Indira Gandhi Delhi Technical University for Women

(Established by Govt. of Delhi vide Act 09 of 2012)

Kashmere Gate, Delhi–110006

Scheme of Examination

&

Detailed Syllabus

(w.e.f. Academic Year 2019-2020 onwards)

for

Bachelor of Technology
(Information Technology)

Department of Information Technology

PROGRAMME OUTCOMES

Engineering Graduates will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities withthe engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding ofthe engineering and management principles and apply these to one's own work, asa member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAMME SPECIFIC OUTCOMES

Programme Specific Outcomes: Department of Information Technology

PSO1. The graduates shall have a scientific outlook with a wide spectrum fundamental knowledge of applied mathematics, basic engineering principles of physics and mechanics and their application as problem solving skills in the designing software applications.

PSO2. With a B.Tech degree in the field of Information Technology, graduates will be able to analyze and recommend the appropriate IT infrastructure needed to implement the project in the field of software application development. The graduates shall have thorough knowledge in design, develop, and testing the software systems to provide solutions to real-world problems.

PSO3. The graduates shall have demonstrable interpersonal and social communication skills along with team building, interpersonal relationship, group discussion, current affairs etc.

PSO4. The Graduates of Information technology will be able to use and implement core Information Technology concepts like human-computer interaction, information management, programming, and networking. The graduates of information technology can effectively integrate IT-based solutions into user-based environment.

THIRD SEMESTER

S. No.	Subject Code	Subject	L-T-P	Credits	Category
1.	BCS-201	Data Structures	3-0-2	4	DCC
2.	BIT-201	Database Management Systems	3-0-2	4	DCC
3.	BCS-203	Discrete Structures	3-1-0	4	DCC
4.	BIT-203	Software Engineering	3-0-2	4	DCC
5.	GEC-201	Generic Open Elective	0-2-0 0-0-4 2-0-0	2	GEC
6.	BIT-253	Industrial Training/Internship	-	1	DCC
7.	BAS-201 BAS-203 BEC-209 BMA-209	Material Science and Engineering Numerical Methods Analog and Digital Electronics Engineering Measurement and Metrology	3-1-0 3-1-0 3-0-2 3-0-2	4	OEC
		Total		23	

FOURTH SEMESTER

S. No.	Subject Code	Subject	L-T-P	Credits	Category
1.	BCS-202	Computer Organization and Architecture	3-0-2	4	DCC
2.	BIT-202	Operating System	3-0-2	4	DCC
3.	BCS-204	Design and Analysis of Algorithms	3-0-2	4	DCC
4.	BIT-204	Object Oriented Programming	3-0-2	4	DCC
5.	BAS-202 BAS-204 BAS-206 BEC-210 BMA-210	Nanostructures & Materials in Engineering Optical Engineering Optimization Techniques Elements of Information Theory Operations Management Engineering	3-1-0 3-0-2 3-1-0 3-1-0 3-1-0	4	OEC
6.	HMC-202	Disaster Management	1-0-2	2	HMC
		Total		22	

FIFTH SEMESTER

S. No.	Subject Code	Subject	L-T-P	Credits	Category
1.	BCS-301	Artificial Intelligence	3-0-2	4	DCC
2.	BIT-301	Data Communication and Computer Networks	3-0-2	4	DCC
3.	BAS-301	Modeling and Simulation	3-0-2	4	BAS
4.	BCS-303	Theory of Computation	3-1-0	4	DCC
5.	HMC-301	Professional Ethics and Human Values	3-0-0	3	HMC
6.	BIT-353	Industrial Training/Internship	-	1	DCC
7.	GEC-301	Generic Open Elective Course	0-2-0 0-0-4 2-0-0	2	GEC
		Total		**22**	

SIXTH SEMESTER

S. No.	Subject Code	Subject	L-T-P	Credits	Category
1.	BCS-302	Wireless Networks	3-0-2	4	DCC
2.	BIT-304	Cloud Computing	3-0-2	4	DCC
3.	BIT-306	Data Mining and Machine Learning	3-0-2	4	DCC
4.	DEC-3xx	DepartmentalElectiveCourse-1	3-1-0 3-0-2	4	DEC
5.	DEC-3xx	DepartmentalElectiveCourse-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**	

List of Departmental Elective Courses (approved)

Category	Course Code	Subject	Credits
Departmental ElectiveCourse-1	BIT-308	Advanced-Data Structure and Algorithm	3-0-2
	BIT-310	Internet of Things	3-0-2
	BIT-312	Advanced Database Management Systems	3-0-2
	BCS-314	Computer Graphics	3-0-2
Departmental ElectiveCourse-2	BIT-314	Enterprise Java Programming	3-0-2
	BCS-306	Compiler Design	3-1-0
	BIT-316	Computer Vision	3-0-2
	BIT-318	Swarm and Evolutionary Optimization	3-0-2

SEVENTH SEMESTER

S. No.	Subject Code	Subject	L-T- P	Credits	Category
1.	BIT-401	Mobile Computing	3-0-2	4	DCC
2.	BIT-403	Software Testing	3-0-2	4	DCC
3.	DEC-4xx	DepartmentalElectiveCourse-3	3-1-0 3-0-2	4	DEC
4.	DEC-4xx	DepartmentalElectiveCourse-4	3-1-0 3-0-2	4	DEC
5.	BIT-451	Minor Project	0-0-8	4	DCC
6.	BIT-453	Industrial Training/Internship	-	1	DCC
		Total		21	

EIGHTH SEMESTER

S. No.	Subject Code	Subject	L-T- P	Credits	Category
1.	BIT-402	Information and Network Security	3-0-2	4	DCC
2.	DEC-4xx	Departmental Elective Course-5	3-0-2	4	DEC
3.	DEC-4xx	Departmental Elective Course-6	3-1-0 3-0-2	4	DEC
4.	BIT-452	Major Project	0-0-16	8	DCC
5.	GEC-402	Generic Open Elective	0-2-0 0-0-4 2-0-0	2	GEC
		Total		22	

List of Departmental Elective Courses

Category	Course Code	Subject	Credits
Departmental Elective Course-3	BIT-405	Soft Computing	3-0-2
	BIT-407	Big Data Analytics	3-0-2
	BEC-409	Digital Image Processing	3-0-2
	BIT-409	Distributed Systems	3-0-2
Departmental Elective Course-4	BIT -413	Software Project Management	3-1-0
	BIT -415	Advanced Operating System	3-1-0
	BIT -417	E- Commerce	3-1-0
	BIT- 419	Cyber Security and Forensics	3-0-2
Departmental Elective Course-5	BIT -404	Requirement Estimation Theory	3-1-0
	BCS -406	Natural Language Processing	3-0-2
	BIT -406	Information Retrieval	3-0-2
	BIT- 408	Neural Networks and Deep Learning	3-0-2
Departmental Elective Course-6	BIT -410	Cryptography	3-1-0
	BCS -410	Quantum Computing	3-1-0
	BIT -412	Advance Software Engineering	3-0-2
	BCS- 412	Computational Optimization Techniques	3-1-2

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 Information Technology. It deals with all aspects of Data structures like static and dynamic data structure and how to choose a particular data structure for any specific problem.

Course Objectives:

- To impart the basic concepts of data structures and algorithms
- To understand concepts about searching and sorting techniques
- To Understand basic concepts about stacks, queues, lists, trees and graphs
- To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.

Pre-requisite: Fundamentals of Programming

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

CO1: To explain the concept of time and space complexity of the algorithm.
CO2: To understand the use of fundamental data structures and algorithm appropriately to solve a number of computational problems.
CO3: To apply various algorithms to solve the problems of searching and of data.
CO4: To design programs using a variety of data structures such as stacks, queues, hash tables binary trees, search trees, heaps, graphs, and B-trees.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations, and quizzes. Students would be encouraged to develop an understanding of the subject. The use of ICT and web-based sources will be adopted.

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, InsertionSort, Quick sort, Merge sort, Heap sort, sorting on different keys, External sorting.	
UNIT-IV	**10 Hours**
Graphs: Terminology and Representations, Graphs & Multi-graphs, Directed Graphs, Representation of graphs and their Transversal, Spanning trees, shortest path and Transitive Closure, Activity Networks, Topological Sort and Critical Paths. **File Structure:** File Organization, Indexing & Hashing, Hash Functions, Collision Resolution Techniques.	

Text Books	
1	Horowitz, Sahni, and Anreson, "Fundamentals of Data structures in C", Universities Press, 2008 / Latest Edition.
2	Tannenbaum, "Data Structures", Pearson Education India, Latest Edition, 2007
3	Richard F. Gilberg, Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", 2004/ Latest Edition.
Reference Books	
1	R.L. Kruse, B.P. Leary, C.L. Tondo, "Data structure and program design in C", PHI, 2009/Latest Edition.
2	Seymour Lipschutz Saucham's series, "Data Structures", Mc-Graw Hill Publication, 2018/Latest Edition.

Database Management Systems	
Course Code: BIT-201 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 3

Introduction:

Database Management System (DBMS) is used for creating and managing the databases. The main aim of a DBMS is to supply a way to store-up and retrieve the desired database information as per the application requirement, which is both convenient and efficient.

Course Objectives:

- To introduce the concepts of database management systems
- To design relational databases by applying normalization techniques to normalize the database
- Strong practice in SQL programming through a variety of database problems.
- Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Pre-requisites: Basic concepts of set theory

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

CO1: To have a high-level understanding of major DBMS components and their function.
CO2: To model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.
CO3: To write SQL commands to create tables and indexes, insert/update/delete data, and query data in a relational DBMS
CO4: To understand the concept of Transaction, concurrency, and Query processing.

Pedagogy:

Lecture delivery via discussions, whiteboard, slideshows, online learning material, Lab work with exercises on SQL.

UNIT-I	10 Hours
Overview of Concepts and Conceptual Database Design: Database Administrator and Database Users, Characteristics of the Database, Database Systems, Concepts and Architecture, Data Models, Schemes & Instances, DBMS Architecture & Data Independence, Database Languages & Interfaces, Overview of Hierarchical, Network & Relational Data Base Management Systems, Data Modeling using Entity-Relationship Model, Strong and Weak Entity Sets, Generalization, Specialization, and Aggregation.	
UNIT-II	**10 Hours**
Relational Model, Languages & Systems: Relational Model Concepts, Relational Model Constraints, Translating your ER Model into Relational Model, Relational Algebra, Relational Calculus (Tuple Calculus) SQL: A Relational Database Language, Data Definiton in SQL, View and Queries in SQL, Specifying Constraints and Indexes in SQL, Practicing SQL commands.	
UNIT-III	**12 Hours**
Relational Data Base Design: Functional Dependencies & Normalization for Relational Databases, Functional Dependencies, Normal Forms (1NF, 2NF, 3NF, BCNF, 4NF, 5NF), Lossless Join and Dependency Preserving Decomposition, Multivalued Dependency, Join dependency. Transaction Management: Transaction Concept and State, Implementation of Atomicity and Durability, Serializability, Recoverability, Implementation of Isolation	
UNIT-IV	**10 Hours**
Concurrency Control: Lock-Based Protocols, Timestamp-based Protocols, Deadlock Handling, Recovery System, Failure Classification, Storage Structure, Recovery and Atomicity, Log-based Recovery. Query Processing: Query Processing Overview, Measures of Query Cost. Framework of Distributed Data Base Management Systems, Introduction to Enhanced Databases: Multimedia Databases, Object Oriented Databases, Mobile Databases.	

Text Books	
1	Elmasri Ramez and Navathe Shamkant, Fundamentals of Database System, Pearson, 6th Ed. (June 2017)
2	Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill, 3rd Ed., 2003/Latest Edition.
3	Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw Hill, 6th Ed//Latest Edition.
Reference Books	
1	Ceri and Pelagatti, Distributed Databases: Principles & Systems, McGraw-Hill, 2017.
2	Conolly & Begg. Database Management Systems, Pearson Education Asia, 5th Edition, 2010

Discrete Structures	
Course Code: BCS-203 Contact Hours: L-3 T-1 P-0 Course Category: DCC	Credits: 4 Semester: 3

Introduction: The discrete structures subject introduces Propositional logic, Sets, Relations, and Functions, Algebraic structures, Graphs and Trees required for building mathematical foundation of computer science.

Course Objectives:

- To introduce and understand the fundamental notions in discrete mathematics.
- To understand basic concept of an algorithm and its application in combinatorial Mathematics.
- To introduce the basic properties of graphs and trees and model simple applications.
- To learn concepts of discrete mathematics.

Pre-requisites: Basic concepts of set theory.

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

CO1: To convert a logic sentence in terms of predicates, quantifiers, and logical connectives and its validation.
CO2: Able to use logical notations to define and reason about fundamental mathematical concepts such as sets relations, functions and combinatorics.
CO3: Able to use logical notations to define and reason about fundamental mathematical concepts of abstract algebra.
CO4: Apply algorithms and use of graphs and trees as tools to analyse and simplify Problems

Pedagogy:
The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations, and quizzes. Students would be encouraged to develop an understanding of the subject. The use of ICT and web-based sources will be adopted.

UNIT-I	10 Hours
Propositional logic: Syntax, semantics, valid, satisfiable and unsatisfiable formulas, Mathematical reasoning, propositions, negation disjunction and conjunction, implication and equivalence, truth tables, predicates quantifiers, natural deduction, rules of Inference **Methods of proofs:** Forward proof, proof by contradiction, contra positive proofs, proof of necessity and sufficiency.	
UNIT-II	**10 Hours**
Sets, relations and functions: Operations on sets, relations, binary relations, partial ordering relations, equivalence relations and partitions, Partial orderings, Posets, Linear and well-ordered sets, principles of mathematical induction. Functions, mappings, injection and surjections, composition of functions, inverse functions, special functions; Peono postulates; pigeonhole principle; recursive function theory. **Size of a set:**Finite and infinite sets, countable and uncountable sets, Cantor's diagonalargument and the power set theorem, Schröder-Bernstein theorem.	
UNIT III	**12 Hours**
Algebraic structures and Morphisms: Algebraic structures with one binary operation - semigroups, monoids and groups, subgroups and their properties, congruence relation and quotient structures. Free and cyclic monoids and groups, permutation groups, substructures, normal subgroups. Algebraic structures with two binary operations - rings, integral domains and fields. Boolean algebra and Boolean ring.	
UNIT IV	**10 Hours**
Graphs and trees: Terminology, Graphs and their basic properties - degree, path, cycle, subgraphs, isomorphism, Eulerian and Hamiltonian walks, Graph coloring, planar graphs,directed graphs, trees terminology, tree traversals, spanning trees.	

Text Books	
1	Kenneth H Rosen (Editor-in-chief), Handbook of Discrete and Combinatorial Mathematics, CRC Press, 2000/Latest Edition.
2	C L Liu, Elements of Discrete Mathematics, McGraw-Hill/Latest Edition.
3	Bernard Kolman, Robert C Busby, and Sharon Cutler Ross, Discrete Mathematical Structures, Prentice-Hall of India/Latest Edition.
Reference Books	
1	Ralph P Grimaldi, Discrete and Combinatorial Mathematics, Pearson Education Asia/Latest Edition.
2	Norman L Biggs, Discrete Mathematics, Oxford University Press/Latest Edition.
3	J P Tremblay and R Manohar, Discrete mathematical structures with applications to Computer Science, McGraw-Hill/Latest Edition.

Software Engineering	
Course Code: BIT-203 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 3

Introduction:

This course introduces students to the different software development lifecycle (SDLC) phases used in developing, delivering, and maintaining software products. Students will also acquire basic software development skills and understand common terminology used in the software engineering profession. The aim of the course is to provide an understanding of the working knowledge of the techniques for estimation, design, testing and quality management of software development projects.

Course Objectives:

- To introduce the concepts of software engineering, software processes and its models.
- To understand the software requirements analysis, transform the requirements using DFD, create software requirement specification document and validation of the software requirements.
- To understand fundamentals of software design, software quality and software maintenance.
- To understand the project planning process, size and cost estimation techniques further development of software.

Pre-requisites: Basic knowledge of Programming Languages.

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

CO1: To understand the concepts of Software engineering, Software process and its models.
CO2: To evaluate the Software Requirements, interpret and structure the requirements in Software required document.
CO3: To apply appropriate software architectures and patterns to carry out high level design of a system and be able to critically compare alternative choices, evaluate the quality and maintenance of the software through software testing.
CO4: To create the software project plan for size and cost estimation including risk analysis.

Pedagogy:

This course is structured around continuous progress. It will include a combination of lectures, and group activities focused on experiential learning, in-class discussions, regular assessments and case studies. The topics will be presented to students using real-world scenarios and problem-solving activities.

UNIT-I	10 Hours
Introduction: Introduction of Software (SW), Type of Software, SW Components: Process, People, Project, Product, Software crisis, Software Process Models: Details of People involved in each Process, SDLC methods/models: Build & Fix, Waterfall, Prototype (Evolutionary & Throw-away), Iterative, Incremental iterative, Spiral, RAD, Agile methodology.	
UNIT-II	**11 Hours**
Requirement Analysis & Specifications: Requirement Analysis, Requirement Specification, Approaches to Requirement analysis, Specifying Behavioral & Non-Behavioral Requirements, SRS Components & various Users of SRS. Introduction of Requirement Specification: Dataflow (DF) Diagram, Data dictionaries, Entity-Relationship (ER) diagram, Object Diagram etc., Requirement Validation.	
UNIT-III	**11 Hours**
Software Design and Testing: Design Architecture and Patterns, Modularity, Function oriented design, Object Oriented Design, Software Testing: Software Testing Strategy and Techniques, Functional testing, Structural testing, Debugging and testing tools, SW/HW reliability, Reliability concepts and models, Reliability allocation, Software Maintenance: Introduction to SW Maintenance and types, SW Maintenance models: Re-engineering & Forward Engineering.	
UNIT-IV	**10 Hours**
Software Project Planning: Role of Software Project Planning, Estimation method, Estimation of Effort & Schedule, Software Metrics: Introduction to Size metrics, Data structure metrics, information flow metrics, entropy-based measures, metric analysis. Basic COCOMO, Intermediate COCOMO, Detailed COCOMO, Quality Planning, Planning Parameter, Quality Defect Removal Cycle, Role of Risk Analysis.	

Text Books	
1	R.S.Pressman,"Software Engineering–A Practitioner's Approach", McGraw Hill, 8thEdition, 2019 / Latest Edition
2	K.K.Aggarwal, Y.Singh, "Software Engineering",NewAge International Ltd, 3rd Edition, 2008/ Latest Edition.
Reference Books	
1	I. Sommerville, "Software Engineering," Pearson, 10th Edition, 2017/ Latest Edition.
2	P. Jalote, "Software Engineering: A precise approach", Wiley Publications, Edition, 2010/ Latest Edition

Generic Open Elective Course	
Course Code: GEC-201 Contact Hours: L-0 T-0 P-4 L-0 T-2 P-0 L-2 T-0 P-0 Course Category: GEC	Credits: 2 Semester: 3

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. GEs are introduced as part of the CBCS. The students can choose their preference from a pool of courses 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 objectives:

- Students will have exposure to a new discipline/subject.
- Prepare students to look for inter-disciplinary research.
- 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.

Prerequisite: Basic knowledge of the selected domain of elective course

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

CO1: Identify new discipline and learn new subject for future careers.

CO2: Apply their knowledge to understand and solve the real-life problems.

CO3: Analyze creative design process through the integration and application of diverse technical knowledge and expertise to address social issues.

CO4: Develop the habit of working independently to 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.

Industrial Training/Internship	
Course Code: BIT253 Course Category: DCC	Credits: 1 Semester: 3

Course Objectives:

Students will carry on the industrial training/internship for at least six weeks in the summer break of previous academic session. The idea of the training is to make 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. The assessment for the same will be done within the first two weeks of opening of academic session by the respective department.

Course Outcomes:

CO1: Understand the Organizational Structure of a company.

CO2: Develop work habits and attitudes necessary for job success (technical competence, professional attitude, organization skills etc.)

CO3: Develop written communication and technical report writing skills.

CO4: Develop an awareness for the need and applications of standards in the industry.

MATERIAL SCIENCE AND ENGINEERING	
Course Code: BAS-201 Contact Hours: L-3 T-1 P-0 Course Category: OEC	Credits: 4 Semester: 3

Introduction:

At the core of any technological advancement are the materials. Material Science and Engineering course give insight into importance of materials, their various classifications and physical properties. The course also provides an insight into various characterization techniques useful in studying the physical properties of materials.

Course Objectives:

- To provides an insight into the scope of Material Science and Engineering and classification of various Materials.
- To acquire basic understanding of the electronic, superconducting dielectric and magnetic properties of materials for technological applications.
- To familiarize with modern engineering materials and bio-materials in various applications.
- To develop an understanding of principles, working and applications of various material characterization techniques.

Pre-requisites: Basic understanding of Applied Physics Course.

Course Outcomes: After Studying this course, the students will be able to:

CO1: Understand scope and importance of materials in technological development.
CO2: Learn importance and utilization of various physical properties of materials in device applications.
CO3: Enhance the knowledge of latest advancements in field of materials, Modern Engineering and Biomaterials.
CO4: Learn the principles, working and applications of various material characterization techniques in studying the materials.

Pedagogy:

Apart from class room teaching, main focus is to enhance problem solving ability supported by weekly assignments and discussing individual's doubts.

UNIT-I	4 Hours
Introduction to materials: Importance of Material science and Engineering, Classification of Materials: Metallic, Ceramic, Polymeric, Electronic and Composite Materials.	

UNIT-II	16 Hours
PROPERTIES OF MATERIALS **Electronic Materials:** Fermi energy and Fermi–Dirac distribution function – Variation of Fermi level with temperature in intrinsic and extrinsic semiconductors – Hall effect. **Superconducting Materials:** Normal and High temperature superconductivity, Applications. **Dielectric Materials:** Polarization mechanisms in dielectrics, Frequency and temperature dependence of polarization mechanism, Piezoelectric properties. **Magnetic Materials:** Types of Magnetism: Diamagnetism, Paramagnetism, Ferromagnetism, Anti-ferromagnetism, Ferrimagnetism, Classification of magnetic materials based on spin, Hard and soft magnetic materials, Spintronics (GMR).	

UNIT-III	10 Hours
MODERN ENGINEERING AND BIOMATERIALS **Photonic Materials:** LED – LCD – Photo conducting materials, Photo detectors, Photonic crystals and applications. **Smart materials:** – Shape memory alloys, Chromic materials (Thermo, Photo and Electro),Composite Materials. **Bio-materials:** Metallic implant materials (stainless steel, cobalt-based and titanium-based alloys) – Polymeric implant materials.	

UNIT-IV	10 Hours
MATERIALS CHARACTERIZATION **Structural Analysis:** X-ray diffraction, SEM, TEM, AFM- Principals, Instrumentations and applications. **Optical Characterizations:** UV-Vis, FTIR-Principals, Instrumentations and applications. **Thermal Analytical Techniques:** TGA, DTA, DSC-Principals, Instrumentations and applications.	

Text Books	
1	William D. Callister, Materials Science and Engineering: An Introduction, 8th Edition Edition, John Wiley & Sons, 2010/Latest Edition.
2	Sam Zhang, Lin Li, Ashok Kumar,"Materials Characterization Techniques", 1st Edition, CRC Press, 2008/Latest Edition.
3	T. Pradeep, "A Text Book of Nanoscience and Nanotechnology", Tata McGraw Hill, New Delhi, 2012/Latest Edition.
Reference Books	
1	Elements of X–ray Diffraction, B. D. Cullity, S.R. Stock, 3rdEdition, Pearson,2001/Latest Edition.
2	R. F. Egerton,Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, 2nd Edition, Springer,2016/Latest Edition.

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

Introduction:

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

Course Objectives:

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

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

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

CO1: Understand the errors, source of error and its effect on any numerical computations and also analysis the efficiency of any numerical algorithms.
CO2: Learn how to obtain numerical solution of nonlinear equations using bisection, secant, Newton, and fixed-point iteration methods
CO3: Solve system of linear equations numerically using direct and iterative methods.
CO4: Understand how to approximate the functions using interpolating polynomials.
CO5: Learn how to solve definite integrals and initial value problems numerically.

Pedagogy:

Apart from class room teaching, main focus is to enhance problem solving ability supported by weekly assignments and discussing individual's doubts.

UNIT 1	10 Hours
Floating-Point Numbers: Floating-point representation, rounding, chopping, error analysis, -conditioning and stability. **Non-Linear Equations**: Bisection, secant, fixed-point iteration, Newton method for simple and multiple roots, their convergence analysis and order of convergence.	
UNIT-II	**11 Hours**
Linear Systems and Eigen-Values: Gauss elimination method using pivoting strategies, LU decomposition, Gauss-Seidel and successive-over-relaxation (SOR) iteration methods and their convergence, ill and well-conditioned systems, Rayleigh's power method for eigen-values and eigen-vectors.	
UNIT-III	**11 Hours**
Interpolation and Approximations: Finite differences, Newton's forward and backward interpolation, Lagrange and Newton's divided difference interpolation formulas with error analysis, least square approximations. Numerical Integration: Newton-Cotes quadrature formulae (Trapezoidal and Simpson's rules) and their error analysis, Gauss--Legendre quadrature formulae.	
UNIT-IV	**10 Hours**
Differential Equations: Solution of initial value problems using Picard, Taylor series, Euler's and Runge- Kutta methods (up to fourth-order), system of first-order differential equations.	

Text Books	
1	Jain M.K., Iyengar, S.R.K., and Jain, R.K. Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International Publication,2012/Latest Edition.
2	Sastry S., Introductory Methods of Numerical Analysis, 5th Edition, Prentice Hall India Learning Private Limited; 2012/Latest Edition.
3	Conte, S.D and Carl D. Boor, Elementry Numerical Analysis: An Algorithmic approach, SIAM-Society for Industrial and Applied Mathematics, 2017/Latest Edition.
4	Grewal, B. S., "Higher Engineering Mathematics", 44thEdition, Khanna Publishers, 2012/Latest Edition.
Reference Books	
1	Gerald C.F and Wheatley P.O., Applied Numerical Analysis, 8thEdition, Pearson Education, 2011/Latest Edition.
2	Chappra S.C., Numerical Methods for Engineers, 7th Edition, McGraw-Hill Higher Education, 2014/Latest Edition.

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

Introduction:

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

Course Objective:

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

Pre-requisite:

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

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

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

Pedagogy:

Class room teaching, problem solving approach, practical based learning, tutorials.

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

Text Books	
1	Morris Mano, "Digital Design", PHI, 5th edition, 2013/Latest Edition.
2	Millman and Halkias, "Electronic Devices and Circuits" TMH, 4th Edition, 2015/Latest Edition.
3	Salivahanan, Suresh Kumar, Vallavaraj, "Electronic Devices and Circuits" TMH, 4th Edition, 2016/Latest Edition.
Reference Books	
1	Balbir Kumar and S. B. Jain, "Electronic Devices and Circuits" PHI, 2nd Edition 2014/Latest Edition.
2	R.P. Jain, "Modern Digital Electronics", TMH, 4th Edtion, 2010/Latest Edition.
3	Roy Choudhury and Jain, "Linear Integrated Circuits", New Age Publishers, 4th Edition, 2017/Latest Edition.

ENGINEERING MEASUREMENT AND METROLOGY	
Course Code: BMA-209 Contact Hours: L-3 T-0 P-2 Course Category: OEC	Credits: 4 Semester: 3

Introduction: This is a basic introductory course on measurement and metrology to be used in industry. A course on how to adopt and apply various methods of measurement. It enlightens the students about the various errors, calibration, sensors, accuracy of measurements thus to help in standardizing the methods.

Course Objectives:

- To enlighten the students on measurement process and why it is so important.
- The course aims to explain the students that in what best way to do measurement and develop standardization of measuring method.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-requisites: **NIL**

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

CO1: Understand Measurement Process and various techniques

CO2: Understand sensors and Transducer.

CO3: Understand measurement instrument capabilities

CO4: Understand Statically control techniques

CO5: The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy:

Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

UNIT I	11 Hours
Introduction: Introduction to measurement and measuring instrument generalized measuring system and functional elements, units of measurement, static and dynamic performance characteristics of measurement devices, calibration concept of error, Types and sources of error, statistical analysis of errors. **Sensors and Transducers:** Types of sensors, types of transducers and their characteristics, Difference b/w Open loop and Closed loop measurement system, Signal conditioning unit, indicating unit, static characteristics i.e. accuracy, precision, sensitivity, resolution, linearity. **Measurement of flow:** Methods of flow measurement, hot wire anemometer, ultrasonic flow meter.	
UNIT II	11 Hours
Measurement of pressure: Elastic and indirect type pressure transducers. Measurement of very low pressures. **Strain measurement:** Types of strain gaugesand their working, temperature Compensation. **Measurement of force and torque:** Different types of load cells, elastic transducers, pneumatic and hydraulic systems. **Temperature measurement:** Thermocouples, pyrometers.	
UNIT III	10 Hours
Metrology and Inspection: Sources of error, Standards of linear measurement, line and end standards, Limit fits and tolerances, Interchangeability and standardization. **Length Standards:** Line standards, end standards, transfer from line standards to end standards, Numerical based on-line standards, slip gauges – its use and care, methods of building different heights using different sets of slip gauges. **Linear and angular measurements devices and systems Comparators:** Types of Gauges, Limit Gauge, Snap Gauge, Receiving Gauge, Taylor's Principle of Gauge Design.	
UNIT IV	10 Hours
Measurement of geometric forms like straightness, flatness, roundness, Tool makers microscope, profile project autocollimator. **Interferometry:** principle and use of interferometer, optical flat. Measurement of screw threads and gears. **Surface texture:** quantitative evaluation of surface roughness and its measurement, Comparators, Feature inspection Form Tolerance Inspection. Tolerance Stack Analysis, CMM, working and features.	

Text Books	
1.	A.K. Tayal, "Instrumentation and Mechanical Measurement", Galgotia Publications Pvt. Ltd., 2003/Latest Edition.
2.	T.G. Beckwith, R.D. Maragoni and J.H Lienhard, "Mechanical Measurements", Addison-Wesley, 1999/Latest Edition.
Reference Books	
1.	R.K. Jain, "Engineering Metrology", Khanna Publishers, Delhi,2010/Latest Edition.
2.	I.C. Gupta, "Engineering Metrology", Dhanpat Rai Publications, Delhi,2011/Latest Edition.
3.	F.W. Galyer& C.R. Shotbolt, "Metrology for Engineers", ELBS edition, 2009/Latest Edition.

Computer Organization & Architecture	
Course Code: BCS- 202 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction:

In order to achieve complete understandings of computer systems, it is always important to consider both hardware and software design of various computer components. In other words, every functionality of the computer has to be studied to increase the performance of the computer. Computer organization and architecture mainly focuses on various parts of the computer in order to reduce the execution time of the program, improve the performance of each part.

Course Objective:

- Understand the basics of computer organization: structure and operation of computers and their peripherals.
- Understand basic processing unit and organization of simple processor.
- Expose different ways of communicating with I/O devices and standard I/O interfaces.
- Understand concept of pipelining and other large computing system.

Pre-requisite: Fundamentals of computers and digital logic.

Course Outcome:

CO1: Ability to Demonstrate an understanding of the design of the functional units of a digital computer system.
CO2: Explain the instruction set, instruction formats and Addressing modes of CPU
CO3: Ability to Recognize and manipulate representations of numbers stored in digital computers and perform Basic arithmetic Operations.
CO4: Ability to analyze memory hierarchy and its impact on computer Cost/performance.

Pedagogy:

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

UNIT-I	12 Hours
Digital Logic Circuit: Basic Logic functions, Synthesis of logic functions using basic and universal gates, Boolean Algebra Properties, Flip-Flops, Registers, Shift- Registers, Counters, Decoders, Multiplexers, Functional Unit of computer system. **Data Representation:** Data types, R & (R-1)'s Complements, Fixed-Point representation, Floating point representation. **Register Transfer and Micro operations:** Register transfer language, register transfer, Bus and Memory transfer, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations	
UNIT-II	10 Hours
Basic Computer Organisation and Design: Instruction Codes, Computer Instructions, Timing and Control, Instruction Cycle, Memory Reference Instructions, Input-Output and Interrupt. **Micro programmed Control:** Control Memory. **Central Processing Unit:** Stack Organization, Instruction Formats, Addressing Modes, Program Control, Reduced Instruction Set Computer: RISC characteristics, CISC characteristics. Performance and Metrics.	
UNIT-III	10 Hours
Pipelining and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipelining, Instruction Pipelining, RISC Pipelining, Vector Processing, Array Processors. **Computer Arithmetic:** Addition and Subtraction, Multiplication Algorithms, Division Algorithms, Floating- Point Arithmetic Operations.	
UNIT-IV	10 Hours
Input-Output Organization: Peripheral Devices, Input-Output interface, Asynchronous data transfer, Modes of transfer, Priority Interrupt, Direct Memory Access. **Memory organization:** Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware.	

Text Books	
1	M. Morris Mano, "Computer System Architecture", PHI, 3rd Edition, 2016/Latest Edition.
2	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, "Computer Organization", McGraw Hill, 5 th Edition, 2012/Latest Edition.
3	William Stallings, "Computer Organization and Architecture", PHI, 11th edition, 2021/Latest Edition.

Reference Books	
1.	John L. Hennessy and David A. Patterson, "Computer Architecture a quantitative approach", Elsevier, 6th Edition, 2019/Latest Edition.
2.	A. Anandkumar, "Fundamentals of digital circuits", PHI, 4th edition, 2016/Latest Edition.

OPERATING SYSTEMS	
Course Code: BIT-202 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction:

This course will aim at introducing classical internal algorithms and structures of modem operating systems including CPU scheduling, memory management, and device management. Topics including file systems, virtual memory, disk request scheduling, concurrent processes, deadlocks, security, and integrity will be covered.

Course Objectives:

- To learn the fundamentals of Operating Systems & the mechanisms of OS to handle processes and their communication.
- To learn the mechanisms involved in memory management.
- To gain knowledge on OS architecture, mutual exclusion algorithms, deadlock detection algorithms etc.

Pre-requisite: Basic programming knowledge in C or C++.

Course Outcome: After studying this course, students will be able:

CO1: To understand various types of OS, basic concepts, various functions of different OS, process management & CPU scheduling.

CO2: To compare and contrast various memory management schemes like paging, segmentation and to apply different deadlock handling algorithms

CO3: To implement different disk scheduling algorithms, to apply and use various process synchronization techniques and device management strategies.

CO4: To analyse management of I/O and different file handling & directory implementation schemes OS.

Pedagogy:

The class will be taught using theory and tutorial-based methods which include board teaching and presentations/slides, discussions, brainstorming, case studies etc. Along with classroom teaching, students will also be given assignments regarding the topics covered.

UNIT-I	11 Hours
Introduction: Introduction to Operating System, **Types of O.S:** Simple Batch, Multi- programmed Batched, Time-Sharing, Personal-computer, Parallel, Distributed, Real-Time,Mobile **Operating-System Structures:** Layered Architecture, System Calls, System Programs,System Structure, Virtual Machine **Processes:** Process Concept, Process Scheduling, Operations on Processes, CooperatingProcesses, Inter-process Communication, Threads, Multithreaded Programming. **CPU Scheduling:** Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Real-Time Scheduling	
UNIT-II	**11 Hours**
Process Synchronization: Background, Critical-Section Problem, Synchronization Hardware, Semaphores, Classical Problems of Synchronization, Critical Regions,Monitors. **Memory Management:** Background, Logical versus Physical Address space, Swapping, Contiguous allocation, Fragmentation, Paging, Segmentation, Segmentation with Paging. **Virtual Memory:** Demand Paging, Page Replacement, Page-replacement Algorithms,Performance of Demand Paging, Allocation of Frames, thrashing. **Deadlocks:** System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock	
UNIT-III	**10 Hours**
Device Management: Techniques for Device Management, Dedicated Devices, SharedDevices, Virtual Devices **Secondary-Storage Structure:** Disk Structure, Disk Scheduling, Disk Management,Swap-Space Management, Disk Reliability, Stable-Storage Implementation	
UNIT-IV	**10 Hours**
Information Management: Introduction, Simple File System, General Model of a File System, Symbolic File System, Basic File System, Access Control Verification, Logical File System, Physical File System **File-System Interface:** File Concept, Access Methods, Directory Structure, Protection, and Consistency Semantics. **File-System Implementation**: File-System Structure, Allocation Methods, Free-Space Management, Directory Implementation, Efficiency and Performance, Recovery.	

Text Books	
1	Silberschatz and Galvin, “Operating System Concepts”, John Wiley, 9th Ed., 2016/Latest Edition.
2	Madnick E. and Donovan J., “Operating Systems”, McGraw Hill, 2017/Latest Edition.
3	Tannenbaum, “Operating Systems”, PHI, 5th Ed/Latest Edition.

DESIGN AND ANALYSIS OF ALGORITHMS	
Course Code: BCS-204 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction:

This course deals with teaching different methodologies of designing algorithms. There are certain standard approaches of analyzing the algorithms. This course deals with all aspects of these analysis. It teaches the concepts of Dynamic programming, different approaches of algorithm design like Greedy approach etc.

Course Objectives:

- Introduction, learning and analysis of performances of algorithmic efficiency of approaches such as searching, sorting etc.
- Introduction, learning and analysis of greedy paradigms.
- Introduction, learning and analysis of dynamic programming and back tracking.
- Introduction, learning and analysis of computational complexity and branch & bound.

Pre-requisites: Data structures.

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

CO1: Understand asymptotic complexities of the algorithms and design algorithms using Divide and apply different deadlock handling algorithms.

CO2: Understand and apply greedy and dynamic programming approaches for designing algorithms.

CO3: Understand, analyse and implement various graph algorithms and the backtracking approach of algorithm design.

CO4: Understand and implement different string-matching algorithms and NP-Complete problems.

Pedagogy:

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

UNIT-I	10 Hours
Algorithm definition and specification, analysis of algorithmic efficiency of algorithms Review of growth of function, space complexity, time complexity, Recurrences: Substitution method, Iteration method, Master method, Divide and Conquer Approach: merge Sort, quick sort, shell sort, heap sort, Simultaneous Max and Min Problem, Strassen's algorithm for matrix multiplications.	
UNIT-II	**10 Hours**
Greedy Algorithms: Elements of Greedy strategy, knapsack problem, job sequencing with deadlines, minimum spanning trees, Activity selection problem, Huffman Codes. **Dynamic Programming:** Elements of Dynamic Programming, Matrix Chain Multiplication, longest common subsequence and optimal binary search trees problems.	
UNIT-III	**12 Hours**
Graph Algorithms: DFS, BFS, Topological Sort, Strongly Connected Components, Kruskal's and Prim's algorithm for MST, Dijkstra's and Bellman Fort Algorithm, All pair shortest paths Algorithm. **Back Tracking:** General method, n-queen's problem, Branch and Bound: General Method, 0/1 knapsack.	
UNIT-IV	**10 Hours**
String matching: Naïve String-Matching algorithm, Rabin-Karp Algorithm, String Matching with finite automata, The Knuth-Morris Pratt algorithm. NP-Complete Problem: Polynomial time verification, NP-Completeness and Reducibility, NP-Completeness Proof, NP-Complete problems.	

Text Books	
1	T .H .Cormen, C .E .Leiserson, R .L .Rivest, "Introduction to Algorithms", 3rd Ed., PHI/Latest Edition.
2	E. Horowitz, S. Sahni, and S. Rajsekaran, "Fundamentals of Computer Algorithms," 2nd Ed., Universities Press/Latest Edition.
3	P. H. Dave, H. B. Dave, "Design and Analysis of Algorithms", 2nd Ed., Pearson Education/Latest Edition.
Reference Books	
1	Design and Analysis of Algorithms, S. Sridhar, Oxford Univ. Press/Latest Edition.
2	Design and Analysis of algorithms, Aho, Ullman and Hopcroft, Pearson Education, 2008./Latest Edition.
3	Foundations of Algorithms, R. Neapolitan and K. Naimipour, 4th edition, Jones and Bartlett Student edition/Latest Edition.

OBJECT ORIENTED PROGRAMMING	
Course Code: BIT-204 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction:

This course provides in-depth coverage of object-oriented programming principles and techniques. Topics include classes, objects, overloading, data abstraction, information hiding, encapsulation, inheritance, polymorphism, file processing, templates, exceptions, container classes etc. The course material embraces the C++ language standard/ Python with numerous examples demonstrating the benefits of C++/Python. In the end some basics of Java will be covered.

Course Objectives:

- To learn the syntax and semantics of the C++/java/python programming language.
- To understand object-oriented programming concepts, and apply them in solving problem
- To understand and design efficient programming.
- To demonstrate skills in writing programs using Java programming.

Pre-requisite: Basics of Programming language**.**

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

CO1: Understand fundamentals syntax and their use to develop Object Oriented
CO2: Java/Python program to express proficiency and improve effective programming skills
CO3: Understand commonly used operations for file system, exception handling and create namespace solutions.
CO4: Implement Java based program and make effective use of Tools

Pedagogy:

Emphasis on lab sessions where students will be given programming assignments to code in C++/Python/Java based on topics learnt in previous lectures.

UNIT-1	10 Hours
Need for Object Oriented Programming, Comparison of Programming paradigms, Characteristics of Object-Oriented Programming Languages, Introduction to Object Oriented concepts (classes, objects, encapsulation, inheritance, data hiding, abstraction, polymorp hism), Fundamentals Data Types & Literals Variables, Arrays, Operators, Control of Flow in OOP, Compilation and Execution of Process , Reference vs. Pointer variable, Classes and Objects: class declaration, Role of private, public and protected access specifiers, Memory organization of class, inline function, friend function, static members , constructor and destructors, instantiation of objects, default parameter value, object types, garbage collection, dynamic memory allocation, new and delete operator	
UNIT-II	**11 Hours**
Polymorphism: Function overloading, Constructor overloading, Compile time polymorphism, Overloading Rules, Operator Overloading (Unary and Binary) as member function/friend function. Inheritance, Types of Inheritance, Use of protected access specifier, Virtual base class, Ambiguity resolution using scope resolution operator and Virtual base class, Overriding inheritance methods, Constructors and Destructor in derived classes, Runtime polymorphism, Pointer to objects, Virtual Functions (concept of virtual table), pure virtual functions, Abstract Class.	
UNIT-III	**11 Hours**
Managing Input / Output, Concept of streams, console I/O – formatted and unformatted, Manipulators, File I/O – Predefined classes, file opening & closing, file manipulation, read & write operations, sequential and random file access, **Exception Handling**: Basic mechanism, Throwing, Catching and Re-throwing. **Namespace**: Basic concept, role of scope resolution operator and using keyword, Introduction to Java- Overview and characteristics of Java, Data types, Organization of the Java Virtual Machine, Compilation and Execution Process in java	
UNIT-IV	**10 Hours**
Java Classes: String and String Buffer classes, Wrapper classes, using super keyword, Multilevel hierarchy abstract and final classes, Object class, Packages and interfaces, Access protection, Exception Handling: Fundamentals exception types, uncaught exceptions, throw, throws, final, built in exception, creating your own exceptions, Multithreaded Programming: Fundamentals, Java thread model: priorities, synchronization, thread classes, Runnable interface, inter thread Communication, suspending, resuming and stopping threads.	

Text Books	
1	Herbert Schildt , "Java: The Complete Reference", 11th Edition, McGraw Hill, 2018/Latest Edition.
2	Martin C. Brown, "Python: The Complete Reference", 4th Edition, McGraw Hill, 2018 /Latest Edition.
Reference Books	
1	Mark Lutz, "Learning Python" 3rd Edition, O'Reilly Media, 5th Ed. 2017 /Latest Edition.
2	Bjarne Stroustrup , "The C++ Programming Language", Pearson, 4th Ed, 2009/Latest Edition.

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

Introduction:

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

Course Objective:

- To Introduce the basic concepts of artificial intelligence, problem solving, knowledge representation and reasoning.
- To introduce the basic concepts of handling uncertainty.
- To help the students to applications of AI in different fields.

Pre-requisite: Discrete Mathematics, Programming Concepts.

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

CO1: Apply the concepts of artificial intelligence for real-world problem solving.
CO2: Work in programming languages like Java or Python.
CO3: 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.

UNIT I	10 hours
Introduction to AI: Brief introduction about Intelligent agents and Problem Solving. Turing Test. 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 Python/Java. Text Feature Extraction - BoW Model, TF-IDF. Word Embeddings - Word2Vec, GloVe, stemming, lemmatization	
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: Real World Applications of AI: Expert System Architecture, Case Studies: MYCIN, Applications in NLP, Medical Sciences, Agriculture, education, Social Network Analysis, Information Retrieval from Search Engines and Metasearch Engines, IoT Applications & Big Data Analytics Applications, Ethics in AI -	

Text Books	
1	S.J. Russell and P. Norvig, "Artificial Intelligence- A Modern Approach", Pearson 3rd Edition, 2010/Latest Edition.
2	P.H. Winston, "Artificial Intelligence", Pearson Education, 3rd Edition, 2002/ Latest Edition.
Reference Books	
1	E. Rich and K. Knight, "Artificial Intelligence", McGraw Hill Education; 3rd Edition 2017,/ 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.

Data Communications & 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 this digital data between two or more computers and a computer network or data network is a telecommunications network that allows computers to exchange data. The physical connection between networked computing devices is established using either cable media or wireless media. The best-known computer network is the Internet.

Course Objectives:

- The students should understand the layers 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: Data Structures and Algorithms.

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

CO1: Describe the fundamental concepts and layered architecture of computer networking.
CO2: Explain the basic concepts of link layer properties to detect error and develop the solution for error control and flow control. Design, calculate, and apply subnet masks and addresses to fulfill networking requirements. Also, compare various routing protocols.
CO3: Comprehend the duties of transport layer and congestion control techniques.
CO4: Illustrate the features and operations of various application layer protocols such as DNS, HTTP, FTP, e-mail protocols and other applications; and focus on network security issues to secure communication towards society.

Pedagogy:

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

UNIT I	11 hours
Introduction: Goals and Applications of Networks, Layering Concept, OSI Reference Model vs 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. Hub & Repeater. Sampling Theorem (Nyquist-Shannon Theorem) **Network Traffic Capturing:** Wireshark (windows) and tcpdump (linux).	
UNIT II	**10 hours**
Data Link Layer: Addressing; Error Detection & Correction – General concepts, Checksum & CRC; Medium Access – Aloha, CSMA, CSMA/CD & CA; Protocols – Ethernet, ARP & RARP; Switch – Learning & Filtering Mechanism, Wireless Access (Bluetooth & Wi-Fi) **Network Layer:** IP Addressing & Subnets; Basic Routing (or Forwarding) Mechanism; IPv4 frame format and functions; Routing protocols – RIP, OSPF & BGP and algorithms – Distance Vector & Link State. **Linux Network Commands**: arp, route, ifconfig, netstat, traceroute, ping.	
UNIT III	**11 hours**
Transport Layer: Port Addresses; Protocols - Simple, Stop n Wait, Go Back N & Selective Repeat; UDP – Services & Applications; TCP – header format, connection setup & termination, state transition diagram, flow control, error control, congestion control & timers.	
UNIT IV	**10 hours**
Application Layer: Web & HTTP, FTP, Email, Telnet, SSH, DNS. **Advanced Protocols:** SNMP, RTP, SIP, BitTorrent, Wireshark (Case Studies)	

Text Books	
1	Forouzan, "Data Communication and Networking", TMH, 5th Edition, 2013/Latest Edition.
2	A.S. Tanenbaum, "Computer Networks", PHI, 4th Edition, 2002/Latest Edition.
3	W. Stallings, "Data and Computer Communication", Macmillan Press, 2013/Latest Edition.
4	Comer, "Computer Networks and Internet", PHI, 2008/Latest Edition.
Reference Books	
1	Stallings, "Data and Computer Communication", McMillan, 2010/Latest Edition.
2	J. Martin, "Computer Network and Distributed Data Processing", PHI,2008/Latest Edition.
3	W. Stallings, "Local Networks", McMillan, 2013/Latest Edition.
4	M.Schwertz, "Computer Communication Network Design and Analysis", PHI, 1977/Latest Edition.
5	S. Keshav, "An Engineering Approach to Computer Networking, Pearson", 2001/Latest Edition.

Theory of Computation	
Course Code: BCS-303 Contact Hours: L-3 T-1 P-0 Course Category: DCC	Credits: 4 Semester: 5

Introduction:

The study of automata and the theory of computation deal with the concepts of working of automatic machine and processing of input formal language data. This subject provides an important background material to students involved in understanding the basic functionalities of automata theory.

Course Objectives:

- Introduce concepts in Automata theory and theory of computation
- Identify different formal language classes and their relationships
- Design grammars and recognizers for different formal languages

Pre-requisite: Basic concepts of mathematics

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

CO1: Understand the basics of automata and its fundamentals.
CO2: Understand theory of computation and concepts of formal languages
CO3: Design grammars and recognizers for different formal languages
CO4: Analyze the finite automata and regular expressions for accepting the language.

Pedagogy:

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

UNIT I	11 hours
Introduction to Theory of Computation: Definitions: Languages, Grammar, Automata, Applications of Theory of Computation, Finite Automata: DFA, NDFA, Equivalence of DFA and NDFA, DFA Minimization Regular Languages, Regular Grammars, Properties of Regular Languages, Pumping Lemma	
UNIT II	**10 hours**
Context Free Language: Introduction, Parsing and Ambiguity, Pushdown Automata (PDA), Non-Deterministic PDA, Context Free Grammar, Chomsky Normal Form, Greibach Normal Form, Parse Tree representation of Derivation Tree, Equivalence of PDA and CFGs, Properties of Context Free Grammars	
UNIT III	**11 hours**
Pumping Lemmas: Pumping Lemma for context free languages, Pumping lemma for linear languages. Turing Machine: Definition, TM as language acceptors, TM as transducers, Hierarchy of Formal Languages and Automata, Chomsky Hierarchy, Context Sensitive Languages and LBA, Unrestricted Grammars	
UNIT IV	**10 hours**
Turing machine Models and complexity: Some NP Problems, Complexity classes P and NP, Unsolvable Problem, Halting problem, Finite State Transducers: Introduction, Mealy Machines**,** Moore Machines, Mealy and Moore Equivalence, Limitations of Finite State transducer	

Text Books	
1	P. Linz, "An Introduction to Formal Languages and Automata", Narosa Publishers, 2010/ Latest Edition.
2	J. Ullman, J. Hopcroft, "Introduction to Automata Theory, Languages and Computation", Pearson Education India, 3rd Edition, 2008/ Latest Edition.
Reference Books	
1	M. Sipser, "Introduction to the Theory of Computation", Cengage, 3rd Edition, 2014/Latest Edition.
2	C.K. Nagpal, "Formal Languages and Automata Theory", Oxford University Press, 2015/Latest Edition.

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

Introduction:

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

Course Objectives:

The objective of this course is to impart a basic understanding of system and their modeling. Students will be introduced to mathematical modeling and their applications with simulation techniques. Also, the use of MATLAB/R/Mathematica will help the students to simulate the various mathematical models.

Pre-requisite: None

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

CO1: Understand the procedure of modeling of various systems using appropriate modeling techniques.
CO2: Learn about various models such as Monte Carlo simulation models, queuing models, and mathematical models.
CO3: Formulate and solve the mathematical models for the systems.
CO4: 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.

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	Chaturvedi, K. Devendra., "Modeling and Simulation of Systems using MATLAB and Simulink", CRC press, 2017/Latest Edition.
2	Gordon, Steven I., and B. Guilfoos, "Introduction to Modeling and Simulation with MATLAB® and Python", CRC Press, 2017/Latest Edition.
Reference Books	
1	Kapur, J. Narain. "Mathematical modeling". New Age International, 1988/Latest Edition.
2	Barnes, Belinda & Fulford, R. Glenn,"Mathematical Modelling with Case Studies, Using Maple and MATLAB" (3rd ed.). CRC Press, Taylor & Francis Group, 2015/Latest Edition.
3	Velten, K. Mathematical Modeling and Simulation: Introduction for Scientists and Engineers. John Wiley & Sons, 2009/Latest Edition.
4	Banerjee, Sandip, "Mathematical Modeling: Models, Analysis and Applications", CRC Press, 2014/Latest Edition.

Professional Ethics and Human Values	
Course Code: HMC 301 Contact Hours: L-3 T-0 P-0 Course Category: HMC	Credits: 3 Semester: 5

Introduction:

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

Course Objectives:

To 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: High school level moral studies

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

CO1: Develop the capability of shaping themselves into outstanding personalities, through a value-based life.

CO2: Students turn themselves into champions of their lives.

CO3: Students take things positively, convert everything into happiness and contribute for the happiness of others.

CO4: Students become potential sources for contributing to the development of the society around them and institutions / organizations they work in.

CO5: 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.

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 Kumar., "Engineering Ethics", Prentice Hall, New Delhi, 2004/Latest Edition.
2	R. Subramaniam, "Professional Ethics", Oxford University Press, New Delhi, 2013/Latest Edition.
3	M. Martin and R. Schinzinger, "Ethics in engineering", McGraw-Hill, New York 1996/Latest Edition.
4	R. R. Gaur, R. Sangal, G.P. Bagaria, "A Foundation Course in Human values and Professional Ethics", Excel Books Pvt. Ltd, New Delhi 2009/Latest Edition.
5	A. N. Tripathi, "Human Values", New Age International Publishers, New Delhi, 2nd Edition, 2004/Latest Edition.
Reference Books	
1	B. P. Banerjee, "Foundation of Ethics and Management", Excel Books, 2005/Latest Edition.

2	Fleddermann, Charles D., "Engineering Ethics", Pearson Education. 2004/Latest Edition.
3	Harris, E. Charles, Protchard, Michael S. And Rabins, Michael, J., Wadsworth, "Engineering Ethics- Concepts and Cases", Thompson Learning, 2000/Latest Edition
4	Boatright, John R., "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003/Latest Edition.
5	S. Ranganathananda, "Universal Message of the Bhagavad Gita: An exposition of the Gita in the light of modern thought and modern needs", Vol. I – III, Advaita Ashrama (Publication Department), Kolkata. 2000/Latest Edition.
6	P. Singer, "Practical Ethics", Oxford University Press, 1993/Latest Edition.

Industrial Training/Internship	
Course BIT 353 Course Category: DCC	Credits: 1 Semester: 5

Course Objectives:

Students will carry on the industrial training/internship for at least six weeks in the summer break of previous academic session. The idea of the training is to make 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. The assessment for the same will be done within the first two weeks of opening of academic session by the respective department.

Course Outcomes:

CO1: Understand the Organizational Structure of a company.
CO2: Develop work habits and attitudes necessary for job success (technical competence, professional attitude, organization skills etc.)
CO3: Develop written communication and technical report writing skills.
CO4: Develop an awareness for the need and applications of standards in the industry.

Generic Open Elective Course	
Course Code: GEC-301 Contact Hours: L-0 T-0 P-4 L-0 T-2 P-0 L-2 T-0 P-0 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. GEs are introduced as part of the CBCS. The students can choose their preference from a pool of courses 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 objectives:

- Students will have exposure to a new discipline/subject.
- Prepare students to look for inter-disciplinary research.
- 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 Outcomes: After completion of the elective course, the students will be able to:

CO1: Identify new discipline and learn new subject for future careers.
CO2: Apply their knowledge to understand and solve the real life problems.
CO3:Analyse creative design process through the integration and application of diverse technical knowledge and expertise to address social issues.
CO4: Develop the habit of working independently to 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

Wireless Networks	
Course Code: BCS - 302 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 6

Introduction:
This course is about teaching of the fundamental concepts of wireless networks and imparting basic knowledge of the different types of ad-hoc networks and underlying protocols. Course will provide the understanding of the architecture of wireless networks for its various application setups.

Course Objectives:

- To understand the basics of wireless adhoc networks, mesh and sensor networks.
- To familiarize students with the challenges involved in wireless networks with respect to wired networks.
- To study about various types of wireless networks, i.e. cellular networks, Bluetooth, Ad hoc networks, wireless mesh networks and wireless sensor networks.
- To discover about various design, security and privacy issues in wireless networks.

Prerequisite: Basic knowledge of wireless communication and computer networks.

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

CO1: Understand the underlying technologies of wireless networks.
CO2: Understand of the existing wireless protocols for MAC layer, Network layer and transport layer.
CO3: Understand the concepts of ad hoc networks and the design / performance issues in wireless local area networks and wide area networks.
CO4: Understand the function of the node architecture and use of sensors for 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.

UNIT I	10 hours
Introduction: Introduction to Ad-hoc networks – definition, characteristics features, applications. Characteristics of Wireless channel, Adhoc Mobility Models: - Indoor and outdoor models. **MAC Protocols:** design issues, goals and classification. Contention based protocols, IEEE Standards: 802.11, 802.15.	
UNIT II	**10 hours**
Network Protocols: Routing Protocols: Design issues, Proactive Vs reactive routing protocols, Unicast routing protocols, Multicast routing protocols, hybrid routing protocols, Energy aware routing protocols, Hierarchical Routing protocols **Transport Layer:** Issues in designing Transport Layer, Transport layer classification, Ad-hoc transport protocols.	
UNIT III	**10 hours**
Wireless Mesh Networks: Necessity for Mesh Networks, MAC enhancements, IEEE 802.11s Architecture, Opportunistic Routing, Heterogeneous Mesh Networks, Vehicular Mesh Networks	
UNIT IV	**12 hours**
Wireless Sensor Networks: Introduction, Sensor Network architecture, Data Dissemination, Data Gathering, Location discovery, Quality of Sensor Networks, Sensor Network Platforms and Tools, Energy Efficient Approaches	

Text Books	
1	C.S.R Murthy and B. S. Manoj, "Ad hoc Wireless Networks Architectures and Protocols", Pearson Education, 2nd Edition, 2004/Latest Edition.
2	H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, Student Edition (Indian), 2016/Latest Edition.

Reference Books	
1	R. Hekmat, "Ad-hoc Networks: Fundamental Properties and Network Topologies", Springer, 1st Edition, 2006/ Latest Edition.
2	C.K.Toh, "Adhoc Mobile Wireless Networks", Pearson Education, 1st Edition, 2015/Latest Edition.
3	W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks –Theory and Practice", Wiley 2010/ Latest Edition.
4	E. Charles "Ad hoc networking", Pearson Education India, 1st Edition, 2008/Latest Edition.

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

Introduction:

Cloud computing is a scalable service 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 Objectives:

- To learn the use of various cloud computing services and cloud deployment models.
- Understand the concept of virtualization in cloud computing.
- To apply the concepts of cloud computing for designing, evaluating, simulating and comparing various applications in a cloud computing environment.
- To gain the confidence in resource management and load balancing algorithms in a cloud computing environment.
- To gain the confidence 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 Outcomes:

CO1: To articulate key concepts of cloud computing and computing techniques, strength and limitations of cloud computing with possible application domains.

CO2: To identify the architecture and infrastructure of cloud computing including SaaS, PaaS, IaaS, public cloud, private cloud and hybrid cloud.

CO3: To interpret various data, scalability and cloud services to acquire efficient database for cloud storage.

CO4: To explain the core issues of cloud computing such as security, privacy and interoperability and deal with controlling mechanism for accessing sage cloud service.

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.

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 and characteristics of cloud computing, Cloud as green and smart, Cloud as IaaS, PaaS, SaaS, BPaaS and 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 and Network virtualization, Storage Network Design: Architecture of storage, Analysis and planning, Storage models, 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 preventive measures: : Infrastructure layer, Network layer and Application layer of cloud computing architecture, Security models in cloud, Resource management in cloud computing, Static and dynamic load balancing in cloud computing, Identity access management and Trust in cloud computing, Thin client.	
UNIT IV	**10 hours**
Cloud providers and case studies: Amazon EC2, Amazon EC service level agreement and recent developments, GoGrid, Salesforce.com, Force.com, Google App Engine, Rackspace, Government of India Cloud, IBM cloud, Eucalyptus cloud, Analysis of Case Studies when deciding to adopt cloud computing architecture.	

Text Books	
1	B. Sosinsky, "Cloud Computing Bible", 1st Edition, Wiley-India, 2011/ Latest Edition.
2	R. Buyya, C. Vecchiola, and S. T. Selvi, "Mastering cloud computing: foundations and applications programming", 1st Edition, Newnes, 2013/ Latest Edition.
3	Thomas Erl, Zaigam Mahmood, Ricardo Puttini, "Cloud Computing Concepts, Technology & Architecture", 1st Edition, Pearson India, 2013/ Latest Edition.
Reference Material	
1	A. Shawish and M. Salama, "Cloud computing: paradigms and technologies." In Inter-cooperative collective intelligence: Techniques and applications, Springer, 2014/ Latest Edition.
2	M. Miller, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", 1st Edition, Pearson Education India, 2008/ Latest Edition
3	https://swayam.gov.in/course/4413-cloud-computing
4	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs20/

Principles of Management	
Course Code: HMC 302 Contact Hours: L-2 T-0 P-0 Course Category: HMC	Credits: 2 Semester: 6

Introduction:

To give a preview of basics of management to engineering students, this course discusses about the basic nature of management and describes the functions of management, the specific roles of contemporary management, 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 Objective:

- 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: Communication skills.

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

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

CO2: Understanding the specific roles of contemporary management.

CO3: Develop understanding of different approaches to designing organizational structures.

CO4: Understand the role of personality, learning and emotions at work.

C**O5**: Discover and understand the concept of motivation, leadership, power and conflict.

CO6: 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.

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.
Reference Books	
1	C. B. Gupta, "Management Concepts and Practices", Sultan/Latest Edition
2	W. Ghillyer, "Management- A Real World Approach", McGraw Hill Education, 2010/Latest Edition.
3	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 elective functioning of an organization. Students will learn some of the tools and techniques of marketing with focus on Indian experiences, approaches and cases.

Course Objective:

- 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: Basic economics.

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

CO1: Understand the concept of marketing and related concepts.

CO2: An in-depth understanding to various elements marketing mix for effective functioning of an organization.

CO3: 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.

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", McGraw Hill Education, 2012/Latest Edition.
2	C.W. Lamb, J.F. Hair, C. McDaniel, D. Sharma, "MKTG: a South Asian Perspective with Coursemate", Cengage Learning, 2016/Latest Edition.
3	R. Winer, "Marketing Management", 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 Objective:

- 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: Basic economics.

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

CO1: Understand the overall role and importance of the finance function for decision-making.
CO2: 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.
CO3: Differentiate between the various sources of finance and their pros and cons.
CO4: Outline capital requirements for starting a business and management of working capital.
CO5: Analyze the complexities associated with management of cost of funds in the capital structure.
CO6: 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.

UNIT I	7 hours
Financial Management Definition, scope, objectives of Financial Management, Functions of a finance manager, Time value of money. Sources of Finance for different Organizations.	
UNIT II	**7 hours**
Capital Structure: Meaning of Capital Structure: Factors Determining Capital Structure. Cost of Capital: Concept, Importance and Classification.	
UNIT III	**7 hours**
Capital Budgeting: Concept, Importance and Appraisal Methods: Pay Back Period, Accounting, Rate of Return, Net Present Value Method (NPV), Profitability Index, and IRR. Capital Rationing.	
UNIT IV	**7 hours**
Working Capital Management: Operating cycle, Working Capital Estimation, Inventory Management: EOQ Problem.	

Text Books	
1	M.Y. Khan and P.K. Jain, "Financial Management", McGraw Hill Education, 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, 2017/Latest Edition.
3	S.N. Maheshwari, "Financial Management: Principles and Practice", Sultan Chand, LN, 2019/Latest Edition.

Advanced Data Structure and Algorithm	
Course Code: BIT 308 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction:

This course builds upon the introductory courses in data structures and algorithms. It introduces students to a number of highly efficient algorithms and data structures for solving data driven computational problems across a variety of areas. Moreover, this course will help students to master the fundamental ideas surrounding the data structure required in becoming an exemplary programmer.

Course Objectives:

- Understand principles behind the advances in data structures and algorithms.
- Enhance the student's expertise in algorithmic analysis and algorithm design techniques.
- Apply data structures and algorithms in real time applications.
- Ensure that the students evolve into a competent programmer.

Pre-requisite: Introduction to Programming, Data Structures and Algorithms.

Course Outcomes: After completing this course, students will be able to:

CO1: Understand the basic concepts of Data structures and its operations.
CO2: Evaluate and apply the Algorithm design techniques to solve the real-world problem such as Sequence Alignment and Knapsack problem.
CO3: Apply the concept of Graph theory to solve the path problem and network problem.
CO4: Develop the algorithm to design software 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.

UNIT I	10 hours
Review of data structures: Arrays, Stacks, Linked Lists, Queues, BST. Hash tables – collision resolution, Hash functions, Open addressing. Dictionary. Data Frames and operations. Multi-dimensional Arrays (NumPy) and operations.	
UNIT II	**10 hours**
Algorithm Design Techniques – Divide and Conquer (Counting Inversions, Integer Multiplication), Greedy (Clustering, Interval Scheduling), Dynamic (Sequence Alignment, Subset Sum & Knapsack), Branch & Bound, Backtracking. Randomized algorithms. Approximation algorithms.	
UNIT III	**10 hours**
Review of Graphs – DFS and BFS, MST, Shortest Path – Single Source and All Pair. Degree Distribution, Paths, Distances, Connectedness, Clustering Coefficient, Random Networks – Evolution, Small World, Barabasi-Albert Model.	
UNIT IV	**10 hours**
Network Flow: Max-Flow problem, Ford-Fulkerson algorithm, Augmenting paths, Bipartite Matching problem, Applications: Airline Scheduling, Image Segmentation. Evolving Networks: Bianconi-Barabasi Model.	

Text Books	
1	A.Aho, J.Ullman, J. Hopcroft.,"Data Structures and Algorithms", Pearson Education, 1st Edition, 1983/ Latest Edition.
2	J. Kleinberg and E. Tardos. "Algorithm Design", 1st Edition, Pearson Education, 2013/ Latest Edition.
Reference Books	
1	T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to Algorithms", MIT Press, 3rd Edition, 2009/ Latest Edition.
2	Al. Barabasi. "Network Science", 1st Edition, Cambridge University Press, 2016/ Latest Edition.
3	P. Brass, "Advanced Data Structures", 1st Edition, Cambridge University Press, 2008/ 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 Objectives:

- Impart understanding of various building blocks and working of state-of-the-art IoT systems.
- Learn the basic issues, policy and challenges in the Internet and understand the cloud and internet environment.
- Design and program own IoT devices by using real IoT communication protocols.
- Analyze the data generated from the IoT devices.

Prerequisite: Design and Analysis of Algorithms, Data Structures and Algorithms and Computer Networks

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

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

Pedagogy:

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

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 Books	
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	H. Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", 1st Edition, CRC Press, 2015/ Latest Edition

Advanced Database Management Systems	
Course Code: BIT-312 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction:

Students study the basic and fundamentals of Database Management Systems at UG level, where they cover basics of RDBMS, Normalization, SQL, Transaction Management and Concurrency control techniques. However, since the complexity and size of databases is continuously increasing, advanced approaches to store and manage the data is required.

Course Objectives:

- To learn advanced and complex queries in SQL
- To learn PL/SQL with an emphasis on Exceptions handling, Cursors, Triggers, Procedures, Functions and Packages in PL/SQL
- To learn new approaches and trends in Databases like OODBMS, DDBMS, Multimedia database Management Systems and Big Data approaches.

Pre-Requisite: Understanding of Database Concepts and SQL.

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

CO1: Write appropriate programs (Procedures/Functions/Triggers) at Server side for better, efficient and secure application development.

CO2: Implement various advanced concepts of Database management Systems like Object Oriented System, Distributed Database Systems and Multimedia Database Management Systems for database design.

CO3: Understand big data along with concepts like Hadoop, Map Reduce, NoSQL, Pig and Hive for management and analytics.

CO4: implement unstructured big data along with concepts like Hadoop, Map

Pedagogy:

The subject will be taught through lectures, presentations and working on case studies. Lab sessions will cover exercises on advanced SQL queries, PL/SQL programs, use of object-oriented concepts in database designing along with hands on experiments on Big Data.

UNIT I	10 hours
Advanced SQL: Joins (Outer, Inner and Self Join), Nested Queries, Views, Indexes, Materialized Views, Embedded SQL, dynamic SQL, SQLJ, Cursor, Exception Handling, Triggers, Procedures, Functions.	
UNIT II	**11 hours**
Indexing and Hashing, B+ Tree Index Files, B-Tree Index Files, Dynamic and Static Hashing, Query Processing, Measures of Query cost, Selection Operation, Sorting, Join operation, evaluation of expressions, Query Optimization, estimating statistics of expression results, transformation of Relational Expressions, Choice of evaluation plans. **Database Security and Authorization:** Levels of database security, Access control, Multilevel security, Statistical database security, Audit trails in the databases.	
UNIT III	**11 hours**
Structured versus Unstructured data, NoSQL database concepts: Types of NoSQL databases, NoSQL data modeling, Benefits of NoSQL, comparison between SQL and NoSQL database systems. NoSQL using MongoDB: Introduction to MongoDB Shell, Running the MongoDB shell, MongoDB client, Basic operations with MongoDB shell, Basic Data Types, Arrays, Embedded Documents, Querying with MongoDB: find() function, specifying which keys to return, query criteria, OR queries, Types specific querying. **Aggregation Introduction:** Aggregation Pipeline, Aggregation using Map reduce, Single purpose aggregation	
UNIT IV	**10 hours**
Distributed Databases, Homogeneous and Heterogeneous Databases, Distributed Data Storage, Distributed Transactions and their commit protocols, Concurrency Control in Distributed Databases, Distributed Query Processing. Multimedia Databases, Mobile Data bases, Temporal database, Image and Semantic-based query processing, Active database.	

Text Books	
1	R. Elmasri, and S.B.Navathe, "Fundamentals of Database Systems", 7th Edition, Pearson Education, 2017/ Latest Edition.
2	A. Silberschatz, and H. F. Korth, S. Sudarshan, "Database System Concepts", 6th Edition/Latest Edition, McGraw Hill Education, 2013/ Latest Edition.
Reference Books	
1	M.T.Ozsu, and P. Valduriez, "Principles of Distributed Database Systems", 3rd Edition, Springer, 2011/Latest Edition.
2	T. Connolly, and C. Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", 6th Edition, Pearson, 2014/ Latest Edition.
3	R. Ramakrishnan, and J.Gehrke, "Database Management Systems", 3rd Edition, McGraw Hill Education, 2014/Latest Edition.
4	W. Lemahieu, S. V. Broucke, and B. Baesens, "Principles of Database Management: Practical Guide to Storing, Managing and Analyzing Big and Small Data", 1st Edition Cambridge University press, 2018/ Latest Edition.

Computer Graphics	
Course Code: BCS 314 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction:
The subject Computer Graphics introduces basic concepts of graphics, output primitives, transformations, projections, curve and surface generation methods and shading algorithms.

Course Objective:

- To introduce the basic concepts of computer graphics
- To introduce the concepts of 2D/3D transformations
- To introduce the concepts of curve generation and hidden surface detection.

Pre-requisite: Basic mathematics.

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

CO1: Understand basic concepts of computer graphics and its applications.
CO2: Use the 2D/3D transformation and projection concepts in various projects
CO3: Understand concepts of curve generation and hidden surface detection.
CO4: Develop various application of computer graphics

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 betterunderstanding. Use of ICT, web-based resources as well as flipped class room teaching will beadopted.

UNIT I	10 hours
Introduction to computer graphics: Introduction, Application of computer graphics, Video Display Devices, Raster Scan Systems, Random Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard Copy Devices, Graphics Software. Colour Models: RGB, HSV etc. Output primitives: DDA Line drawing algorithm, Bresenham's Line Drawing Algorithm, Mid-point circle algorithm, Mid-point Ellipse algorithms, filling algorithms, boundary fill and flood fill algorithms, scanline filling.	
UNIT II	**10 hours**
Transformations: Basic 2D Transformations, Matrix representations & Homogeneous Coordinates, Matrix Representations for basic 2D and 3D transformations (Translation, Scaling, Rotation), Composite Transformations, reflection and shear transformations, affine transformation, transformations between coordinate systems. Two-dimensional viewing: The viewing Pipeline, Window to viewport coordinate transformation, Clipping Operations: Point Clipping, Line Clipping (Cohen Sutherland and Liang-barsky), Polygon Clipping, Sutherland-Hodgeman polygon clipping, Wailer-Atherton polygon clipping, curve clipping, Text clipping.	
UNIT III	**10 hours**
Curves and Surfaces: Representation of surfaces, polygon meshes, plane equations, parametric cubic curves, Hermite Curves, Bezier Curves, 4 point and 5 point Bezier curves using Bernstein Polynomials, Conditions for smoothly joining curve segments, Bezier bi-cubic surface patch, B-Spline Curves, Cubic B-Spline curves using uniform knot vectors, Testing for first and second order continuities. Visible surface detection, Back Face Detection, Depth Buffer (Z-Buffer, A-Buffer) Method. Scan Line Method, Depth Sorting Method, Area Subdivision Method.	
UNIT IV	**11 hours**
Three-Dimensional Concepts: 3D Transformations, Parallel Projection and Perspective Projection. Shading and Illumination Model: Shading, Illumination Model for diffused Reflection, Ambient light, Specular Reflection Model, Reflection Vector. Shading Models, Flat shading, Gouraud Shading, Phong Model. Case studies: Design case studies to perform 2D representations of lines and curves, perform 2D and 3D transformations on different objects.	

Text Books	
1	D. Hearn and M. P. Baker, "Computer Graphics", Pearson Education; 2nd Edition, 2014/Latest Edition
2	Z. Xiang and R. Plastock, "Computer Graphics", Schaum's Series, McGraw Hill Education; 2nd Edition, 2006/ Latest Edition.
Reference Books	
1	D. Rogers and J. Adams, "Mathematical Elements for Computer Graphics", McGraw Hill Education; 2nd Edition 2017/ Latest Edition.
2	J.H. Hughes et al., "Computer Graphics Principles & practice", Pearson Education India, 2nd Edition 2002/ Latest Edition.
3	D. F. Rogers, "Procedural elements for Computer Graphics", McGraw Hill Education; 2nd Edition 2017/ Latest Edition.

Enterprise Java Programming	
Course Code: BIT 314 Contact Hours: L-3 P-0 T-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction:

This enterprise java programming course develops knowledge about the use of java for application development. This course shall inculcate programming capability to handle enterprise scale software and develop and deploy applications using Java Platform.

Course Objective:

- To give the students an understanding of the enterprise applications development and its related technologies
- To learn Application Development and Deployment using J2EE.

Pre-requisite: Basic Knowledge of Object-Oriented programming, Java Programming Language and Database Management.

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

CO1: To learn Java programming to express proficiency and improve effective programming skills

CO2: Design and implement application development with database connection and learn servlet

CO3: Develop data driven, distributed application using web and business components.

CO4: Students will learn how to build and deploy Java Enterprise Applications.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Emphasis would be given on lab session where students will be given lab assignments based on topics studied in previous lectures. Course will have a blend of theory and practice for the benefit of students.

UNIT 1	10 Hours
Introduction to java: introduction of java classes, objects and methods, inheritance, package and interface, Collections: Collection Interfaces, Concrete Collections, Collections Framework, Exceptional handling -checked, unchecked exception and user defined, exception handling mechanism, use of throw and throws **Multithreading:** Life cycle of thread, Creating and running thread, Use of Runnable interface, Thread priorities, Multithreading, synchronization, inter thread communication, **Fundamentals in Networking:** Sockets in Java - Internet Addressing - DNS, URL class - TCP/IP and Datagram. Creating and using TCP/IP Sockets : Socket class and its constructors and methods . Creating TCP servers &clients: TCP/IP server sockets - Constructors and methods of ServerSocket class - Program to create a TCP/IP server and client	
UNIT 2	**10 Hours**
Working with database: JDBC API, JDBC architecture, JDBC drivers, Use of Statement and Prepared Statement and Callable statement. ResultSet: Methods of ResultSet, ResultSetMetaData, Program example using JDBC, Executing a sql query, Use of ResultSetMetaData and its methods. Introduction to J2EE and building J2EE applications, Java EE evolution, working with glass fish server**,** MVC architecture, **Servlet-** Introduction to servlets and its life cycle, cgi interface and its problems, Generic and HTTP servlet, inter servlet communication- request dispatcher and redirect, session management in servlet, cookies, session object	
UNIT 3	**10 Hours**
JSP Basics and Architecture: JSP vs Servlet, JSP functions, JSP syntax,JSP documents, JSP elements, JSP directives,JSP action, implicit objects, JSP client request and JSP server response, Working with Java Beans **EJB Fundamentals:** J2EE technologies, EJB Overview, Benefits of EJB,Why use EJB EJB system, Enterprise beans and types, distributed objects and middleware, developing EJB components, bean class and deployment descriptor. **Introducing session beans:** Session beans life time, state full and Stateless session beans, lifecycle of session beans, working with session beans	
UNIT 4	**10 Hours**
Java Messaging Service(JMS)- requirement and advantages of JMS,JMS Programming model **Working with java Server Faces-** JSF MVC, components of JSF , How JSF Works , JSF UI components, JSF application, JSF expression language **Working with Hibernate-**Hibernate overview, supported database, hibernate architecture.	
Text Books	
1. Java Platform, Enterprise Edition 8: The Java EE Tutorial, Oracle, Java Documentation, 2018/Latest Edition.	
2. Jim Koegh, “Java EE Complete Reference”, Mc Graw Hill , First Edition, 2017/Latest Edition.	
3. Jim Farley, William Crawford, “ Java Enterprise in a Nutshell”, O’Reilly and Associates, 3rd Ed/Latest Edition.	

Reference Books
1. Francesco Marchioni ,"Practical Enterprise Application Development", /Latest Edition.
2. John Hunt and Chris Loftus, "Guide to J2EE: Enterprise Java" Springer Verlag Publications/Latest Edition.
3.Joe Wigglesworth and McMilan Paula, "Java Programming: Advanced Topic", Thomson, 3rd Ed., 2003/Latest Edition.
4.David R. Heffelfinger, "Java EE 8 Application Development", Packt Publishing, First Edition, December 2017/Latest Edition.
5. "Core and Advanced Java, Black Book", DreamTech Publications, First Edition, 2018 /Latest Edition.

Compiler Design	
Course Code: BCS - 306 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 6

Introduction:

This course provides the complete description about inner working of a compiler. This course focuses mainly on the design of compilers and optimization techniques. It also includes the design of Compiler writing tools. This course also aims to convey the language specifications, use of regular expressions and context free grammars behind the design of compiler.

Course Objectives:

- Introduce major concepts of language translation and compiler design.
- Impart the knowledge of practical skills necessary for constructing a compiler.

Prerequisite: Basic programming skills

Course Outcomes: The students will be able to:

CO1: Explain the compiler architecture and different phases of compilation with compile time error handling.

CO2: Compare top down with bottom-up parsers, and develop appropriate parser to produce parse tree representation of the input

CO3: Illustrate language tokens using regular expressions, context free grammar and finite automata and design lexical analyzer for a language.

CO4: Design a compiler for a small subset of C language.

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.

UNIT I	10 hours
Introduction to compilers – Analysis of the source program, Phases of a compiler, grouping of phases, compiler writing tools– bootstrapping. Case study: MiniC (A small subset of C language) Lexical Analysis-The role of Lexical Analyzer, Input Buffering, Specification of Tokens using Regular Expressions, Review of Finite Automata, Recognition of Tokens, Case study: Lexical Analysis for MiniC, Syntax Analysis**:** Review of Context-Free Grammars – Derivation trees and Parse Trees, Ambiguity.	
UNIT II	**12 hours**
Top-Down Parsing: Recursive Descent parsing, Predictive parsing, LL (1) Grammars**.** Bottom-Up Parsing: Shift Reduce parsing – Operator precedence parsing (Concepts only). LR parsing – Constructing SLR parsing tables, Constructing Canonical LR parsing tables and Constructing LALR parsing tables. Case study: Syntax analysis for MiniC	
UNIT III	**10 hours**
Syntax directed translation: Syntax directed definitions, Bottom- up evaluation of S- attributed definitions, L- attributed definitions, Top-down translation, Bottom-up evaluation of inherited attributes. Type Checking: Type systems, Specification of a simple type checker. Run-Time Environments: Source Language issues, Storage organization, Storage allocation strategies.	
UNIT IV	**10 hours**
Intermediate Code Generation (ICG): Intermediate languages – Graphical representations, Three Address code, Quadruples, Triples. Assignment statements, Boolean expressions. Code Optimization: Principal sources of optimization, Optimization of Basic blocks, Code generation: Issues in the design of a code generator. A simple code generator. Case study: MiniC Code Generator for the MiniC Architecture	

Text Books	
1	A. Monica, S. Lam, R. Sethi and D. Ullman, "Compilers – Principles Techniques and Tools", Pearson Education India; 2nd edition, 2013/ Latest Edition.
2	K. C. Louden, "Compiler Construction – Principles and Practice", Cengage Learning Indian Edition 2006/ Latest Edition.
Reference Books	
1	A. I. Hollub, "Compiler Design in C", Pearson Education India; 1st edition, 2015/ Latest Edition.
2	A.W. Appel, M. Ginsburg, "Modern Compiler Implementation in C", Cambridge University Press, 2004/ Latest Edition.
3	K. Muneeswaran, "Compiler Design", Oxford University Press, 2012/ Latest Edition.
4	S. D. Bergmann, "Compiler Design theory, tools and examples", C/C++ Edition, Rowan University, 2010/ Latest Edition.

Computer Vision	
Course Code: BIT-316 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction:

Computer vision is an important applied research area encompassing aspects from geometry, machine learning, probabilistic models, optimization etc. The course consists of various important aspects of computer vision namely geometry, motion, image features, and low-level and high-level image labeling.

Course Objectives:

- To review image processing techniques for computer vision.
- To understand shape and region analysis.
- To understand Hough Transform and its applications to detect lines, circles, ellipses.
- To understand three-dimensional image analysis techniques.
- To understand motion analysis.
- To study some applications of computer vision algorithm

Pre-requisites: Introduction to Image processing

Course Outcomes:

Upon successful completion of the course, students will be able to apply a variety of computer techniques for the design of efficient algorithms for real-world applications, such as optical character recognition, face detection and recognition, motion estimation, human tracking, and gesture recognition. The topics covered include image filters, edge detection, feature extraction, object detection, object recognition, tracking, gesture recognition, image formation and camera models, and stereo vision.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Emphasis would be given on assignments where students will be given assignments based on topics studied in previous lectures. Course will have a blend of theory and practice for the benefit of students. Use of ICT, web based sources as well as blackboard teaching will be adopted. Lecture delivery via discussions, whiteboard, slideshows, online learning material. Lab-work with exercises.

Unit-I	**10 hours**
Geometric Image Features: Elements of Differential Geometry, Contour Geometry. **Analytical Image Features**: Elements of Analytical Euclidean Geometry, Geometric Camera Parameters, Calibration Methods.	
Unit-II	**10 hours**
Linear Filters: Linear Filters and Convolution, Shift invariant linear systems, Spatial Frequency and Fourier Transforms, Sampling and Aliasing **Edge Detection:** Estimating Derivatives with Finite Differences, Noise, Edges and Gradient-based Edge Detectors.	
Unit-III	**10 hours**
Texture: Representing Texture, Analysis (and Synthesis) Using Oriented Pyramids, Application: Synthesizing Textures for Rendering, Shape from Texture: Planes and Isotropy **Shape from Shading**: Introduction to the concept of Shading From Shading (SFS), Application of SFS (Texture Shop, Image-Based Material Emitting, Optimization Based SFS), Photometric stereo, Spherical Illumination, Displacement Mapping, Feature Mapping	
Unit-IV	**10 hours**
Affine Structure from Motion: Elements of Affine Geometry, Affine Structure from Two Images, Affine Structure from Multiple Images, From Affine to Euclidean Images, Affine Motion Segmentation. **Projective Structure from Motion**: Elements of Projective Geometry	
Text Books	
D. Forsyth and J. Ponce, Computer vision: A modern approach, second edition, Pearson, 2012/Latest Edition.	
R. Hartley and A. Zisserman, Multiple view geometry in computer vision, second edition, Cambridge univ. press, 2003/Latest Edition.	
E. Trucco and A. Verri, Introductory Techniques for 3D Computer Vision, Prentice Hall/Latest Edition.	
R. Szeliski, Computer Vision: Algorithms and Applications, Springer 2011/Latest Edition.	
Reference Books	
S. Prince, Computer vision: Models, learning and inference, Cambridge univ. press, 2012/Latest Edition	
B. K. P. Horn, Robot Vision, MIT Press (Cambridge) /Latest Edition.	

Mobile Computing	
Course Code: BIT - 401 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 7

Introduction:

Mobile Computing refers a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device. It is free from having a connection with a fixed physical link. It facilitates the users to move from one physical location to another during communication.

Course Objective:

- To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks as well as systems issues for the design and implementation of mobile computing systems and applications.
- To understand the basic concepts of mobile communication and computing.
- To understand telecommunication systems and gain knowledge about different mobile platforms and application development.

Prerequisite: Computer-Networks.

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

CO1: Learn the basic concepts and applications of Mobile Computing and Cellular architecture;
CO2: Evaluate the effectiveness of the existing telecommunication systems such as GSM, GPRS, and UMTS
CO3: Analyze the protocol suite for the wireless architecture (Mobile IP, Mobile TCP, and Wireless application protocols)
CO4: Explain the Bluetooth technology, and develop mobile applications for different domains.

Pedagogy:

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

Unit I	11 hours
Introduction to Mobile Computing: History, Types, Benefits, Application, Evolution, Characteristics of Mobile computing, Security Concern regarding Mobile Computing, Different Propagation Modes, Wireless Architecture and its types. First-Generation Analog, Second-Generation TDMA, Second-Generation CDMA, Third-Generation Systems **Cellular Concept:** Cellular Systems and Principles of Cellular Networks, Hexagonal geometry cell and concept of frequency reuse, Channel Assignment Strategies, Distance to frequency reuse ratio; Electromagnetic Spectrum, **Antennas and Propagation**-Antennas, Propagation Modes, Line-of-Sight Transmission, Fading in the Mobile Environment, Signal Characteristics; Channel Capacity, Multiplexing, Spread Spectrum: DSSS & FHSS, CDMA.	
Unit II	**10 hours**
Telecommunication Systems: GSM: Architecture, Channel allocation, call routing, PLMN interface, GSM addresses and identifiers, network aspects, frequency allocation, authentication and security, Handoffs Technique; **GPRS:** network architecture, network operation, data services, Applications, Billing and charging; **UTRAN,UMTS**; **Mobile Networking**: Medium Access Protocol, Internet Protocol and Transport layer, Medium Access Control: Motivation for specialized MAC, Introduction to multiple Access techniques (MACA)	
Unit III	**12 hours**
Mobile IP: Features of Mobile IP and its need, IP packet delivery, Key Mechanism in Mobile IP, Agent Discovery, Registration, Tunnelling and encapsulation, Reverse Tunnelling, Routing (DSDV,DSR), Route optimization, IP Handoff; **Mobile TCP:** Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission; **Wireless Application Protocol:** Introduction, Application, Architecture, Protocol Stack and Challenges.	
Unit IV	**10 hours**
Bluetooth: Introduction, User Scenario, Architecture, protocol stack; IP Mobility, Macro Mobility and Micro Mobility, Introduction to 4G and 5G; LTE, HIPERLAN, Mobile Device Operating Systems, Special Constraints & Requirements, Commercial Mobile Operating Systems, Software Development Kit: iOS, Android, BlackBerry, Windows Phone, M-Commerce, Structure, Mobile Payment System	
Text Books	
1. John H. Schiller, Mobile Communications, Pearson Education, 2nd Edition, 2003/Latest Edition.	
2. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, Mobile Computing: Technology, Applications and Service Creation, 2nd Edition, Tata McGraw Hill, 2010/Latest Edition.	
3. Andreas F. Molisch, Wireless Communications, 2nd Edition, Wiley –India, 2006/Latest Edition.	
Reference Books	
1. Raj Kamal, Mobile Computing, 3rd Edition, Oxford University Press, 2018/Latest Edition.	
2. Frank Adelstein, S.K.S. Gupta, Golden G. Richard III and Loren Schwiebert, "Fundamentals of Mobile and Pervasive Computing", McGraw-Hill Professional/Latest Edition	

Software Testing	
Course Code: BIT - 403 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 7

Introduction: Software testing helps in finalizing the software application or product against business and user requirements. It is very important to have good test coverage in order to test the software application completely and make it sure that it's performing well and as per the specifications. Software testing makes sure that the testing is being done properly and hence the system is ready for use. Software Quality Assurance includes standards and procedures that developers may use to review and audit software products and activities to verify that the software meets quality criteria which link to standards.

Course Objectives:

- The students should understand software testing and quality assurance as a fundamental component of software life cycle.
- Finding defects which may get created by the programmer while developing the software.
- Gaining confidence in and providing information about the level of quality.
- To make sure that the end result meets the business and user requirements.
- To gain the confidence of the customers by providing them a quality product.

Prerequisite: Software Engineering, Programming Skills, Database Management System.

Course Outcome:

CO1: Understand the process of applying tests to software and the fundamental components of a test case.
CO2: Use different testing techniques to create test cases.
CO3: Select Test Cases and explain verification methods to prove the correctness of the program.
CO4: Generate test cases from requirements, design test case matrix and discuss testing level, metrics, Object-oriented testing, and tools.

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.

UNIT I	10 hours
Introduction: Testing Objectives, Software Testing Process, Software Testing Principles, Tester Role in Software Development Organization, Test Case Implementation and Execution. Testing Concepts: Levels of Testing, Test Cases Design and Strategy, Test Suit, Test Plan, Testing as a Process, Testing and Debugging, Limitations of Testing, Software Testing Tools: Characteristics of Modern Tools, Static Testing Tools, Dynamic Testing Tools, Process Management Tools.	
UNIT II	**10 hours**
Functional Testing: Boundary Value Analysis, Robustness Testing, Worst case testing, Special Value Testing, Equivalence Class Testing-Weak normal, Strong normal, weak robust and Strong Robust, Decision Table Based Testing, Cause Effect Graphing Technique. **Structural Testing:** Control flow testing-Statement, Branch, Condition and Path coverage, Data Flow Testing, Testing strategies, Generation of test cases, Slice-based Testing, Mutation Testing, Integration Testing, Decomposition based Integration, Call Graph based Integration, System Testing: Thread Testing.	
UNIT III	**10 hours**
Introduction to Object Oriented Testing, State Based Testing, Class Testing, Web Testing, Issues in Object Oriented Testing, Regression testing, Selection of test cases, reducing the number of test cases, Prioritization guidelines.	
UNIT IV	**11 hours**
Software Verification Methods, SRS Verification, SDD Verification, Source Code Reviews, Software Project Audit, Debugging Process and Approaches, Software Testing Metrics, Metric used in Testing, Software Quality and Quality Models.	

Text Books	
1	Yogesh Singh, "Software Testing", Cambridge University Press, 2011/Latest Edition
2	Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications; 3rd Edition, 2013/Latest Edition
Reference Books	
1	Ilene Burnstein, "Practical Software Testing: A Process-Oriented Approach", Springer, 2003/Latest Edition.
2	Aditya P. Mathur, "Foundations of Software Testing", Prentice Hall 2008/Latest Edition.

BIG DATA ANALYTICS	
Course Code: BIT- 407 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 7

Introduction:

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

Course Objectives:

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

Pre-Requisites:

Essential: Distributed Systems, Data warehouse
Desirable: NoSQL Databases

Course Outcomes:

CO1: Perform data gathering of large data from a range of data sources.
CO2: Critically analyse existing Big Data datasets and implementations, taking practicality, and usefulness metrics into consideration.
CO3: Understand the role of statistics in the analysis of large of datasets.
CO4: Apply suitable statistical measures and analyses techniques for data of various structure and content and present summary statistics.

Pedagogy:

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

Unit I	**10 hours**
Introduction: Need for Big Data, Structured and unstructured Big Data, Limitations of conventional data management and processing techniques for handling Big Data. Data Streams: Real time stream Data; Issues with streams of data, Data Stream Management Systems, Concept of Windows: Time based windows, Tuple count based windows, Movement of windows- fixed, sliding, Tumbling, Hoping; Event streaming: architecture, events, producers, consumers. Use in website activity tracking, stream processing, stream query processing	
Unit II	**8 hours**
Data Warehouse for Big Data:Review of dimensional modeling, bus, hub and spoke architecture, ETL for real time DW, Big Data clusters; Cloud Warehousing: Cloud versus on-prem storage, setting up 'Infrastructure as code'	
Unit III	**11 hours**
Data Lakes: Data Lakes versus Data Warehouse, Lambda and Kappa Architectures, Meta data management, Curating, designing and deriving value from data lakes, Data pipelines: ETL versus ELT, streaming data pipelines, scheduling batch data pipelines, automated data pipelines. Data governance Data Virtualization: Need for data virtualization, architecture, abstraction, views and services, design principles, defining specifications for transformations	
Unit IV	**11 hours**
Map Reduce Framework: Distributed Processing with Hadoop Framework; Architecture; Basic Programs on Read and Write, architecture of a MR job, Mapper, Reducer, Combiner, Partitioner Interfaces; Use of distributed relational Store: HIVE architecture and features; different types of tables and implications; data types; basic queries Societal Issues with Big Data: Data rights, policy and regulation; data and ethics, data and communication. Data as a strategic resource	
Text Books	
1. Gorelik A., The Enterprise Big Data Lake, O'Reilly/Latest Edition	
2. Marz N. and Warren J., Big Data: Principles and best practices of scalable realtime data systems, Manning Publications/Latest Edition	
3. Erl T. Khattak W., Buhler P., Big Data Fundamentals: Concepts, Drivers & Techniques, The Pearson Service Technology Series from Thomas ERL/Latest Edition	
Reference Books	
1. DT Editorial Services, Big Data, Black Book, Dreamtech Press/Latest Edition	

DISTRIBUTED SYSTEMS	
Course Code: BIT- 409 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 7

Introduction:

This course deals with distributed system architecture, enabling technologies for distributed systems, and the applications that can be built on distributed systems. It forms essential background for modern technology that puts computer networks to productive use, for example, service orientation, cloud and edge computing, NoSQL data bases, IoT middleware, and handling Big Data. The course shall introduce students to a selection of these areas through specific examples and situations

Course Objectives:

At the end of the course students should demonstrate the ability to provide support for development of distributed systems and distributed applications

Pre-Requisites:

Operating Systems, Computer Networks, Relational DBMS

Course Outcomes:

CO1: To provide hardware and software issues in modern distributed systems.
CO2: To get knowledge in distributed architecture, naming, synchronization, consistency and Replication, fault tolerance, security, and distributed file systems.
CO3: To analyze the current popular distributed systems such as peer-to-peer (P2P) systems.
CO4: To know about Shared Memory Techniques

Pedagogy:

The course will be delivered in workshop mode with lecture material and problem-solving exercises suitably interspersed during lecture contact hours. Tutorial work shall be pen and paper problem solving as well as implementing/simulating components of distributed systems. Take home work shall be either specific assignments or extensions of tutorial work and students should expect about 5 hours per week of take-home work.

Unit I	**7 hours**
Introduction: Network OS versus Distributed systems, definition, Transparency levels, scalability, transaction systems, enterprise application integration, pervasive systems Architecture styles: Layered, Object oriented, event based, shared data space, centralized client server. structured/unstructured peer to peer, edge server systems	
Unit II	**10 hours**
Communication and Synchronization: Physical clocks, Clock synchronization, Berkeley, Christian algorithms, NTP. Logical clocks, Lamport's algorithm, Fidge's algorithm, Global state. Remote Procedure Calls, RMI, message oriented persistent and transient communication, Stream oriented communication Coordination, manual coordinator, Election: Bully algorithm, ring algorithm; Mutual Exclusion: via centralized server, completely distributed, logical token ring Distributed Transactions: Primitive transaction operations, structure, role of logs, transaction managers	
Unit III	**11 hours**
Consistency and Replication: Data centric Models: strict, sequential. Causal, FIFO, Weak and Release consistency; User Centric Models: Continuous, Eventual, Monotonic Read, Monotonic Write, Write, read your writes, writes follow reads. ACID and BASE Replication: permanent replicas, Client initiated, server-initiated replicas, Update propagation: push pull, epidemic protocol, remote write and local write Reliable group communication, 2 and 3 phase commit protocols	
Unit IV	**12 hours**
Distributed File Systems: Files in Client server model, cluster based, symmetric, NFS model, naming and automounting, file sharing and replication, Peer to Peer systems, Byzantine failures, security and authentication Distributed Databases: Vertical, horizontal, hybrid partitioning, CRUD operations, query optimization, Master slave, peer to peer architectures, CAP theorem Distributed Web: Web clients and servers, HTTP connections, methods, messaging, SOAP, naming, proxy caching, replication, security	
Text Books	
1. Tanenbaum A.S., and Steen M.V., "Distributed Systems: Principles and Paradigms", Prentice Hall. Also Pearson Education/Latest Edition	
2. Colouris G. Dollimore J., Kindberg T., Blair G., "Distributed Systems: Concepts and Design", Addison Wesley; also Pearson Education/Latest Edition	
Reference Books	
1. Sukumar Ghosh , "Distributed Systems: An Algorithmic Approach" Chapman and Hall/CRC; 2 edition, 2014 /Latest Edition	
2. Mukesh Singhal and N. G. Shivaratri,Singhal and Shivaratri, "Advanced Concepts in Operating Systems", McGraw Hill, 2001/Latest Edition	

DIGITAL IMAGE PROCESSING	
Course Code: BEC- 409 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 7

Introduction:

This course aims at learning and understanding the fundamentals of digital image processing, and various image transforms, image enhancement techniques, image restoration techniques and methods, image compression and segmentation used in digital image processing.

Course Objective:

- The fundamentals of digital image processing.
- Image transform used in digital image processing.
- Image enhancement techniques used in digital image processing.
- Image restoration techniques and methods used in digital image processing.
- Image compression and segmentation used in digital image processing.

Pre-requisite: Linear signals and systems, digital signal processing, basic linear algebra, basic probability theory and basic programming techniques.

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

CO1: Discuss digital image fundamentals.
CO2: Apply image enhancement and restoration techniques.
CO3: Use image compression and segmentation techniques.
CO4: Represent features of images.

Pedagogy:

The class will be taught using theory and tutorial-based methods which includes board teaching and presentations/slides, discussions, case studies etc. Along with classroom teaching, students will also be given assignments regarding the topics covered.

UNIT-I	**10 Hours**
Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, sampling and quantization. Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian. Fourier Transforms and properties, FFT (Decimation in Frequency and Decimation in Time Techniques), Convolution, Correlation, 2-D sampling, Discrete Cosine Transform, Frequency domain filtering.	
UNIT-II	**10 Hours**
Basic Framework, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections. Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem, Huffman Coding, Arithmetic Coding, LZW coding.	
UNIT-III	**10 Hours**
Transform Coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length coding, Symbol-based coding, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation, Multi-resolution analysis, Scaling functions, Wavelet series expansion, Transform(DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform.	
UNIT-IV	**10 Hours**
Bit plane slicing, Digital Watermarking, information-hiding capacity, Wavelet transformation, Use of energy-based embedding using wavelet coefficients, Spread spectrum watermarking. Steganalysis, Steganography	
Text Books	
1	Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”, 4th edition/LatestEdition, 2018, Pearson Education/Latest Edition
2	A K Jain, “Fundamentals of Digital Image Processing”, 1st edition/Latest Edition, 2015, PHI/Latest Edition
Reference Books	
1	William K Pratt, "Digital Image Processing", John Willey, 3rd edition/Latest Edition, 2004/Latest Edition
2	Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing Analysis and Machine Vision"- Thompson Learning, 4th edition/Latest Edition, 2017/Latest Edition.

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

Introduction:

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

Course Objectives:

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

Pre-requisite: Artificial Intelligence, Data Structures and Algorithms, Programming languages.

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

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

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

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

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

Pedagogy:

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

Unit I	**11 Hours**
Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques. Differential Evolution, Hill Climbing, Tabu Search, Cuckoo Search, Harmony Search, PSO, ACO, Bat algorithm, Artificial Bee Colony optimization, meta heuristic algorithms: applications to solve complex problems.	
Unit II	**10 Hours**
Fuzzy Set Theory: Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, introduction & features of membership functions, Extension Principle, Fuzzy If-Then Rules, Fuzzy Inference Systems, Sugeno Fuzzy Models, Fuzzification, Defuzzification, Applications, Fuzzy clustering, cluster validity measures.	
Unit III	**10 Hours**
Genetic Algorithm: Difference between Traditional Algorithms and GA, The basic operators, Schema theorem, convergence analysis, stochastic models, applications in search and optimization. Encoding, Fitness Function, Reproduction, Cross Over, Mutation.	
Unit IV	**12 Hours**
Bayesian Networks, Probabilistic reasoning, Neural Networks: NN vs ANN, Learning networks of ANN – Perceptron's - Adaline – Back Propagation, Multilayer Perceptron, Unsupervised Learning Neural Networks.	
Text Books	
1. S. N. Sivanandam and S. N. Deepa, "Principles of Soft Computing", 2nd Edition/ Latest edition, Wiley - India, 2011/Latest Edition.	
2. S. Rajasekaran, "Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications", 2nd Edition/ Latest edition, PHI Learning, 2017/Latest Edition.	
3. Honbo Zhou,"The Internet of Things in the Cloud: A Middleware Perspective", Latest edition, CRC Press, 2012/Latest Edition	
Reference Books	
1. N. P. Padhy and S.P. Simon, "Soft Computing techniques with MATLAB programming", UK Edition/ Latest edition, Oxford University Press, 2015/Latest Edition.	
2. X. Wang, X. Z. Gao and K. Zenger, "An introduction to harmony search optimization method", Springer International Publishing, Latest Edition, 2015/Latest Edition.	

Software Project Management	
Course Code: BIT 413 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 7

Introduction:

This course is aimed at introducing the primary important concepts of project management related to managing software development projects. The main objective of this course is to help the students to learn how to successfully plan and implement a software project management activity, and to complete a specific project in time with the available budget.

Prerequisite: Knowledge of Software Engineering, Basic Programming Course

Course Objective:

- To learn software project management phases.
- To establish a project plan and then execute that plan to accomplish the project objective.
- To create a work breakdown structure, assign responsibility, define specific activities and sequencing them for a software project.
- To learn planning and estimation and scheduling of software project activity components, resources and durations.

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

CO1: Apply techniques for controlling and enhancing the software development process.
CO2: Understand the essential project management stages and problems that could make an IT project successful or unsuccessful.
CO3: Understand project management principles and methods in an IT project.
CO4: Understand the project's business context and extent, choose the best project management strategy.

Pedagogy:

The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations, and quizzes. Students would be encouraged to develop an understanding of the subject. The use of ICT and web-based sources will be adopted.

UNIT-1	10 Hours
Introduction and Software Project Planning: Fundamentals of Software Project Management (SPM), Need Identification, Vision and Scope document, Project Management Cycle, SPM Objectives, Management Spectrum, SPM Framework, Software Project Planning, Planning Objectives, Project Plan, Types of project plan, Structure of a Software Project Management Plan, Software project estimation, Estimation methods, Estimation models, Decision process.	
UNIT-II	**11 Hours**
Project Organization and Scheduling: Project Elements, Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Project Life Cycle and Product Life Cycle, Ways to Organize Personnel, Project schedule, Scheduling Objectives, Building the project schedule, Scheduling terminology and techniques, Network Diagrams: PERT, Monte Carlo Approach, CPM, Bar Charts: Milestone Charts, Gantt Charts.	
UNIT-III	**11 Hours**
Project Monitoring and Control: Dimensions of Project Monitoring & Control, Earned Value Analysis, Earned Value Indicators: 23 Budgeted Cost for Work Scheduled (BCWS), Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI), Interpretation of Earned Value Indicators, Error Tracking, Software Reviews, Types of Review: Inspections, Deskchecks, Walk through, Code Reviews, Pair Programming. Types of Resources, Identifying Resource Requirements, Resource Scheduling.	
UNIT-IV	**10 Hours**
Software Quality Assurance and Testing:Testing Objectives& Principles, Test Plans, Test Cases, Types of Testing, Levels of Testing, Test Strategies, Program Correctness, Program Verification & validation, Testing Automation & Testing Tools, Concept of Software Quality, Software Quality Attributes, Software Quality Metrics and Indicators, The SEI Capability Maturity Model CMM), SQA Activities, Formal SQA Approaches: Proof of correctness, Statistical quality assurance, Clean room process. **Project Management and Project Management Tools:** Software Configuration Management, Risk Management, Cost Benefit Analysis, Software Project Management Tools: CASE Tools, Planning and Scheduling Tools, MS-Project.	

Text Books	
1	Software Project Management, Bob Hughes & Mike Cotterell, McGraw Hill Education; Sixth edition ,2017/Latest Edition
2	Software Project Management in Practice, Pankaj Jalote, Addison-Wesley; 1st edition ,2002/Latest Edition
3	Software Project Management, Walker Royce, Pearson Education, 1998/Latest Edition.
Reference Books	
1	Software Engineering Project Management, Richard H. Thayer & Edward Yourdon, second edition, Wiley India, 2004/Latest Edition.
2	Agile Project Management, Jim Highsmith, Pearson education, 2004/Latest Edition.
3	The art of Project management, Scott Berkun, O'Reilly, 2005/Latest Edition.

ADVANCED OPERATING SYSTEMS	
Course Code: BIT- 415 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 7

Introduction:
This course covers general issues of design and implementation of advanced modern operating systems. The focus is on issues that are critical to the applications of distributed systems and computer networks, which include inter-process communication, distributed processing, sharing and replication of data and files.

Course Objective:
The aim of this module is to study, learn, and understand the main concepts of advanced operating systems (parallel processing systems, distributed systems, real time systems, network operating systems, and open-source operating systems); Hardware and software features that support these systems.

Pre-requisite: Basic Operating Systems course.

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

CO1: Understand the advanced concepts of distributed operating systems.
CO2: Understand the idea of networking of computers, inter-process communication &network OS.
CO3: Learn the topics related to cloud computing, mobile computing & real-time operatingsystems.
CO4: Study the basics of embedded OS, grid & cluster computing.

Pedagogy:
The class will be taught using theory and tutorial-based methods which includes boardteaching and presentations/slides, discussions, case studies etc. Along with classroomteaching, students will also be given assignments regarding the topics covered.

UNIT-I	10 Hours
Multiprocessor & Distributed Operating Systems: Introduction, Architecture, Organization, Resource sharing, Load balancing, Availability & Fault tolerance, design & development challenges, Inter-process communication, distributed applications, mutual exclusion, distributed file systems.	
UNIT-II	**10 Hours**
Real time & Embedded operating systems: Introduction, hardware elements, structure-interrupt driven, nanokernel, microkernel, monolithic kernel-based models, scheduling-periodic, aperiodic & sporadic tasks, introduction to energy aware CPU scheduling.	
UNIT-III	**10 Hours**
Cluster & Grid computing: Introduction to cluster computing & MOSIX OS, introduction to the grid, grid architecture. Computing Platforms: Operating Systems & Network Interfaces, grid monitoring & scheduling, performance analysis, case studies.	
UNIT-IV	**10 Hours**
Cloud Computing: Introduction to cloud, cloud building blocks, cloud as IaaS, PaaS, SaaS, Hardware & software virtualization, virtualization of OS- Hypervisor KVM, SAN, NAS back-end concepts. Mobile Computing: Introduction, Design principles, structure, platform, features of mobile OS (Android, IOS, Windows Mobile OS)	
Text Books	
1	Andrew S. Tanenbaum, "Modern operating system", PHI, Latest Edition ,2017/Latest Edition
2	Andrew S. Tanenbaum and Van Steen. “Distributed Systems: Principles and Paradigms”, Prentice Hall, Latest Edition, 2017.
3	Silberschatz and Galvin, “Operating System Concepts”, John Wiley, 9th Ed./ Latest Edition, 2016
Reference Books	
1	Tannenbaum, “Operating Systems Design and Implementation”, Pearson, 3rd Edition/ Latest Edition, 2007.
2	William Stallings, “Operating Systems Internals & Design Principles”, Pearson Education, 9th Ed./ Latest Edition, 2018
3	Madnick E. and Donovan J., “Operating Systems”, Tata McGraw Hill, Latest Edition, 2017.

E-Commerce	
Course Code: BIT- 417 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 7

Introduction:

E-commerce is abbreviated for Electronic Commerce. Its function is the transference of financial and other commerce related information using Information Technology and Telecommunications. E-Commerce helps to simplify the business processes and makes them faster and efficient. These business transactions occur either as business-to-business (B2B), business-to-consumer (B2C), consumer-to-consumer (C2C) or consumer-to-business (C2B). Benefits of e-commerce include its around-the-clock availability, the speed of access, the wide availability of goods and services for the consumer, easy accessibility and international reach.

Course Objectives:

- To understand the advantages and disadvantages of using e-commerce platforms.
- To learn various e-business strategies.
- To understand the various payment methods associated with e-commerce.
- To learn the concepts of security at various levels of e-commerce.

Pre-requisite: Knowledge on the basics of Information Security, Networking

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

CO1: Understand the basic concepts and principles of e-commerce.
CO2: Compare the advantages and disadvantages of using e-commerce platforms.
CO3: Understand various e-business strategies.
CO4: Identify security and privacy issues in e-commerce.

Pedagogy:

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

UNIT I	10 hours
Electronic Commerce Introduction: - Definition of E- Commerce, Electronic commerce and Physical Commerce, Architectural framework, Impact of E-commerce on business, different typeof e-commerce, some e-commerce scenario, Economic potential of electronic commerce, Advantages and Disadvantages, Incentives for engaging in electronic commerce, forces behind E-Commerce.	
UNIT II	**10 hours**
E-business strategy: Introduction, Characteristics of e-Business, Business models, E-Businessvs E-commerce, e-business Requirements, impacts of e-business, Strategic positioning, Levels of e-business strategies, Strategic planning process, Success factors for implementation of e-business strategies, CRM, MRP. ERP: Introduction, need of ERP, Modules of ERP.	
UNIT III	**10 hours**
Electronic Payment Methods: Overview, SET Protocol for credit card payment, E-cash, E- check, Micropayment system, Credit card, Magnetic strip card, Smart cards, Electronic Data Interchange, E-Commerce Law. Security Architecture, Encryption techniques, Symmetric & Asymmetric encryption, Digital Signatures, Virtual Private Network, IPsec, Threats, Firewalls.	
UNIT IV	**10 hours**
M-Commerce: Introduction, Attributes, customer and provider views, Architecture,Infrastructure of m-commerce, Requirement of the m-commerce, characteristics, Mobile Information device, Mobile Computing Applications, Mobile wallet, Mobile payments, Mobile portals, Pros and Cons of m-commerce, Secure Transaction Processes: Wireless Application Protocol, Bluetooth, The role of emerging wireless LANs and 3G/4G wireless networks.	
Text Books	
1. R. Kalakota, A. Whinston, "Frontiers of Electronic Commerce", 2nd Edition/Latest edition, Addison Wesley, 1996.	
2. B. Mennecke and T. Strader, "Mobile Commerce: Technology, Theory and Applications", IdeaGroup, 2003/Latest edition3.	
3. D. Chaffey, "E-Business and E-Commerce Management", 3rd Edition/Latest edition, Pearson Education, 2009.	
Reference Books	
1. H. Chan, "E-Commerce Fundamentals and application", 1st Edition/Latest edition, Wiley publication, 2001.	
2. Bajaj and Nag, "E-Commerce the cutting edge of Business", 2nd Edition/Latest edition, TMH, 2005.	
3. P. Loshin, J. Vacca, "Electronic commerce", 1st Edition/Latest edition, Firewall Media, 2005.	

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

Introduction:

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

Course Objectives:

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

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

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

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

Pedagogy:

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

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

Information and Network Security	
Course Code: BIT- 402 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction:

Knowing the concepts, principles and mechanisms for providing security to the information/data is very important for the students of Computer Engineering/Information technology. The goal is to cover information security topics like symmetric and asymmetric cryptography, hashing, messageand user authentication, digital signatures, key distribution and various Network Security topics like Firewalls, IPSec, VPN, IDS etc.

Course Objectives:

- Define the concepts of Information security and their use.
- Describe the principles of symmetric and asymmetric cryptography.
- Understand the concepts of hashing with algorithms and apply them.
- Understand and use the message authentication and its requirement.

Pre-requisite: Mathematical concepts: Random numbers, Number theory, finite fields.

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

CO1: Understand and apply the concepts of Information Security
CO2: Understand and apply the concepts of Network Security

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 resource es as well as flipped classroom teaching will be adopted.

UNIT-I	10 Hours
Basics of Cryptography, Integer Arithmetic, Modular arithmetic, Linear Congruences, Algebraic structures, GF(2n), Traditional Symmetric Key Ciphers, Active and Passive Attacks; Substitution and Transposition techniques, Stream ciphers and block ciphers, Block Cipher structure, Data Encryption standard (DES), AES, triple DES, ECB, CBC, OFB, CFB, CTR; Malicious Software: Virus, Worms, Information Theft, Keyloggers, Phishing, Spyware, Backdoors, Rootkit, DDoS attack	
UNIT-II	**10 Hours**
Public Key Cryptography: Public Key Cryptosystems with Applications, Requirements and Cryptanalysis, RSA algorithm, its computational aspects and security, Key Distribution and Management, Diffie-Hillman Key Exchange algorithm, Digital Signature, NIST digital Signature algorithm, Public key infrastructure, ECC, El Gamal	
UNIT-III	**10 Hours**
Authentication: Authentication Requirements, Cryptographic Hash Functions and their applications, Message Authentication Codes, MD5, Secure Hash Algorithm (SHA), User Authentication: Password, Certificate based & Biometric Authentication, Remote user authentication with symmetric and asymmetric encryption, Kerberos	
UNIT-IV	**10 Hours**
IP Security: Architecture, Authentication Header, Encapsulating security Payload; Web Security threats and approaches; Email Security: PGP, S/MIME; Transport-level Security: Transport layer security, SSL, HTTPS and SSH; Firewalls, IDS, IPS, VPN	
Text Books	
1. William Stallings, "Cryptography and Network Security-Principles and Practice", 6th Edition/Latest Edition, Pearson, 2017	
2. Behrouz A Forouzen, and Debdeep Mukhopadhyay, "Cryptography and Network Security", 3rd Edition /Latest Edition, 2015.	
3. Nina Godbole, "Information System Security: Security Management, Metrics, Frameworks and Best Practices", 2nd Edition/Latest Edition, 2017.	
Reference Books	
1. Atul Kahate, "Cryptography and Network Security", 3rd Edition /Latest Edition, 2017.	

Requirement Estimation Theory

Course Code: BIT-404 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 8

Introduction:

A requirement gathering is the cornerstone of any software development project. In this course, students will gain the knowledge and skills needed to capture software requirements using clearly defined processes. They will learn to specify user and system requirements, match the process to the size of the software project, and apply quality and consistency tests to the requirements model. It will equip the students with skills and knowledge in developing, leading, designing, testing or managing a requirements initiative for a software system.

Course Objectives:

- To introduce the essential aspects of software requirements; elicitation technique, requirements analysis; software quality attributes
- Understand the software requirements management principles and practices.
- Learn the fundamental of Software estimation components, size estimation, effort, schedule ad Cost Estimation models.
- Demonstrate the techniques learned for requirements Management and estimation requirements Management for size estimation and cost estimation through case studies.

Pre-requisite: Introduction to Software Engineering.

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

CO1: Understand and demonstrate essential software requirements
CO2: Describe requirement analysis process of software from engineering perspective
CO3: Perform cost estimation using estimation models like Function Point Analysis and COCOMO
CO4: Apply different Techniques for software management and estimation

Pedagogy:

This course is structured around continuous progress. It will include a combination of lectures, and group activities focused on experiential learning, in-class discussions, regular assessments and case studies. The topics will be presented to students using real-world scenarios and problem-solving activities

UNIT-I	10 Hours
Software Requirements: Why has Requirement Engineering Become so important? INdustrila challenges in Requirements, Requirement Engineering and Artifact Modelling, Eliciting Requirements, Interview, IBIS, CORE, FODA, SSM, Model Driven Requirements Engineering, MDRE Process, Elicitation and Analysis Model Heuristics, Determining Model Completeness, Quality Attribute Requirements.	
UNIT-II	**11 Hours**
Requirement Management, Change Management, Requirements Management Activities, Traceability, Creation of Requirements Management, Requirement-Driven System Testing, Process, Software Measurement, Why Measurement, Measurement Foundations, Making Measurement a success, Simple effective Measurement Process, Planning the Measurement Process, Planning with Measurement Frameworks, ISO 15939, CMMI, GQM Approach, CAME Approach.	
UNIT-III	**11 Hours**
Software Estimation techniques and Estimate Planning, Executing the estimate, Software sizing, Planning and controlling the project via the Estimate, SLOC, Logical SLOC counting Details, Function Point Sizing, International Function Point User Group Counting Standards, Basic Process, SEER-Function Based Sizing, COSMIC Full Function Point Approach	
UNIT-IV	**10 Hours**
Software Cost Estimation Methods: heuristic approach, parametric approach COCOMO, COCOMO II, strategy and rationale, Development Effort Estimates, Software Economies and Diseconomies of Scale, Cost Factors, Application Composition Model, Early Design Model, Post-Architecture Model, Case study, Software Cost-Estimating Research Issues	

Text Books	
1	Brian Berenbach ,Daniel Paulish , Juergen Kazmeier ,Arnold Rudorfer : Software & Systems Requirements Engineering: In Practice Hardcover– March 26, 2009/Latest Edition
2	M. A. Parthasarathy: Practical Software Estimation: Function Point Methods for Insourced and Outsourced Projects, Addison-Wesley Professional,2007/Latest Edition
Reference Books	
1	Daniel D. Galorath and Michael W. Evans, Software Sizing, Estimation and Risk Management, Auerbach Publications, 2006/Latest Edition
2	Capres Jones, Estimating Software Costs, McGraw Hill, 2nd Edition, 2009/Latest Edition
3	Christof Ebert and Reiner Dumke, Software Measurement: Establish, Extract, Evaluate, Execute, Springer, 2007/Latest Edition

NATURAL LANGUAGE PROCESSING	
Course Code: BCS 406 Contact Hours: L- 3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 8

Introduction:

This course aims at teaching the basics about processing of Natural Languages. Natural language processing is the feature of 5th Generation Computer and is part of Artificial intelligence. It teaches about the different phases of natural language processing, methodologies, algorithms, data structures used for Natural Language Processing.

Course Objectives:

- To provide an introduction to the basic principles, techniques, and applications of Natural Language Processing.
- To provide an understanding of the basic phases of natural language processing like morphological analysis, syntactic analysis, semantic analysis, pragmatic analysis
- To teach algorithms and data structures etc for performing syntactic analysis, semantic analysis.
- To understand about grammars and their hierarchy.
- To teach about the latest tools of NLP like Word Net, concept of WSD , Hindi WORDNET etc.

Pre-requisites: Artificial Intelligence, Data structures and algorithms, programming languages.

Course Outcomes: After completion of the course the students will be able to:
CO1: To provide an introduction to the basic principles, techniques, and applications of Natural Language Processing.
CO2:To provide an understanding of the basic phases of natural language processing like morphological analysis, syntactic analysis, semantic analysis, pragmatic analysis
CO3: To teach algorithms and data structures etc for performing syntactic analysis, semantic analysis.
CO4:To understand about grammars and their hierarchy.
CO5:To teach about the latest tools of NLP like Word Net, concept of WSD , Hindi WORDNET etc.

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.

UNIT-I	10 Hours
Introduction: Basic concepts of Natural language Processing, evolution of NLP, issues and challenges in NLP, basic concepts of phases of natural language processing morphological analysis, syntactic analysis, semantic analysis, pragmatic analysis, tools and techniques used for performing these analysis, ambiguities, Types of ambiguities	
UNIT-II	**11 Hours**
Syntactic analysis: Concept of Grammars, Chomsky hierarchy of grammars, concept of parsing, top down parsing, bottom up parsing, bidirectional parsing, generating parse tree, data structures and algorithms used for parsing, tokeniser Case study of parsers of NLP systems like ELIZA, LUNAR	
UNIT-III	**11 Hours**
Semantic Analysis : understanding meaning, CASE grammars, transformational grammars used for performing semantic analysis. Resolving ambiguities to generate correct meaning, Word Sense Disambiguation Case study of Toolkit of word sense disambiguation used in WORDNET	
UNIT-IV	**10 Hours**
Software tools for Performing NLP: English WORDNET, components of WorldNet understanding NLTK tool for using wordnet, HINDI wordnet, Indian Govt initiative for language analysis and machine translation	

Text Books	
1	Allen,James, "Natural Language Understanding", Second Edition, Benjamin/ Cumming, 1995/Latest Edition.
2	Jurafsky, Danand Martin, James," Speech and Language Processing", Second Edition,Pre ntice Hall,2008/Latest Edition
3	Ela Kumar, " Natural Language Processing", IK international Publication, second edition 2014/Latest Edition

Reference Books	
1	Bharati Akshar, Chaitanya Vineet, Sangal, Rajeev, "Natural Language Processing: A Paninian Perspective", Prentice Hall India Learning Private Limited; EASTERN ECONOMY ed. edition , 1995/Latest Edition
2	Philipp Koehn, Statistical Machine Translation, Cambridge University Press; 1st edition ,2009/Latest Edition
3	U.S. Tiwari and Tanveer Siddiqui, Natural Language Processing and Information Retrieval, Oxford UniversityPress,2008/Latest Edition.

Generic Open Elective Course	
Course Code: GEC-402 Contact Hours: L-0 T-0 P-4 L-0 T-2 P-0 L-2 T-0 P-0 Course Category: GEC	Credits: 2 Semester: 8

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. GEs are introduced as part of the CBCS. The students can choose their preference from a pool of courses 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 objectives:

- Students will have exposure to a new discipline/subject.
- Prepare students to look for inter-disciplinary research.
- 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.

Prerequisite: Basic knowledge of the selected domain of elective course.

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

CO1: Identify new discipline and learn new subject for future careers.
CO2: Apply their knowledge to understand and solve the real life problems.
CO3: Analyse creative design process through the integration and application of diverse technical knowledge and expertise to address social issues.
CO4: Develop the habit of working independently to 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.

Cryptography	
Course Code: BIT- 410 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 8

Introduction:

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

Course Objective:

- To understand the fundamentals of Cryptography
- To acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity
- To explain and use modern cryptographic methods (symmetric encryption, public key encryption, hash functions, key management, digital signatures, certificates)
- To discuss electronic mail security, SSL/TLS and recent developments affecting security and privacy on the Internet.

Pre-requisite: None

Course Outcome:

CO1: Understand applied cryptographic basics.
CO2: Analyze and differentiate between public-key and private key cryptosystems.
CO3: Evaluate security mechanisms using rigorous approaches by key ciphers and hash functions.
CO4: Design cryptographic protocols to solve real world problems.

Pedagogy:

Emphasis on lab sessions where students will be given programming assignments to code in lab based on topics learnt in previous lectures.

UNIT-I	10 Hours
Course Introduction and terminology, Conventional Cryptography: Definitions, Classical encryption techniques, One time pad, Perfect Secrecy, DES, Triple DES, Finite fields, AES, Modes of Encryption	
UNIT-II	**11 Hours**
Asymmetric Cryptography: Number Theory, public key cryptography: RSA, ElGamal, and Elliptic Curve Cryptography, Diffie Hellman Key management , Digital Certificates: X.509	
UNIT-III	**11 Hours**
Stream Ciphers, LFSR based stream ciphers, Message Authentication Codes, Hash functions, Hash algorithms, Digital Signatures and Authentication Protocols, Firewalls	
UNIT-IV	**10 Hours**
Intrusion Detection, PGP, S/MIME, Key Management, Kerberos, IPSec, SSL/TLS, Password Hashing and Management	

Text Books	
1	W Stallings, “Cryptography and Network Security: Principles and Practice, 7/e”, Prentice Hall, 2017/Latest Edition
2	B. Forouzan, D. Mukhopadhyay, "Cryptography and Network Security 2/e", McGraw Hill/Latest Edition
3	Bernard Menezes, “Network Security and Cryptography 2/e”, Cenege Learning, 2012/Latest Edition.
Reference Books	
1	A. Menezes, P. van Oorschot, S. Vanstone. “Handbook of Applied Cryptography,2/e”, CRC press, 2018/Latest Edition.
2	Douglas R. Stinson, “Cryptography: Theory and Practice 3/e”, CRC Press, 2006/Latest Edition
3	B. Schneier. “Applied Cryptography, 2/e”, John Wiley & Sons, Inc., 2015/Latest Edition

Quantum Computing	
Course Code: BCS- 410 Contact Hours: L-3 T-1 P-0 Course Category: Elective	Credits: 4 Semester: 8

Introduction:

Quantum computation captured the imagination of computer scientists with the discovery of efficient quantum algorithms for factoring and fast algorithm for search. Quantum computing exploits the quantum mechanical nature of matter to simultaneously exist in multiple possible states. Building up on the digital binary logic of bits, quantum computing is built on the basis of interacting two-level quantum systems or 'qubits' that follow the laws of quantum mechanics. Addressability of the quantum system and its fragility to fidelity are the major issues of concern, which if addressed appropriately, will enable this new approach to revolutionize the present form of computing. The aim of quantum computing is to do computation using the quantum mechanical effects.

Course Objective:

- To impart the basic understanding of quantum mechanics and its usage in quantum computing.
- To provide the general introduction to the algebra of complex vector spaces.
- To simulate quantum computing algorithms using IBM Qiskit Technology.
- To give insights to conceive and model quantum systems on their own for societal applications.

Pre-requisite: Binary Digital Logic, Linear Algebra, Algorithms Design, Probability and Statistics

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

CO1: Learn the fundamentals of quantum computing and quantum mechanics;
CO2: Explain the basics of quantum circuits, quantum information, and cryptography;
CO3: Analyze existing quantum algorithms and evaluate their performance in different domains.
CO4: Design and analyze quantum algorithms incorporating noise and error correction.

Pedagogy:

Course teaching and learning through lectures, tutorials, assignments, projects and quizzes. Encouragement to the students for developing an understanding and simulations of the existing quantum computational models. Emphasis on mathematical and programming assignments based on topics from previous lectures. Course will have a blend of theory and lab practice for the benefit of students. Use of ICT, web-based sources as well as blackboard teaching will be adopted.

UNIT-I	10 Hours
Introduction to Quantum Computation: Classical deterministic systems, classical probabilistic systems, quantum systems, basic quantum theory. Quantum bits, Bloch sphere representation of a qubit, multiple qubits. **Background Mathematics and Physics**: Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.	
UNIT-II	**11 Hours**
Quantum Circuits: single qubit gates, multiple qubit gates, design of quantum circuits, classical gates, quantum gates. **Quantum Information and Cryptography**: Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem. Asymmetric and symmetric encryption, quantum key distribution.	
UNIT-III	**11 Hours**
Quantum Algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Quantum circuits, reversibility of quantum circuits, power of quantum algorithms, Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search, applications of quantum algorithms.	
UNIT-IV	**10 Hours**
Noise and error correction: Graph states and codes, Quantum error correction, fault-tolerant computation, Single-Qubit Errors, Quantum Operations and Krauss Operators, The Depolarization Channel, The Bit Flip and Phase Flip Channels, Amplitude Damping, Phase Damping.	

Text Books	
1	Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press, 2002/Latest Edition.
2	Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific, 2004/Latest Edition.
3	Pittenger A. O., An Introduction to Quantum Computing Algorithms 2000/Latest Edition.
Reference Books	
1	Quantum Computation and Quantum Information. Michael A. Nielsen, Isaac L. Chuang. Cambridge University Press, Dec 9, 2010 - Science/Latest Edition.
2	An Introduction to Quantum Computing. Phillip Kaye, Raymond Laflamme, Michele Mosca. Oxford University Press Inc., New York, 2007/Latest Edition.
3	Quantum Computing: An Applied Approach. Jack D. Hidary. Springer; 1st ed. 2019 edition (20 September 2019) /Latest Edition.

Computational Optimization Techniques	
Course Code: BCS- 412 Contact Hours: L-3 T-1 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction:

The aim of this course is to have some basic understanding of mathematical concepts of optimization and having skills necessary to solve and interpret optimization problems in engineering.

Course Objectives:

- To explain the basic mathematical concepts of optimization.
- To develop the modelling skills necessary to describe and formulate optimizationproblems.
- To conduct and interpret the post optimal and sensitivity analysis and explain theprimal-dual relationship.
- To provide the skills necessary to solve and interpret optimization problems in engineering.

Pre-requisites: Exposure to relevant concepts at undergraduate level and instructor consent.

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

CO1: To explain the basic mathematical concepts of optimization.
CO2: To develop the modelling skills necessary to describe and formulate optimization problems.
CO3: To conduct and interpret the post optimal and sensitivity analysis and explain the primal dual relationship.
CO4: To provide the skills necessary to solve and interpret optimization problems in engineering.

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.

UNIT-I	10 Hours
Introduction: Engineering applications of optimization, statement of an optimization problem with example for minimum weight and optimum cost consideration, classification of optimization problems and techniques, Single variable optimization, multi-variable optimization with equality and inequality constraints and without constraints, Objective function, single objective function, multi objective function and optimality.	
UNIT-II	**11 Hours**
Linear Programming: Introduction, Techniques of linear programming: Simplex method,slack variable, Revised simplex method: Duality in linear programming, decomposition principle, integer linear programming, Transportation problem, scheduling, applicationsto engineering design, real life application of optimization techniques.	
UNIT-III	**11 Hours**
Non Linear Programming: Introduction, Basic ideas of one- Dimensional optimization problem, unconstrained and constrained optimization problem-Lagrange's multiplier, quadratic programming-wolfe's method, direct search method, descent method, conjugate gradient method various search methods, Travelling salesperson problem, descent method, steepest descent method, two person zero sum game, Maximin-Minimax principle, engineering application of optimization techniques.	
UNIT-IV	**10 Hours**
Nature Inspired Optimization Algorithm: particle swarm optimization, ant colony optimization, simulated annealing, Tabu search, neural network based optimization, fuzzy optimization technique, cuckoo search, bat algorithm, firefly algorithm, flower pollination algorithm, Bee algorithm,	

Text Books	
1	S. S. Rao, Engineering Optimization- Theory and Practice, Wiley; 5th edition/ LatestEdition, 2019.
2	X in-She Yang, Nature-Inspired Optimization Algorithms, Academic Press Inc; 2ndedition/ Latest Edition, 2020.
Reference Books	
1	Kajla Basu, Samarjit Kar, Computational Optimization and Applications, NarosaPublishing House, Latest Edition, 2012
2	Rajesh Kumar Arora, Optimization: Algorithms and Applications, Chapman andHall/CRC; 1st edition/ Latest Edition, 2015.
3	Deb K., Optimisation for Engineering Design-Algorithms and Example, Prentice Hall IndiaLearning Private Limited; Second edition/ Latest Edition, 2012.