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**	

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**	

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	Modeling 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**	

*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

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.

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

- Understand the procedure of modeling of various systems using appropriate modeling techniques.
- Learn about various models such as Monte Carlo simulation models, queuing models, and mathematical models.
- Formulate and solve the mathematical models for the systems.
- Write 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 class room 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.

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 ofdigital modulator and demodulator and their real time applications.

Course Objective:

- Solve various types of problems on digital communications
- 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:

- Understanding basic theories of digital communication and solve various types problems
- Apply theory for analyzing a practical problem related to modern communication 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	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, MasoudSalehi, "Digital Communications", McGraw Hil, 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.

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:

- Understand DFT, DTFT and FFT.
- Understand design and operation of digital filters.
- Understand multirate signal processing

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 savemethods, 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 quantizationerror, Product quantization error, Overflow error, limit cycle oscillations due to product roundoffand	

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.

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 loopcontrol 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 asthe 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, student will be able to:

- Categorize different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form.
- Characterize any system in Laplace domain to illustrate different specification of the system using transfer function concept.
- Interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
- Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions.
- Formulate different types of analysis in frequency domain to explain the nature of stability of the system.
- Identify the needs of different types of controllers and compensator 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 class room 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.

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:

- Understand the coding theory thoroughly.
- Understand various applications associated with research
- Analyse 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 class room 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.	

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 s electronics and electrical circuits
- Basic concept of measurement system

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

- Understand significance of measurement in various laboratories.
- Understand different and intense applications of electronic and electrical circuit.
- Analyse implementation of circuits and does synthesis using various working principle.

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.

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 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:

- 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:

- Understand basics of MOSFET family devices
- Understand various applications of MOSFET
- Analyse logic processes and implement logical operations using MOS/CMOS combinational logic circuits
- 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:

- Understand and execute programs based on 8086 microprocessor.
- Design Memory Interfacing circuits.
- Design and interface I/O circuits.
- 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: ARMCore & 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 analyse 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 analyse 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 Outcome: After completion of the course, student will be able to:

At the end of the course, students will be able to

- Understand the axiomatic formulation of modern Probability Theory and think of random variables as an intrinsic need for the analysis of random phenomena.
- Characterize probability models and function of random variables based on single & multiples random variables.
- Evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits.
- Understand the concept of random processes and determine covariance and spectral density of stationary random processes.
- 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, rthmean, 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, "StochasticProcesses:TheoryforApplications",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, "ProbabilityandStochasticProcessesforEngineers",Prentice Hall, 3rd Edition, 2004/latest edition.
4	V. Veerarajan, "Probability, Statistics and Random Processes", Tata McGraw-Hill Education, 2008/latest edition.

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:

- Understand antenna fundamentals and basic concepts of radiation mechanism of an antenna
- Design different types of basic antennas
- 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 $\lambda/2$ antenna, Half wave dipole, quarter wave monopole, Array Antenna, Array of two driven $\lambda/2$ 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 WaveSpace 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 behaviour 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:
- Demonstrate VLSI tool-flow and appreciate FPGA architecture
- Understand the basics of system on chip and on chip communication architectures.
- Understand the issues involved in ASIC design, including technology choice, design management, tool flow.
- 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.hniques for System-Level Design", Published in The Morgan Kaufmann series, 2008

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:

- Relate basic semiconductor physics to properties of power devices, and combine circuit mathematics and characteristics of linear and non-linear devices.
- Describe basic operation and compare performance of various power semiconductor devices, passive components and switching circuits
- Design and Analyze power converter circuits and learn to select suitable power electronic devices by assessing the requirements of application fields.
- Formulate and analyze a power electronic design at the system level and assess the performance.
- Identify the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus.
- 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 step down 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 cycloconvertor and three phase to three phase cycloconvertor.	
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.

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: None

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

- Understand the nature of management and describe the functions of management·
- Understanding the specific roles of contemporary management.
- Develop understanding of different approaches to designing organizational structures.
- 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.

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

- Understand the concept of marketing and related concepts.
- An in-depth understanding to various elements marketing mix for effective functioning of an organization.
- Learn some of the tools and techniques of marketing with focus on Indian experiences, approaches and cases.

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 ed.) 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:

- Understand the overall role and importance of the finance function for decision-making.
- Recommend whether and why a particular investment should be accepted or rejected by determining an appropriate investment criteria and projecting cash flows associated with corporate project evaluation.
- Differentiate between the various sources of finance and their pros and cons.
- Outline capital requirements for starting a business and management of working capital.
- Analyse the complexities associated with management of cost of funds in the capital structure.
- 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 ofCapital Structure: Factors Determining Capital Structure. Cost of Capital: Concept, Importance and Classification.	
UNIT-III	7 Hours
Capital Budgeting: Concept, Importanceand 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: Operatingcycle, Working Capital Estimation, Inventory Management: EOQ Problem.	
Text Books	
1	M.Y. Khan and P.K. Jain, "Financial Management", McGraw Hill Education, 8th 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:

- Develop an understanding of the concept of human resource management and to understand its relevance in organizations.
- Develop necessary skill set for application of various HR issues.
- Analyze the strategic issues and strategies required to select and develop manpower resources.
- 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 Conceptand 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: HumanResource 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 behaviour, decisions, and actions in performing the duty to the family, organization, and to the society.

Course Objectives:

To facilitate the development of a Holistic perspective among students towards life, profession and happiness, based on a correct understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Value based living in a natural way. To inculcate Ethics and Human Values into the young minds and develop moral responsibility and mould them as best professional which will create ethical vision and achieve harmony in life.

Pre-requisite: Basic ethics knowledge

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

- Develop the capability of shaping themselves into outstanding personalities, through a value based life.
- Students turn themselves into champions of their lives.
- Students take things positively, convert everything into happiness and contribute for the happiness of others.
- Students become potential sources for contributing to the development of the society around them and institutions / organizations they work in.
- Students shape themselves into valuable professionals, follow professional ethics and are able to solve their ethical dilemmas.

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 Enquiry, 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:

- To investigate future careers.
- Allow diligent students to improve their knowledge and area of weakness.
- Help students build a strong resume that shows students willingness and curiosities to the officials and employers.
- 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.

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:

- Distinguish the importance of different networking components.
- Understand the functionalities of each networking layer and standards.
- Write simple networking-based programs at real and simulator level.

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, ifconfig, 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.

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 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 Outcome:
- Develop smart IoT Applications using smart sensor devices and cloud systems.
- Analyze the protocol Stack for IoT in order to address the issues related to heterogeneous devices and networks.
- Design IoT system specific secure protocols.
- 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

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:

- Understand the key dimensions of Cloud Computing.
- Analyze the trade-off between deploying applications in the cloud and over the local infrastructure.
- Compare the advantages and disadvantages of various cloud computing platforms.
- Identify security and privacy issues in cloud computing.
- Explain recent research results in cloud computing and identify their pros and cons.

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", 1stEdition, 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/

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

- Apply the concepts of artificial intelligence for real world problem solving.
- Work in programming languages like Lisp or Prolog.
- 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.

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: Introduce the different concepts for enhancing speed of computation beyond achievable speed from a uniprocessor system. Make students learn about different computer architectures.

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

Learning Outcome: The students will be able to

- Understand the concept of highest achievable computing speed in uniprocessor system
- Acknowledge the concept of pipelining, parallelism etc for achieving higher speed.
- Realise the use of multiprocessor for achieving higher speed .
- Understand different architectures of multiprocessor systems.
- 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.