TV system design - Direct broadcast satellite television transmitters and receivers - DBS TV link budget - Radio and satellite navigation –GPS position location principles – GPS navigation messages and signal levels - GPS receivers design – Role of satellites in future networks –Advanced error control codes for satellite systems. Contemporary Issues		
Text Books		
1	T. Pratt, C.W. Boastian and Jeremy Allnutt Satellite Communication, 2013, 2nd edition, JohnWiley and Sons, Bangalore, India (Latest Edition).	
2	D.Roddy, Satellite Communications, 2011, 4th edition (sixth reprint), Tata McGraw Hill, NewYork (Latest Edition).	
3	Daniel Minoli, Innovations in Satellite Communication and Satellite Technology, 2015, 1st edition, Wiley. New Delhi, India (Latest Edition).	
Reference Books		
1	Tri.T.Ha, “Digital Satellite Communications”, Tata McGraw-Hill Education-2009 (Latest Edition).	
2	Dr.D.C. Agarwal, “Satellite Communications”, Khanna Publishers, 2001 (Latest Edition).	
3	Trimothy Pratt, Charles W. Bostian, Jeremy E. Allnutt “Satellite Communications”, John Wiley &Sons, 2002 (Latest Edition).	

INFORMATION RETRIEVAL	
Course Code: BIT 406 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	Credits: 4 Semester: 8

Introduction: The main objective of this course is to present the scientific support in the field of information search and retrieval. This course explores the fundamental relationship between information retrieval, hypermedia architectures, and semantic models, thus deploying and testing several important retrieval models such as vector space, Boolean and query expansion. It discusses implementation and evaluation issues of new algorithms like clustering, pattern searching, and stemming with advanced data/file structures, indirectly facilitating a platform to implement comprehensive catalogue of information search tools while designing an e-commerce web site.

Course Objectives:

- To understand the advantages and disadvantages of Information Retrieval.
- To learn various Information Retrieval Technique.
- To understand the how to retrieve data from web.
- To learn how statistical models of language can be used to solve document indexing and retrieval problems.

Prerequisite: Knowledge on the basics of Information Retrieval.

Course Outcome: Upon successful completion of this course, students will be able to:

CO1: Understand the Data Base Management systems and data ware houses.
CO2: Apply the knowledge of data structures and indexing methods in information retrieval Systems.
CO3: Understand how to choose clustering and searching techniques for different data base systems
CO4: Design the method to build inverted index.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped classroom teaching will be adopted.

Course Details

UNIT I	10 hours
Vector Space Model of retrieval Word statistics, Text preprocessing, Term weighting, Similarity function, Indexing, Relevance feedback, Query expansion (with local analysis from external resources), the impact of document normalization, Multi-field retrieval, Evaluation of retrieval. Applications. and Disadvantages, Incentives for engaging in electronic commerce, forces behind E-Commerce.	
UNIT II	**10 hours**
Latent Semantic Indexing Basic concepts, Singular Value Decomposition, Latent semantic indexing (LSI), LSI search engine, up	

dating, Toward a theoretical foundation-Probabilistic analysis of LSI, applications of LSI.	
UNIT III	**10 hours**
Web Retrieval: Search Engines, Spidering, Web Crawling, Meta-crawlers, Directed spidering, link analysis, Static ranking: Page Rank HITS, shopping agents, Query log analysis, Adversarial IR. Information Extraction and Integration: Extracting data from text, XML, Ontologies, Thesauri, Semantic Web, collecting and integrating specialized information on the web.	
UNIT IV	**10 hours**
Integrating structured: data and text. A historical progression, Information retrieval as relational application, Semi Structured search using a relational schema. Distributed Information Retrieval: A theoretical Model of Distributed retrieval, web search.	
Text Books	
1. David A. Grossman, Ophir Frieder, Information Retrieval – Algorithms and Heuristics, Springer, (Distributed by Universal Press), (Latest Edition), 2004.	
2. Gerald J Kowalski, Mark T Maybury Information Storage and Retrieval Systems: Theory and Implementation, (Latest Edition), Springer.	
3. Soumen Chakrabarti, Mining the Web: Discovering Knowledge from Hypertext Data, Morgan – Kaufmann Publishers, (Latest Edition), 2002.	
4. Christopher D Manning, Prabhakar Raghavan, Hinrich Schutze, An Introduction to Information Retrieval By Cambridge University Press, England, (Latest Edition), 2009.	

ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING	
Course Code: BEC-410 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:** 8

Introduction: The course will introduce fundamental principles of neural networks and deep learning. A neural network is a method in artificial intelligence that teaches computers to process data in a way that is inspired by the human brain. It is a type of machine learning process, called deep learning, that uses interconnected nodes or neurons in a layered structure that resembles the human brain. The course provides sufficient basic knowledge for the undergraduate to understand the concepts of artificial neural networks and deep learning.

Course Objective:

- Understand the design and analysis of various neural network and deep learning algorithms
- Understand the fundamental concepts and techniques used in deep learning

Pre-requisite: Basic concept of engineering mathematics, Student should have the prior knowledge of basic machine learning and statistics.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand basic neural networks and their working
CO2: Understand various applications of deep learning in industry and research
CO3: Understand building blocks of Neural Networks.
CO4: Design and develop applications using neural networks.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Introduction of soft computing: soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing. Concept Of Uncertainty: Presence of uncertainty in real world problems, handling uncertain knowledge, degree of belief, degree of disbelief, uncertainty and rational decisions, decision theory, utility theory, concept of in dependent events, Bayes rule, Using Bayes rule for combining events.	
UNIT-II	**12 Hours**
Introduction to Neural Networks: Overview of biological neurons, Mathematical model of Neuron, Perceptron and Multi-Layer Perceptron, Learning in Artificial Neural Networks; Supervised, Unsupervised and Competitive Learning paradigms; Learning rules and Functions, Back propagation algorithms.	
UNIT-III	**12 Hours**
Introduction to deep learning: Convolutional neural networks, Visualizing and Understanding Convolutional Networks, Deep Inside Convolutional Networks, Types of CNN, Visualizing Image Classification Models and Saliency Maps, Understanding basic Neural Networks Through Deep Visualization, Learning Deep Features based on case studies/applications.	
UNIT-IV	**06 Hours**
Case study applications of deep learning in computer vision, natural language processing, healthcare, agriculture, stock market etc.	
Text Books	

1	Soft Computing: Fundamentals and Applications by D. K. Pratihar, Alpha. Science International Ltd, 2015 (latest edition).
2	Neural Networks and Deep Learning: A Textbook by Charu C. Aggarwal, Springer, 2018, BN 978-3-319-94462-3 (latest edition)
3	Deep Learning by Ian Good fellow and Yoshua Bengio and Aaron Courville, Published by An IT Press book (latest edition).
Reference Books	
1	Deep Learning with Python by François Chollet, Manning Publications Co, ISBN: 978-1-617-443-3 (latest edition)
2	Deep Learning - A Practical Approach by Rajiv Chopra, Khana Publications, ISBN: 978-9-6-17341-6 (latest edition)
3	Roy Choudhury and Jain, "Linear Integrated Circuits", New Age Publishers, 4^{th}Edition, 2017 (latest edition).

NON CONVENTIONAL ENERGY RESOURCES	
Course Code:BEC-412 **Contact Hours:** L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:** 8

Introduction: The course will introduce fundamental concepts of Non-conventional energy resources. The course provides sufficient basic knowledge for the undergraduate to understand the generation of electrical energy from non-conventional energy resources.

Course Objective:

- Understand the design and analysis of various non-conventional energy resources.
- Understand the fundamental concepts and techniques used for energy conversion and integration of various sources to grid.

Pre-requisite: Basic concept of circuit theory, Student should have the prior knowledge of power electronics, Basic concept of power systems.

Course Outcome: After completion of the course, student will be able to:

CO1: Understand the generation of electrical energy from various non-conventional energy resources.
CO2: Understand the need of renewable energy resources.
CO3: Understand the application and utility of energy from non-conventional energy sources.
CO4: Understand the Geothermal &Tidal energy, its mechanism of production and its applications

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Introduction to various sources of energy; Solar thermal, Photovoltaic, hydro power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy. Solar Radiations: Extra-terrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Declination angle, Surface azimuth angle, Hour angle, Zenith angle, Local apparent time, Apparent motion of sun, Day length. Solar Energy: Solar thermal power and it's conversion, solar collectors, flat plate, performance analysis of flat plate collector, solar concentrating collectors, types of concentrating collectors, thermal analysis of solar collectors. Solar thermal energy storage, different systems and their applications, water heating, space heating & cooling, solar distillation, solar pumping, solar cooking, greenhouses, solar power plants.	
UNIT-II	**10 Hours**
Solar Photovoltaic System: Photovoltaic effect, efficiency of solar cells, semiconductor materials for solar cells, solar photovoltaic system, standards of solar photovoltaic system, applications of PV system, PV hybrid system. Biogas: Photosynthesis, bio gas production aerobic and anaerobic bio-conversion process, properties of biogas (composition and calorific value), storage and enrichment, community biogas plants, problems involved in bio gas production, bio gas applications, Biomass: generation, characterization, use as energy source, biomass conversion techniques, biomass co-generation, fuel properties, biomass resource development.	

UNIT-III		10 Hours
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity, wind machine fundamentals, types of wind machines and their characteristics, horizontal and vertical axis wind mills, elementary design principles, selection of a wind mill, wind energy farms, economic issues, and recent development. Tidal and Wave Power: Tides and waves as sources of energy, fundamentals of tidal power, use of tidal energy, limitations of tidal energy conversion systems.		
UNIT-IV		**10 Hours**
Geothermal Energy: Structure of Earth's interior, geothermal sites, geothermal resources, hot springs, steam system, types of geothermal station with schematic representation, site selection for geothermal power plants, problems associated with geothermal conversion. Ocean Energy: Principle of ocean thermal energy conversion, wave energy conversion machines, power plants based on ocean energy, problems associated with ocean thermal energy conversion systems, thermoelectric OTEC.		
Text Books		
1	G.D Rai, "Non-Conventional Energy Sources," Khanna Publishers, 2011(latest edition)	
2	John Twideu and Tony Weir, Renewal Energy Resources Routledge Publishers, 3rd edition, 2015 (latest edition).	
Reference Books		
1	D.P. Kothari, K.C. Singal and Rakesh Ranjan, "Renewable Energy Resources and Emerging Technologies," Prentice Hall India Pvt. Ltd, 2011 (latest edition)	
2	Manfred Kleemann, Michael Meliss, Ranjan Kaul and Kaushik Ghosh, "Renewable Energy Sources and Conversion Technology," Tata Mc Graw Hill, 1990 (latest edition)	

WIRELESS SENSOR NETWORKS	
Course Code: BEC-414 **Contact Hours:** L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:**8

Introduction: Course covers various aspects of Wireless Sensor Networks; followed by application- oriented case studies; and research focused discussion of many Routing Protocols with node level programing using various simulation tools.

Course Objective:

- To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
- To study the various protocols at various layers and its differences with traditional protocols.
- To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Pre-requisite: Basic concept of Wireless Communication and Digital Communication

Course Outcome: After completion of the course, student will be able to:

CO1: Understand challenges and technologies for wireless networks.
CO2: Understand architecture and sensors.
CO3: Analysis of various critical parameters in deploying a WSN.
CO4: Design the infrastructure and simulations.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
Introduction: Introduction to Sensor Networks, Constraints and Challenges, Advantage of Sensor Networks, Applications of Sensor Networks. Architecture: Single-Node Architecture- Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems, Network Architecture-Sensor Network Scenarios, Optimization Goals, Gateway Concepts. Networking Sensors: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, classification of MAC protocols, MAC protocols for sensor network, location discovery, S-MAC, IEEE 802.15.4.	
UNIT-II	**10 Hours**
Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Protocols- Energy-Efficient Routing, Geographic Routing; Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – COUGAR ACQUIRE – Hierarchical Routing - LEACH, PEGASIS.	
UNIT-III	**10 Hours**
Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB.	

UNIT-IV		10 Hours
Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Case study of Wireless Sensor Networks for different applications. Platform, Tool and Security: Sensor Node Hardware Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, Security issues in Sensor Networks, Future Research Direction.		
Text Books		
1	Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks," John Wiley, 2005 (latest edition).	
2	Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach," Elsevier, 2007 (latest edition).	
3	Waltenegus Dargie and Christian Poellabauer, "Fundamentals of Wireless sensor Networks: Theory and Practice" Wiley Education, 2nd Edition (latest edition)	
Reference Books		
1	Dr.Xerenium, Shen, and Dr. Yi Pan, "Fundamentals of Wireless Sensor Networks, Theory and Practice," Wiley Series on Wireless Communication and Mobile Computing, 1st Edition, 2010 (latest edition).	
2	KazemSohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols, And Applications," John Wiley, 2007 (latest edition)	
3	Bhaskar Krishnamachari, "Networking Wireless Sensors," Cambridge University Press, 2005 (latest edition).	
4	Anna Hac, "Wireless Sensor Network Designs," John Wiley, 2003 (latest edition).	

DATA ANALYTICS WITH PYTHON	
Course Code: BEC-416 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DEC	**Credits:** 4 **Semester:**8

Introduction: This course is designed to teach students how to analyze different types of data using Python. Students will learn how to prepare data for analysis, perform simple statistical analysis, create meaningful data visualizations and predict future trends from data.

Course Objective:

- To understand basics of python for performing data analysis
- To understand the data, performing pre-processing, processing and data visualization to get insights from data.

Pre-requisite: Student should have the prior knowledge of basics of programming and algorithms.

Course Outcome: After completion of the course, student will be able to:

CO1: Analyze the need for data preprocessing and visualization techniques.
CO2: Apply unsupervised learning algorithms for grouping the given data.
CO3: Formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges.
CO4: Apply modern data science methods to one or more domains of application (e.g. business analytics, finance, biotechnology, and public health).

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	10 Hours
Python Fundamentals for Data Analysis Python data structures, Control statements, Functions, Object Oriented programming concepts using asses, objects and methods, Exception handling, Implementation of user-defined Modules and Package, le handling in python.	
UNIT-II	**10 Hours**
Introduction to Data Understanding and Preprocessing Knowledge domains of Data Analysis, Understanding structured and unstructured data, Data Analysis process, Dataset generation, Importing Dataset: Importing and Exporting Data, Basic Insights from Datasets, Cleaning and Preparing the Data: Identify and Handle Missing Values.	
UNIT-III	**10 Hours**
Data Processing and Visualization Data Formatting, Exploratory Data Analysis, Filtering and hierarchical indexing using Pandas. Data Visualization: Basic Visualization Tools, Specialized Visualization Tools, Seaborn Creating and Plotting Maps. **Mathematical and Scientific applications for Data Analysis** Numpy and Scipy Package, Understanding and creating N-dimensional arrays, Basic indexing and Slicing	
UNIT-IV	**12 Hours**
Boolean indexing, Fancy indexing, Universal functions, Data processing using arrays, File input and output with arrays.	

Analysing Web Data Data wrangling, Web scrapping, Combing and merging data sets, Reshaping and pivoting, Data transformation, String Manipulation, case study for web scrapping. **Model Development and Evaluation** Introduction to machine learning- Supervised and Unsupervised Learning, Model development using Linear Regression, Model Visualization, Prediction and Decision Making, Model Evaluation: Over-fitting, Under-fitting and Model Selection.	
Text Books	
1	David Ascher and Mark Lutz, “Learning Python”,Publisher O’Reilly Media, 4thedition, 2009 (latest edition)
2	Wes Mckinney, “Python for Data Analysis”, Publisher O’Reilly Media, 2nd edition, 2017 (latest edition)
Reference Books	
1	Reema Thareja, “Python Programming using Problem Solving approach”, Oxford University press, 1st edition, 2019 (latest edition)
2	David Taieb, “Data Analysis with Python: A Modern Approach”, 1st Edition, Packt Publishing, 2018 (latest edition)

APPLIED OPTIMIZATION FOR WIRELESS, MACHINE LEARNING, BIG DATA	
Course Code: BEC-418 **Contact Hours:** L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:** 8

Introduction: Design of current systems is increasingly faced with the challenge of guaranteeing given quality-of-service or cost constraints, while providing optimal performance in terms of resource utilization. In addition, the emerging paradigm of efficient designs calls for modern optimization techniques to be performed in a distributed and possibly competitive fashion.

Course Objective: This course is focused on developing the fundamental tools/ techniques in modern optimization as well as illustrating their applications in diverse fields such as Wireless Communication, Machine Learning, Big Data and Finance.

Pre-requisite: Basic knowledge of Calculus, Probability, Matrices, Machine Learning, Big Data, Communications and random signal analysis is required.

Course Outcome: On successful completion of the course, the students will be able to

CO1: Understand the various tools and techniques for solving Convex optimization problems
CO2: Build a sound foundation of fundamental concepts that form the basis of optimization
CO3: Understand optimization concepts such as optimal power allocation, cost and energy efficiencies.
CO4: Solve various optimization problems especially in the context of Machine learning, Big Data and Communication.

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web- based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	**11 Hours**
Introduction to properties of Vectors, Norms, Positive Semi-Definite matrices, Gaussian Random Vectors, Introduction to Convex Optimization – Convex sets, Hyperplanes/ Half-spaces etc. Application: Power constraints in Wireless Systems, Convex/ Concave Functions, Examples, Conditions for Convexity. Application: Beam forming in Wireless Systems, Multi-User Wireless, Cognitive Radio Systems, Convex Optimization problems, Linear Program, Application: Power allocation in Multi-cell cooperative OFDM.	
UNIT-II	**10 Hours**
QCQP, SOCP Problems, Channel shortening for Wireless Equalization, Robust Beam forming in Wireless Systems, Duality Principle and KKT Framework for Optimization. Application: Water- filling power allocation, Optimization for MIMO Systems, OFDM Systems and MIMO-OFDM systems, Optimization for signal estimation, LS, WLS, Regularization. Application: Wireless channel estimation, Image Reconstruction-Deblurring.	
UNIT-III	**11Hours**
Convex optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines, Cooperative Communication, Optimal Power Allocation for cooperative Communication, Geometric Program, Radar for target detection, Array Processing, MUSIC, MIMO-Radar Schemes for Enhanced Target Detection	
UNIT IV	**10 Hours**

Big data analysis, Evolutionary optimization for scheduling, Evolutionary optimization for manufacturing optimization, Hybrid evolutionary optimization for big data, Parallel evolutionary optimization, Many-objective big data, Evolutionary multi-objective optimization using high performance computing. Convex optimization for Big Data Analytics, Recommender systems, User Rating Prediction, Optimization for Finance.	
Text Books	
1	Stephen Boyd and Lieven Vandenberghe, Convex Optimization, Cambridge University Press. 2004 (latest edition).
2	Cognitive Radio Communications and Networks Principles and Practice Alexander M. Wyglinski, Maziar Nekovee, Y. Thomas House, Published by Elsevier, 2010 (latest edition)
Reference Books	
1	B. MacKenzie and L. A. DaSilva, Game theory for wireless engineers, Morgan & Claypool publ., 2006. (latest edition)
2	D.P. Bertsekas, Angelia Nedic and Asuman E. Ozdaglar, Convex Analysis and optimization, Athena Scientific, 2003. (latest edition)
3	Introduction to Machine Learning Ethem Alpaydın The MIT Press, 2013 (latest edition)

CRYPTOGRAPHY AND NETWORK SECURITY	
Course Code:BEC-420 **Contact Hours:** L-3 T-1 P-0 **Course Category:** DEC	**Credits:** 4 **Semester:**8

Introduction: This course will introduce students to the basic building blocks of cryptography and applications of cryptographic protocols in real world. The focus will be on how cryptography and its application can maintain privacy and security in electronic communications and computer networks. The course also deals with the practice of network security

Course Objective:

- To understand basics of Cryptography and Network Security
- To understand and use modern cryptographic methods
- To acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity
- To understand the fundamental security design principles

Pre-requisite: Student should have the prior knowledge of basic mathematics

Course Outcome: After completion of the course, student will be able to:

- Understand the most common type of cryptographic algorithm.
- Understand security protocols for protecting data on networks.
- Implement and identify electronic mail security system, SSL/TLS and recent developments affecting security and privacy on the Internet.
- Apply and use cryptographic concepts to real world problems

Pedagogy: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based sources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	10 Hours
Conventional Cryptography: Definitions, Classical encryption techniques, One time pad, Perfect Secrecy, DES, Triple DES, Finite fields, AES, Modes of Encryption.	
UNIT-II	**11 Hours**
Asymmetric Cryptography: Number Theory, public key cryptography: RSA, ElGamal, and Elliptic Curve Cryptography, Diffie Hellman Key management, Digital Certificates: X.509 Codes and Ciphers, Stream ciphers, Block ciphers.	
UNIT-III	**11 Hours**
Network Security: Hash function – Authentication: Protocols – Digital Signature standards. Electronics Mail Security – PGP (Pretty Good Privacy) MIME, Data Compression technique. IP Security: Architecture, Authentication Leader, Encapsulating security Payload – Key management. Web Security: Secure Socket Layer & Transport Layer security, Secure electronic transactions. Firewalls Design principle, established systems.	

UNIT-IV		**10 Hours**
Telecommunication Network architecture, TMN management layers, Management information Model, Management servicing and functions, Structure of management information and TMN information Model.		
Text Books		
1	W Stallings, “Cryptography and Network Security: Principles and Practice”, Prentice Hall, 7th edition, 2017 (latest edition)	
2	B. Forouzan, D. Mukhopadhyay, "Cryptography and Network Security 2/e", TataMcGraw Hill (latest edition)	
3	Bernard Menezes, “Network Security and Cryptography 2/e”, Cenege Learning, 2011 (latest edition)	
Reference Books		
1	Douglas R. Stinson, “Cryptography: Theory and Practice”, CRC Press, 4th edition, 2018 (latest edition)	
2	Christof Paar, Jan Pelzl, “Understanding Cryptography: A textbook for students and practitioners, 1/e”, Springer (latest edition)	
3	William Stallings, “Network Security Essentials”, Prentice Hall, 4th Edition, 2011 (latest edition)	
4	John E. Canavan, " The Fundamentals of Network Security," Artech House, 2001 (latest edition)	

DIGITAL SIGNAL PROCESSING	
Course Code: BEC-302 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:**6

Introduction: The course is designed to introduce fundamental principles of Digital Signal Processing. The course provides sufficient understanding of the analysis and representation of discrete-time signal systems, including DFT, DTFT, z-transform and design of digital filters.

Course Objective:

- Understand the fundamental concepts and techniques used in digital signal processing.
- Understand the design and analysis of FIR and IIR filters.

Pre-requisite: Basics of signals and systems, Student should have the prior knowledge of frequency domain analysis.

Course Outcome: After completion of the course, student will be able to:

CO1: Analyze the digital signals using various digital transforms DFT, FFT etc.
CO2: Understand design and operation of digital filters.
CO3: Design and develop the basic digital system.
CO4: Interpret the finite word length effects on functioning of digital filters.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

Contents

UNIT-I	12 Hours
DFT and its properties, Relation between DTFT, Z transform with DFT, Overlap-add and save methods, FFT computations using Decimation in time (DIT) and Decimation in frequency (DIF)algorithms for radix 2 and composite number.	
UNIT-II	**10 Hours**
Review of design of analogue Butterworth and Chebyshev Filters, Frequency transformation in analogue domain, Design of IIR digital filters using impulse invariance technique, Design of digital filters using bilinear transform, pre warping, Realization using direct, cascade, parallel, state space and lattice form.	
UNIT-III	**10 Hours**
Symmetric and Antisymmetric FIR filters, Linear phase FIR filters, Design using Hamming, Hanning Rectangular, Blackmann and Bartlett Windows, Frequency sampling method ,Realization using direct, cascade, and lattice form.	
UNIT-IV	**10 Hours**
Fixed point and floating point number representations, Comparison, Truncation and Rounding errors, Quantization noise, derivation for quantization noise power, coefficient quantization error, Product quantization error, Overflow error, limit cycle oscillations due to product roundoff and	

overflow errors, Introduction to Multirate signal processing, Decimation-Interpolation,rational sampling rate conversion, Applications of Multirate signal processing.	
Text Books	
1	J. G Proakis, D. G Manolakis, “Digital Signal Processing Principles, Algorithms and Application”, PHI, 3rdEdition, 2000 (latest edition).
2	A. V. Oppenheim, R. W. Schafer, J. R Back, “Discrete Time Signal Processing”, PHI, 3rdEdition, 2010 (latest edition).
Reference Books	
1	J.R. Johnson, “Introduction to Digital Signal Processing”, Learning Private Limited, 2011 (latest edition).
2	S.K. Mitra, "Digital Signal Processing - A Computer based approach", Tata McGraw-Hill, 4th Edition, 2013 (latest edition).