Course Structure for B. Tech. (ECE-AI) Second Year

Third Semester					
S. No.	**Course Code**	**Subject**	**L-T-P**	**Credits**	**Category**
1.	BEC-205	Network Analysis and Synthesis	3-0-2	4	DCC
2.	BEC-209	Communication Systems	3-0-2	4	DCC
3.	BAI-205	Neural Networks and Artificial Intelligence	3-0-2	4	DCC
4.	BCS-201	Data Structures	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 BIT-201 BCS-203 BMA-211	Material Science & Engineering Numerical Methods Database Management Systems Discrete Structures Engineering Measurements and Metrology	3-0-2 3-0-2 2-0-4 3-1-0 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-206	Electromagnetic Field Theory	3-1-0	4	**DCC**
3.	BEC-210	Digital Communication Systems	3-0-2	4	**DCC**
4.	BAI-204	Optimization Techniques and Decision Making	3-0-2	4	**DCC**
5.	BCS-202 BIT-204 BMA-210 BAS-202 BAS-204 BAI-206	Computer Organization and Architecture Object Oriented Programming Operations Management Nano Structures & Materials in Engg. Optical Engineering Introduction to Data Science	3-0-2 3-0-2 3-1-0 2-1-2 3-0-2 3-0-2	4	**OEC**
6.	HMC-202	Disaster Management	1-0-2	2	**HMC**
		Total		**22**	

COMMUNICATION SYSTEMS	
Course Code: BEC-209 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 3

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

Course Objective:

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

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

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

- Understand the use of communication in electronic systems, computers, automation and control system.
- Analyse and apply different modulation techniques as per the design requirements.
- Analyse different parameters of analog communication techniques.
- Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.

Pedagogy: Classroom teaching, Power-point presentations, Design based Problems.

Contents

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

Linear modulation: Time and frequency domain expression of AM (including intensity modulation of light), DSB, SSB and VSB, Generation of linearly modulated signals, Coherent demodulation and envelope detection	
UNIT-III	**11 Hours**
Angle modulation: Instantaneous frequency; phase and frequency modulation. Single tone FM and its spectral analysis. NBFM and WBFM. Bandwidth requirements of angle modulated signals. Demodulation of angle modulated signal Radio and Television broadcasting: AM radio broadcasting and FM radio and TV broad casting. Frequency division multiplexing, radio transmitters and receivers.	
UNIT-IV	**10 Hours**
Noise in Communication systems: Thermal noise, shot noise and white noise. Noise equivalent bandwidth, noise figure and noise temperature. Time domain representation of narrowband noise. Properties of narrowband noise. Noise in CW modulation systems. Figure of merit: Noise performance of linear and exponential modulation. Pre-emphasis and de-emphasis in FM. Comparison of the noise performance of CW modulation schemes	
Text Books	
1.	Simon Haykin, "Communication System", John Wiley & sons., 4th Edition, 2006
2.	Taub & Schilling, "Principles of Communication System", McGraw hill, 4th Edition, 2017
3.	John G. Proakis, "Communication Systems", McGraw Hill, 5th Edition, 2014.
Reference Books	
1.	B. P. Lathi, "Linear Systems and Signals", Oxford Publication, 3rd Edition, 2017.
2.	Leon W. Couch, "Analog and Digital Communication", Pearson Education, 8th Edition, 2012.
3.	George Kennedy, "Electronic Communication Systems", Tata McGraw Hill, 6th Edition, 2017.

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

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

Course Objective:

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

Pre-requisite: Basic course in Electrical Engineering.

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

- Apply the fundamental concepts in solving and analysing different electrical networks
- Analyse the electrical network in different conditions by selecting relevant technique and apply mathematics in synthesizing the networks in time and frequency domain
- Evaluate the performance of a particular network from its analysis
- Understand the various laws and theorems related to electric networks.
- Understand the concept of two port networks.
- Understand and remember network synthesis.

Pedagogy: Classroom teaching which focusses upon relating the textbook concepts with real world phenomena, along with tutorial classes to enhance the problem solving ability.

Contents

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

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

Neural Networks and Artificial Intelligence	
CourseCode: BAI-205 Contact Hours: L-3 T-0 P- 2	Credits: 4 Semester: 3rd

Introduction:

Neural Networks are an application of artificial intelligence that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. It is used in almost every field of engineering, law, healthcare, finance etc. This course focuses on developing a sound understanding of various neural networks and artificial intelligenceapplications in industry or research.

Course Objective:

- To introduce the basic concepts of artificial intelligence, problem solving, knowledge representation and reasoning.
- To introduce the basic concepts of handling uncertainty
- To provide an understanding of the theoretical concepts and applications of various neural networks and artificial intelligence.

Prerequisite:

Basics of statistics and mathematics.

Course Outcomes:

On successful completion of this course, students will be able to

- Apply the concepts of handling uncertainty in various applications
- Apply the concepts of artificial intelligence for real world problem solving.
- Understand the fundamentals and types of neural network and artificial intelligence and its impact in daily life applications.
- Build basic neural network based pipelines for various applications in the field of engineering, law, healthcare, finance etc.

Pedagogy:

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

Contents

UNIT I	10 Hours
Introduction to Artificial Intelligence, Task Domains of AI, AI Techniques: search knowledge, abstraction. Introduction to Intelligent program and Intelligent agents, State Space representation of problems, Concept of Search, Issues in design of Intelligent search algorithm	
UNIT II	10 Hours
Heuristic search Techniques: Hill climbing techniques, Best First search, A* Search, Problem Reduction: AO* Search, Constraint Satisfaction, Means-End Analysis. Game Playing: Game Tree, Searching procedure Minimax, alpha-beta pruning	
UNIT III	14 Hours
Knowledge Representation and the various issues. Knowledge Representation using Predicate Logic, Rule Based Systems, Forward versus backward reasoning, conflict resolution, Structured Knowledge Representation, Semantic Nets, Frames, conceptual dependency, scripts	
UNIT IV	06 Hours
Introduction to Neural Networks, Overview of biological neurons, Mathematical model of Neuron, Perceptron and Multi Layer Perceptron, Learning in Artificial Neural Networks-Supervised, Unsupervised and Competitive Learning paradigms, Learning rules and Functions, Back propagation algorithm, Radial Basis Function, Hopfield networks, Applications of Artificial Neural Networks.	

Text Books	
1.	Elaine Rich, K. Knight, Artificial Intelligence, McGrawHill, Latest Edition, 2017
2.	Livingstone, David J., ed. Artificial neural networks: methods and applications. Totowa, NJ, USA: Humana Press, 2008.
3.	Christopher Bishop, Pattern recognition and machine learning, Springer Verlag, Latest Edition.

Reference Books	
1.	Fausett, Laurene V. Fundamentals of neural networks: architectures, algorithms and applications. Pearson Education India, 2006.
2.	Nakamoto, Pat. Neural networks and deep learning: deep learning explained to your granny A visual introduction for beginners who want to make their own Deep Learning Neural Network. CreateSpace Independent Publishing Platform, 2017.
3.	Nielsen, Michael A. Neural networks and deep learning. Vol. 25. San Francisco, CA, USA: Determination press, 2015.
4.	Charu, C. Aggarwal. "Neural Networks and Deep Learning: A Textbook." (2018). Springer, ISBN 978-3-319-94462-3

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

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

Course Objective:

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

Pre-requisite: Fundamentals of Programming

Course Outcome:

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

Pedagogy: Classroom teaching which focuses on developing understanding of students to digest the concepts of subject with large number of examples.

Contents

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

Applications of Queues, Priority queues.

Linked Lists: Singly linked lists, Representation of linked list, Operations of Linked list such as Traversing, Insertion and Deletion, Searching, Applications of Linked List. Concepts of Circular linked list and Doubly linked list and their Applications. Stacks and Queues as linked list.

UNIT-III	12 Hours

Trees: Basic Terminology, Binary Trees and their representation, binary search trees, various operations on Binary search trees like traversing, searching , Insertion and Deletion , Applications of Binary search Trees , Complete Binary trees, Extended binary trees. General trees, AVL trees, Threaded trees, B- trees.

Searching and Sorting: Linear Search, Binary search, Interpolation Search, Insertion Sort, Quick sort, Merge sort, Heap sort, sorting on different keys, External sorting.

UNIT-IV	10 Hours

Graphs: Terminology and Representations, Graphs & Multi-graphs, Directed Graphs, Representation of graphs and their Transversal, Spanning trees, shortest path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths.

File Structure: File Organization, Indexing & Hashing, Hash Functions, Collision Resolution Techniques.

Text Books	
1	Horowitz and Sahni, "Fundamentals of Data structures", Galgotia publications, 1983
2	Tannenbaum, "Data Structures", PHI, 2007(Fifth Impression)
3	An introduction to data structures and application by Jean Paul Tremblay & Pal G. Sorenson (McGraw Hill).
Reference Books	
1	R.L. Kruse, B.P. Leary, C.L. Tondo, "Data structure and program design in C", PHI, 2009(Fourth Impression)
2	Seymour Lipschutz Saucham's series , data Structures, Mc, Graw Hill Publication, 2018
3.	Nitin Upadhaya, Data Structures using C, S K Kataria Publicatrions, 2015

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

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

Course Objective:

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

Pre-requisite:

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

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

- Understand the concept, working principles and applications of Op-Amp
- Analyse linear and non-linear Op-Amp circuits
- Apply Op-Amp to solve a variety of application problems
- Remember the concepts of Op-Amps and its practical applications
- Analyse and design analog electronic circuits using discrete components

Pedagogy: Class room teaching, tutorials, Practical based learning

Contents

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

Power amplifiers, Classification of amplifier, Analysis of class A, B and AB amplifiers, Push pull amplifier, Complementary symmetry amplifiers, Conversion efficiency, Cross over distortion, Power distortion, Heat sinks, Tuned amplifiers, Power BJT, IC power amplifiers, MOS power transistors.		
UNIT-IV		**10 Hours**
Active RC filters, Idealistic & realistic response of filters (LP, BP, and HP), Butterworth & Chebyshev approximation filter functions, All pass, Notch filter, Quadrature filter. IC PLL - Operating principle, Monolithic PLL ICs, PLL applications. IC 555 Timer - Internal operation and its applications as Astable and Monostable multivibrator		
Text Books		
1	R. A. Gayakward, "Op-Amps and Linear Integrated Circuit" PHI.	
2	D. Roychaudhary, and S. B. Jain, "Linear Integrated Circuits" New Age International – 2018.	
3	Albert Malvino, David J. Bates, "Electronic principles", 8th Edition, 2015.	
Reference Books		
1	Sedra and Smith, "Microelectronic Circuits", 7th Edition, Oxford University Press, 2010.	
2	J. B. Gupta, "Electronic Devices & Circuits" S. K. Kataria, 2013.	

Digital Communication Systems	
Course Code: BEC-210 **Contact Hours:** L-3 T-0 P-2 **Course Category:** DCC	**Credits:** 4 **Semester:** 4

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.

OPTIMIZATION TECHNIQUES AND DECISION MAKING	
Course Code: BAI-204 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction: Optimization is the process of obtaining the best result under given circumstances. In design, construction and maintenance of any engineering system, engineers have to take many technological and managerial decisions at several stages. A number of optimization methods have been developed for solving different types of optimization problems. This course introduces optimization techniques using linear programming, quadratic programming, integer programming, semi definite programming and different optimization algorithm. It also introduces the basic concepts of decision-making process.

Course Objectives: The objective of this course is to:

- Provide insight to the mathematical formulation of real-world problems.
- Optimize these mathematical problems using nature-based algorithms.

Prerequisite: Basic Mathematics, Differential Calculus

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

- Formulate optimization problems.
- Understand and apply the concept of optimality criteria for various types of optimization problems.
- Apply the methods of optimization in real life situation
- Relate key concepts and applications of various optimization techniques
- Identify the appropriate optimization technique for the given problem
- Explain basic steps in decision analysis and decision-making environments.

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 optimization: Engineering application of Optimization, Formulation of design problems as mathematical programming problems. General Structure of Optimization Algorithms, Constraints, The Feasible Region.	
UNIT-II	**10 Hours**
Branches of Mathematical Programming: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming, Semi Definite Programming.	
UNIT-III	**12 Hours**
Optimization Algorithms: Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc. Real life Problems and their mathematical formulation as standard programming problems. Recent trends: Applications of ant colony optimization, genetics and linear and quadratic programming in real world applications.	
UNIT-IV	**10 Hours**
Decision Making: Basic Steps in Decision Analysis, Decision-Making Environments, Decision Making Under Uncertainty, Decision Making Under Risk, Utility Theory, Decision Tree, Group Decision Making: GDM Methods, Content-Oriented Methods, Multicriteria Decision Making.	
Text Books	
1	Rao, S. S., "Engineering optimization: theory and practice", John Wiley & Sons, 4th Edition, 2009/Latest Edition.
2	Edwin K., P. Chong & Stanislawh. Zak., "An Introduction to Optimization", Wiley-Inter science, 2nd Edition, 2001/Latest Edition.
3	Andreas Antoniou, Wu- Sheng Lu, "Practical Optimization Algorithms and Engineering Applications", Springer, 2007/Latest Edition.
4	Ishizaka, Alessio, and Philippe Nemery, "Multi-criteria decision analysis: methods and software", John Wiley & Sons, 2013/Latest Edition.
Reference Books	
1	Dimitris Bertsimas, Robert Weismantel, "Optimization over integers Dynamic Ideas", 2005/Latest Edition.
2	H. Paul Williams, "Logic and Integer Programming", Springer, 2009/Latest Edition.
3	Xu, Zeshui. "Uncertain multi-attribute decision making: Methods and applications", Springer, 2015/Latest Edition.
4	Tzeng, Gwo-Hshiung, and Jih-Jeng Huang. "Multi Attribute Decision Making: Methods and Applications", USA, CRC Press. 2016/Latest Edition.

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

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

Course Objective:

- To list Maxwell's equations and solve them for specific regular geometries.
- Understand general electromagnetic wave propagation and its applications to engineering problems.

Pre-requisite: No requisite

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

- Understand EM Waves
- Remember the concepts of Electrostatic and Magneto statics field.
- Analyze and formulate fields and electromagnetic waves propagation problems in a multi-disciplinary frame individually or as a member of a group.
- Remember the different concepts of electrostatic, magnetostatic and time varying electromagnetic systems.
- Understand and remember the different coordinate systems.

Pedagogy: Class room teaching, smart classes, Tutorials.

Contents

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

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

INTRODUCTION TO DATA SCIENCE	
Course Code : BAI-206 **Contact Hours**: L-3 T-0 P-2 **Course Category**: OEC	**Credits**: 4 **Semester** : 4

Introduction: This course provides basics of the standards of collecting, organizing, managing, exploring and using data. This course acknowledges the inter-disciplinarily of data science and the importance of building a strong foundation with students.

Course Objective:

- To develop broad academic and practical literacy in statistics with relevance in data science
- To enable students to critically select and apply appropriate methods and techniques to extract relevant and important information from data.
- To understand not only how to apply certain methods, but when and why they are appropriate
- To expose students to real world problems in the classroom through experimental learning.

Pre-requisite: No requisite

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

- Identify and describe the methods and techniques for obtaining and analysing data
- Recognize how data analysis, modelling and statistical computing can be utilized in an integrated capacity.
- Demonstrate the ability to prepare data for analysis and assemble data from a variety of sources.

Pedagogy: Classroom teaching which focuses upon relating the textbook concepts with real world phenomena, along with tutorial classes to enhance the problem solving ability.

Contents

UNIT I	10 Hours
Introduction to Data Science, Evolution of Data Science, Data Science Roles, Stages in a Data Science Project, Applications of Data Science in Various Fields, Data Security Issues.	
UNIT II	12 Hours
Data Collection Strategies, Data Pre-Processing Overview, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization. Descriptive Statistics, Mean, Standard Deviation, Skewness and Kurtosis, Box Plots, Pivot Table, Heat Map, Correlation Statistics, ANOVA.	
UNIT III	10 Hours
Model Development: Simple and Multiple Regression, Model Evaluation using Visualization, Residual Plot, Distribution Plot, Polynomial Regression and Pipelines, Measures for In-Sample Evaluation, Prediction and Decision Making.	
UNIT IV	10 Hours
Model Evaluation: Generalization Error, Out-of-Sample Evaluation Metrics, Cross Validation, Over fitting, Under Fitting and Model Selection, Prediction by using Ridge Regression, Testing Multiple Parameters by using Grid Search.	
Text Books	
1.	Jojo Moolayil, “Smater Decisions: The Intersection of IoT and Data Science”, PACKT, 2016.
2.	Cathy O’Neil and Rachel Schutt, “Doing Data Science”, O’Reilly, 2015.

Reference Books	
1.	David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big Data Analytics”, EMC 2013.
2.	Raj, Pethuru, “Handbook of Research on Cloud Infrastructures for Big Data Analytics”, IGI Global.