Indira Gandhi Delhi Technical University for Women

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

Kashmere Gate, Delhi - 110006

DEPARTMENT OF ARTIFICIAL INTELLIGENCE
&
DATA SCIENCES

FOUR YEAR UNDERGRADUATE

PROGRAMME (B.Tech CSE- AI)

TEACHING SCHEME AND SYLLABUS

SEMESTER III

Code	Subject	L-T-P	Credits	Category
BAI-201	Artificial Intelligence	3-0-2	4	DCC
BCS-201	Data Structures	3-0-2	4	DCC
BCS-203	Discrete Structures	3-1-0	4	DCC
BIT-203	Software Engineering	3-0-2	4	DCC
Bxx-2xx	Open Elective Courses	-	4	OEC
GEC-201	Generic Open Elective	0-2-0 0-0-4 2-0-0	2	GEC
BAI-253	Industrial Training/Internship	-	1	DCC
		Total	**23**	

List of Open Elective Courses (New Courses may be added)

Code	Subject	Code	Credits
BAS-201	Material Science and Engineering	3-1-0	4
BAS-203	Numerical Methods	3-1-0	4
BEC-209	Analog and Digital Electronics	3-0-2	4
BMA-209	Engineering Measurement and Metrology	3-0-2	4
BAI-203	IT Workshop using R (for other Dept.)	2-0-4	4

SEMESTER IV

Code	Subject	L-T-P	Credits	Category
BAI-202	Computer Networks	3-0-2	4	DCC
BIT-202	Operating Systems	3-0-2	4	DCC
BCS-204	Design and Analysis of Algorithms	3-0-2	4	DCC
BAI-204	Optimization Techniques and Decision Making	3-0-2	4	DCC
Bxx-2xx	Open Elective Courses	3-0-2	4	OEC
HMC-202	Disaster Management	2-0-0	2	HMC
		Total	**22**	

List of Open Elective Courses (New Courses may be added)

Code	Subject	L-T-P	Credits
BAS-202 BAS-204 BAS-206 BEC-210 BMA-210 BAI-206	Nano Structures & Materials in EngineeringOptical Engineering Optimization Techniques Elements of Information TheoryOperations Management Introduction to Data Science (for other Dept.)	3-1-0 3-0-2 3-1-0 3-1-0 3-1-0 3-0-2	4 4 4 4 4 4

SEMESTER V

Code	Subject	L-T-P	Credits	Category
BAI-301	Machine Learning	3-0-2	4	DCC
BAI-303	Cyber Security	3-0-2	4	DCC
BAI-305	Deep Learning – I	3-0-2	4	DCC
BCS-303	Theory of Computation	3-1-0	4	DCC
HMC-301	Professional Ethics and Human Values	3-0-0	3	HMC
BAI-353	Industrial Training/Internship	-	1	DCC
GEC-301	Generic Open Elective	0-2-0 0-0-4 2-0-0	2	GEC
		Total	**22**	

SEMESTER VI

Code	Subject	L-T-P	Credits	Category
BAI-302	Natural Language Processing	3-0-2	4	DCC
BAI-304	Deep Learning- II	3-0-2	4	DCC
BAI-3xx	Departmental Elective - I	-	4	DEC
BAI-3xx	Departmental Elective - II	-	4	DEC
BAI-306	Digital Image Processing	3-0-2	4	DCC
HMC-30x	Management Elective	-	2	HMC
		Total	**22**	

List of Departmental Elective Courses (New Courses may be added)

Category	Course Code	Subject	L-T-P	Credits
Departmental Elective-I	BAI-308	Cloud Computing	3-0-2	4
	BAI-310	Blockchain Technologies	3-0-2	4
	BAI-312	Quantum Computing	3-0-2	4
	BCS-306	Compiler Design	3-0-2	4
Departmental Elective-II	BAI-314	Information Retrieval	3-0-2	4
	BAI-316	Recommender Systems	3-0-2	4
	BAI-318	Semantic Web	3-0-2	4
	BAI-320	Advanced Machine Learning	3-0-2	4
	BAI-322	Data Warehousing and Business Intelligence	3-0-2	4

List of Management Elective Courses (New Courses may be added)

Course Code	Subject	L-T-P	Credits
HMC-302	Principles of Management	2-0-0	2
HMC-304	Marketing Management	2-0-0	2
HMC-306	Financial Management	2-0-0	2
HMC-308	Human Resource Management	2-0-0	2

SEMESTER VII

Code	Subject	L-T-P	Credits	Category
BAI-415	Recent Trends in AI	3-0-2	4	DCC
BIT-407	Big Data Analytics	3-0-2	4	DCC
BAI-417	Multimodal Data Analysis	3-0-2	4	DCC
DEC-4xx/3xx	Departmental Elective - III	-	4	DEC
DEC-4xx	Departmental Elective - IV	-	4	DEC
BAI-451	Minor Project	0-0-8	4	DCC
BAI-453	Internship	-	1	
		Total	**25**	

List of Departmental Elective Courses (New Courses may be added)

Category	Code	Subject	L-T-P	Credits
Departmental	BAI-403 BAI-407 BIT-403	Computer Vision Pattern Recognition Software Testing	3-0-2 3-0-2 3-0-2	4 4 4
Departmental Elective -IV	BAI-409 BAI-411 BIT-413	Conversational AI Parallel and Distributed AI Software Project Management	3-0-2 3-0-2 3-1-0	4 4 4

SEMESTER VIII

Subject	Code	L-T-P	Credits	Cat.
Creativity, Innovation and Entrepreneurship	HMC-402	3-0-0	3	HMC
Departmental Elective – V	BAI-4xx	-	4	DEC
Departmental Elective – VI	BAI-4xx	-	4	DEC
Industrial Project/R&D Project/Start-up Project	BAI-452	-	8	DCC
Generic Open Elective	GEC-402	0-2-0 0-0-4 2-0-0	2	GEC
		Total	**21**	

List of Departmental Elective Courses (New Courses may be added)

Category	Code	Subject	L-T-P	Credits
Departmental Elective-V	BAI-402 BAI-404 BAI-406 BAI-408 BAI-410	Augmented Reality and Virtual Reality Social Media Analytics AI for Games Multi-agent Systems Security and Privacy for Big Data Analytics	3-0-2 3-0-2 3-0-2 3-0-2 3-0-2	4 4 4 4 4
Departmental Elective-VI	BAI-412 BAI-414 BAI-416 BCS-410	Internet of Things Cognitive computingAI in Healthcare Quantum Computing	3-0-2 3-0-2 3-0-2 3-1-0	4 4 4 4

ARTIFICIAL INTELLIGENCE	
Course Code: BAI-201 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 3

Introduction: This course is an introduction to the basic knowledge representation, problem solving and learning methods in the field of artificial intelligence. After completing this course, students should be able to understand the basic concepts of problem solving and learning.

Course Objectives:

- Introduce the basic concepts of artificial intelligence, problem solving, knowledgerepresentation and reasoning.
- Learn the basic concepts of handling uncertainty
- Help the students to applications of AI in different fields

Prerequisite: Discrete Mathematics, Programming Concepts.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Learn the different concepts and strategies of Artificial Intelligence.
CO2: Recognize various representations techniques for knowledge extraction using differenttools.
CO3: Apply concepts of decision making for handling uncertainty in various applications.
CO4: Implement different strategies of artificial intelligence for solving 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 makethe classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT-I	10 Hours
Introduction to AI: Brief introduction about Intelligent agents and Problem Solving. TuringTest. Uninformed Search Strategies, Informed Search Strategies, Heuristics. Solving problemsby searching, BFS, DFS, Issues in design of Intelligent Search Algorithms.	
UNIT-II	**10 Hours**
Knowledge Representation: Knowledge Representation using predicate logic, Rule BasedSystems, Ontology, WordNet and Concept Net as Knowledge representation tool Programming with Prolog/Lisp. Text Feature Extraction - BoW Model, TF-IDF. WordEmbeddings - Word2Vec, GloVe.	
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, Social Network Analysis Information Retrieval from Search Engines and Metasearch Engines, IoT Applications & BigData Analytics Applications. Ethics in AI.	

Text Books	
1	S.J. Russell and P. Norvig, "Artificial Intelligence- A Modern Approach", Pearson 3rdEdition, 2010/Latest Edition.
2	P.H. Winston, "Artificial Intelligence", Pearson Education, 3rd Edition, 2002/ LatestEdition.
Reference Books	
1	E. Rich and K. Knight, "Artificial Intelligence", McGraw Hill Education; 3rd Edition2017, Latest Edition.
2	N.J. Nilsson, "Principles of Artificial Intelligence", Narosa Publ. House, 2002/ LatestEdition.
3.	L. Luger,"Artificial Intelligence : Structures and Strategies for Complex ProblemSolving", Pearson Education, 5th Edition 2008/ Latest Edition.
4.	E. Kumar, "Artificial Intelligence", Dreamtech Press, 2020/ Latest Edition.

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

Introduction: Data structure is a specific way to store and organize data in a computer's memoryso that these data can be used efficiently later. This course introduces about various data structuresand their useful applications in computer science domain.

Course Objectives:

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

Pre-requisite: Fundamentals of Programming

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Explain the concept of time and space complexity of the algorithm.
CO2: Understand the use of fundamental data structures and algorithm appropriately to solve anumber of computational problems.
CO3: Apply various algorithms to solve the problems of searching and of data.
CO4: Design programs using a variety of data structures such as stacks, queues, hash tables, binarytrees, search trees, heaps, graphs, and B-trees.

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

CONTENTS

UNIT-I	10 Hours
Introduction: 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 Queue Applications of Queues Priorityqueues. **Linked Lists:** Singly linked lists, Representation of linked list, Operations of Linked listsuch as Traversing, Insertion and Deletion, Searching, Applications of Linked List. Concepts of Circular linked list and Doubly linked list and their Applications. Stacks andQueues as linked list.	
UNIT-III	**12 Hours**
Trees: Basic Terminology, Binary Trees and their representation, binary search trees, variou operations on Binary search trees like traversing, searching, Insertion and DeletionApplications of Binary search Trees, Complete Binary trees, Extended binary trees. Generatrees, AVL trees, Threaded trees, B- trees. **Searching and Sorting:** Linear Search, Binary search, Interpolation Search, Insertion SortQuick sort, Merge sort, Heap sort, sorting on different keys, External sorting.	
UNIT-IV	**10 Hours**
Graphs: Terminology and Representations, Graphs & Multi-graphs, Directed Graph Representation of graphs and their Transversal, Spanning trees, shortest path and TransitiveClosure, Activity Networks, Topological Sort and Critical Paths. **File Structure:** File Organization, Indexing & Hashing, Hash Functions, CollisionResolution Techniques.	

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

DISCRETE STRUCTURE	
Course Code: BCS -203 Contact Hours: L-3 T-1 P-0Course 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 combinatorialmathematics
- To introduce the basic properties of graphs and trees and model simple applications
- Learn concepts of discrete mathematics

Pre-requisite: Nil

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

CO1: To convert a logic sentence in terms of predicates, quantifiers, and logicalconnectives and its validation

CO2: Able to use logical notations to define and reason about fundamental mathematicalconcepts such as sets relations, functions and combinatorics.

CO3: Able to use logical notations to define and reason about fundamental mathematicalconcepts of abstract algebra.

CO4: Apply algorithms and use of graphs and trees as tools to analyse and simplifyProblems.

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

CONTENTS

UNIT-I	10 Hrs
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 ofnecessity and sufficiency.	
UNIT-II	**10 Hrs**
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 o mathematical induction. Functions, mappings, injection and surjections, composition of functions, invers 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 th power set theorem, Schröder-Bernstein theorem.	
UNIT III	**12 Hrs**
Algebraic structures and Morphisms: Algebraic structures with one binary operation - semigroups, monoids and groups, subgroup 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 Hrs**
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 CombinatorialMathematics, CRC Press, 2000.
2	C L Liu, Elements of Discrete Mathematics, Second Edition, Tata McGraw-Hill.
3	Bernard Kolman, Robert C Busby, and Sharon Cutler Ross, Discrete MathematicalStructures, fifth edition, Prentice-Hall of India.
Reference Books	
1	Ralph P Grimaldi, Discrete and Combinatorial Mathematics, Pearson Education Asia.
2	Norman L Biggs, Discrete Mathematics, Oxford University Press.
3	J P Tremblay and R Manohar, Discrete mathematical structures with applications toComputer Science, Tata McGraw-Hill.

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

Introduction:
Software engineering is the branch of computer science that creates practical, cost-effective solutions to computing and information processing problems, preferentially by applying scientific knowledge, developing software systems in the service of mankind. This course covers the fundamentals of software engineering, including understandingsystem requirements, finding appropriate engineering compromises, effective methods of design,coding, and testing, team software development, and the application of engineering tools.The course willcombine a strong technical focus with a capstone project providing theopportunity to practice engineering knowledge, skills, and practices in a realisticdevelopment.

Course Objectives:
- Study the current software engineering techniques and examines the software life- cycle,including software specification, design implementation, testing and maintenance.
- Present software engineering methodologies for the development of Quality, cost- effective,schedule adhered software.
- Develop an understanding of ethical and professional issues related to Software ProjectDelivery.

Pre-requisite: Nil

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Understand the concepts of Software engineering, Software process and its models.
CO2: Evaluate the Software Requirements, interpret and structure the requirements in SoftwareRequirement Document
CO3: Apply appropriate software architectures and patterns to carry out high level design of a systemand be able to critically compare alternative choices, evaluate the quality and maintenance of the software through software testing.
CO4: Create the software project plan for size and cost estimation including risk analysis.

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

CONTENTS

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 involve 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 Behavioural & Non-Behavioural Requirements, SRS Components & various User's 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 andTechniques, 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, Estimationof 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, PlanningParameter, Quality Defect Removal Cycle, Role of Risk Analysis.	
Text Books	
1	K. K. Aggarwal, Yogesh Singh: Software Engineering, New Age International Ltd, 3rd Ed. 2008.
2	Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publishing,2010.
Reference Books	
1	R.S. Pressman, Software Engineering – A Practitioner's Approach, 8th Edition, McGrawHill, 2019.
2	Ian Sommerville, Software Engineering, 10th Edition, Pearson, 2017.

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 andclassificationof various Materials.
- To acquire basic understanding of the electronic, superconducting dielectric and magneticproperties of materials for technological applications.
- To familiarize with modern engineering materials and bio-materials in variousapplications.
- To develop an understanding of principles, working and applications of various materialcharacterization techniques.

Pre-requisites: Basic understanding of Applied Physics Course.

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

CO1: Understand scope and importance of materials in technological developments.

CO2: Learn importance and utilization of various physical properties of materials inDevice applications.

CO3: Enhance the knowledge of latest advancements in field of materials, ModernEngineering and Biomaterials.

CO4: Learn the principles, working and applications of various material characterizationTechniques in studying the materials.

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

CONTENTS

UNIT-I	4 Hours
Introduction to materials: Importance of Material science and Engineering, Classificationof 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 Ferm 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, Hardand soft magnetic materials, Spintronics (GMR).	
UNIT-III	**10 Hours**
MODERN ENGINEERING AND BIOMATERIALS **Photonic Materials:** LED – LCD – Photo conducting materials, Photo detectors, Photoniccrystals 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-basedalloys) – Polymeric implant materials.	
UNIT-IV	**10 Hours**
MATERIALS CHARACTERIZATION **Structural Analysis:** X-ray diffraction, SEM, TEM, AFM- Principals, Instrumentations andapplications. **Optical Characterizations:** UV-Vis, FTIR-Principals, Instrumentations and application **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.
2	Sam Zhang, Lin Li, Ashok Kumar, "Materials Characterization Techniques", 1st Edition, CRC Press, 2008.
3	T. Pradeep, "A Text Book of Nanoscience and Nanotechnology", TataMcGraw Hill, New Delhi, 2012.
Reference Books	
1	Elements of X–ray Diffraction, B. D. Cullity, S.R. Stock, 3rd Edition, Pearson,2001
2	R. F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM,and AEM, 2nd Edition, Springer,2016.

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. Thesemethods 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 solvemathematical problems representing various engineering, physical and real lifeproblems.
- To provide constructive methods for obtaining answers to such problem for which analyticalmethods fails to find solutions.

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

Course Outcomes: Upon completion of this course, the students will be able to:
CO1: Understand the errors, source of error and its effect on any numerical computationsand alsoanalysis 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: The teaching-learning of the course would be organized through lectures, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT-I	10 Hours
Floating-Point Numbers: Floating-point representation, rounding, chopping, error analysis, -conditioning and stability. Non-Linear Equations: Bisection, secant, fixed-point iteration, Newton method for simpleand 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 thei 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 backwardinterpolation, Lagrange and Newton's divided difference interpolation formulas with erroranalysis, 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'sand 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. NumericalMethods for Scientific andEngineering Computation, 6th Edition, New Age International Publication, 2012.
2	Sastry S., Introductory Methods of Numerical Analysis, 5th Edition, Prentice HallIndia Learning Private Limited; 2012.
3	Conte, S.D and Carl D. Boor, Elementry Numerical Analysis: An Algorithmicapproach, SIAM-Society for Industrial and Applied Mathematics, 2017.
4	Grewal, B. S., "Higher Engineering Mathematics", 44thEdition, Khanna Publishers,2012.
Reference Books	
1	Gerald C.F and Wheatley P.O., Applied Numerical Analysis, 8th Edition, PearsonEducation, 2011.
2	Chappra S.C., Numerical Methods for Engineers, 7th Edition, McGraw-HillHigher Education, 2014.

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 inindustry focused on how to adopt and apply various methods of measurement. It enlightens thestudents about the various errors, calibration, sensors, accuracy of measurements thus to help in studying 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 anddevelop standardization of measuring methods.
- The students are to be provided hands on practical exposure on topics covered in thecourse.

Pre-Requisites: NIL

Course Outcomes: Having successfully completed this course, the student will be able to
CO1: Understand Measurement Process and various techniques
CO3: Understand sensors and Transducers
CO3: Understand measurement instrument capabilities
CO4: Understand statically control techniques

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

CONTENTS

UNIT I	11 Hours
Introduction: Introduction to measurement and measuring instruments generalized measuringsystem and functional elements, units of measurement, static and dynamic performancecharacteristics 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 characteristic Difference b/w Open loop and Closed loop measurement system, Signal conditioning unit, indicatingunit, 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 gauges and their working, temperature Compensation **Measurement of force and torque:** Different types of load cells, elastic transducers, pneumatic andhydraulic 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, Limi Gauge, Snap Gauge, Receiving Gauge, Taylor's Principle of Gauge Design.	
UNIT IV	**10 Hours**
Measurement of geometric forms like straightness, flatness, roundness, Tool maker'smicroscope, 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 PublicationsPvt. Ltd., 2003..
2.	T.G. Beckwith, R.D. Maragoni and J.H Lienhard, "Mechanical Measurements",Addison-Wesley, 1999.
Reference Books	
1.	R.K. Jain, "Engineering Metrology", Khanna Publishers, Delhi,2010
2.	I.C. Gupta, "Engineering Metrology", Dhanpat Rai Publications, Delhi,2011
3.	F.W. Galyer& C.R. Shotbolt, "Metrology for Engineers", ELBS edition, 2009

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

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

Course Objectives:

- 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 numbersystem

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 logiccircuits
CO4: Design sequential circuits

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

CONTENTS

UNIT-I	12 Hours
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 collecto (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,	
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 simplificationof logical functions Don't care conditions, X-OR & X-NOR simplification ofK-maps. Combinational circuits: Multiplexers, Demultiplexers, Decoders & Encoders, Adders & Subtractor, Cod 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 synchronouscounters and Sequence detectors, Sequence generators	

Text Books	
1	Morris Mano, "Digital Design", PHI, 5th edition, 2013.
2	Millman and Halkias, "Electronic Devices and Circuits" T MH, 4th Edition, 2015.
3	Salivahanan, Suresh Kumar, Vallavaraj, "Electronic Devices and Circuits" MH, 4th Edition, 2016.
Reference Books	
1	Balbir Kumar and S. B. Jain, "Electronic Devices and Circuits" PHI, 2nd Edition2014.
2	R.P. Jain, "Modern Digital Electronics", TMH, 4th Edtion, 2010
3	Roy Choudhury and Jain, "Linear Integrated Circuits", New Age Publishers, 4th Edition, 2017.

COMPUTER NETWORKS	
Course Code: BAI-202 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction: The course introduces main concepts of computer networking, application areas, classification, reference models, transmission environment, technologies, routing algorithms, IP,UDP and TCP protocols; reliable data transferring methods, application protocols and perspectives of communication networks.

Course Objectives:

- To equip the students with a general overview of the concepts and fundamentals ofcomputer networks.
- Familiarize the students with the standard models for the layered approach to communication between machines in a network and the protocols of the various layers

Prerequisite: NIL

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

CO1: Comprehend the basic computer network technology and functions of each layer in theOSI and TCP/ IP reference model.

CO2: Explain various protocols of the data link layer to handle design issues.

CO3: Discuss the algorithms of the network layer to perform subnetting and routingmechanisms.

CO4: Identify and analyse different elements of transport and application layer for securenetworking.

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

CONTENTS

Unit I	10 Hours
Evolution of Computer Networking-Types of Network- networks topologies-Protocols & standards-Network Devices-The OSI reference model- TCP/IP Reference Model. Physical Layer: transmission media, twisted pairs, coaxial cable, fiber optics, Wireless transmission.	
Unit II	**12 Hours**
Data Link Layer Design Issues-Services provided to the Network Layer-Framing-Error Control-Flow Control-Error Detection and Correction- Elementary Data Link Protocols-Sliding Window Protocols, A one-bit sliding window protocol, A protocol using Go-Back-N,A protocol using Selective Repeat, Example data link protocols. Medium Access sub layer:The channel allocation problem, Multiple access protocols: ALOHA, Carrier sense multipleaccess protocols, collision free protocols. Wireless LANs, Data link layer switching, Multiple Access Protocols-An overview of IEEE Standard for LANs, MAC Address.	
Unit III	**10 Hours**
Introduction to Network Layer – Services – Circuit Switching Vs Packet Switching-PacketSwitched Networks-Types of Routing-routing algorithms- congestion control algorithms, Hierarchical routing, Broadcast, Multicast, distance vector routing -Network Protocols-IP-IPV4, IPV6, Subnets, Gateways- Congestion Avoidance in Network Layer, Quality of Service, Internetworking, The Network layer in the internet	
Unit IV	**10 Hours**
The Transport Services – Services provided to the upper layers –Elements of transportProtocols – Internet Transport Protocols- Congestion Controls in Transport Layer Principles of Network Applications-Web and HTTP-Electronic mail-DNS Application Layer –Domain name system, SNMP, Electronic Mail; the World WEB, HTTP,Streaming audio and video Overview of Network Security	
Text Books	
1	Andrew S. Tanenbaum, Computer Networks, Pearson Education India, 5th Edition.
2	William Stalllings, Data and Computer Communications , Pearson Education India,10th Edition.
3	Schaum's Outline Of Computer Networking, McGraw Hill, 2020
Reference Books	
1	Behrouz A Forouzan, Data Communications and Networking, McGraw Hill HigherEducation, Special Indian Edition, 4th or Latest Edition, 2017.
2	Keith W. Ross, James F. kurose, Computer Networking: A Top-Down Approach,Pearson, 6th Edition, 2017

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 modern 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 Objective:

- To learn the fundamentals of Operating Systems.
- To learn the mechanisms of OS to handle processes and threads and their communication.
- To learn the mechanisms involved in memory management in contemporary OS.
- To gain knowledge on OS architecture, mutual exclusion algorithms, deadlock detectionalgorithms etc.
- To know the components and management aspects of concurrency management.

Pre-requisite: Analysis of algorithms, algorithm design techniques, programming knowledge inC, C++ or JAVA.

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

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 processsynchronization techniques and device management strategies.

CO4: To understand management of I/O and different file handling & directoryimplementation schemes in OS.

Pedagogy

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

CONTENTS

UNIT-I	11 Hours
Introduction: Introduction to Operating System, **Types of O.S:** Simple Batch, Multi programmed Batched, Time-Sharing, Personal-computer, Parallel, Distributed, Real-TimeMobile **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, SwappingContiguous 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 FileSystem 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.
2	R. C. Joshi, “Operating Systems”, Wiley Dreamtech, 2008.
3	Deitel, Deitel and Choffnes, “Operating Systems”, Pearson, 3rd Edition, 2003
Reference Books	
1	Tannenbaum, “Operating Systems”, PHI, 5th Ed., 2000.
2	Madnick E. and Donovan J., “Operating Systems”, Tata McGraw Hill, 2017.
3	Flynn McHoes, “Operating System”, Cengage Learning, 6th edition, 2013.
4	Sibsankar Halder and Alex A. Arvind, “Operating System”, Pearson, 2009

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 Objective:

- Introduction, learning and analysis of performances of algorithmic efficiency ofapproaches 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-requisite: Data structures

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

CO1: Understand asymptotic complexities of the algorithms and design algorithms usingDivide and Conquer strategy.

CO2: Understand and apply greedy and dynamic programming approaches for designingalgorithms.

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

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

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

CONTENTS

UNIT-I	10 Hours
Introduction: 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:mergeSort, 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 withdeadlines, minimum spanning trees, Activity selection problem, Huffman Codes. Dynamic**Programming**: Elements of Dynamic Programming, Matrix Chain Multiplication, Longes common subsequence and optimal binary search trees problems.	
UNIT-III	**12 Hours**
Graph Algorithms: DFS, BFS, Topological Sort, Strongly Connected Components Kruskal' and Prim's algorithm for MST, Dijkstra's and Bellman Fort Algorithm, All pai shortest pathAlgorithm. **Back Tracking**: General method, n-queen's problem, Branch and Bound: GeneraMethod, 0/1 knapsack.	
UNIT-IV	**10 Hours**
String matching: Naïve String Matching algorithm, Rabin-Karp Algorithm, String Matchingwith finite automata, The Knuth-Morris Pratt algorithm. NP-Complete Problem: Polynomia 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", 3rdEd., PHI.
2	E. Horowitz, S. Sahni, and S. Rajsekaran, "Fundamentals of Computer Algorithms,"2nd Ed., Universities Press.
3	P. H. Dave, H. B. Dave, "Design and Analysis of Algorithms", 2nd Ed.,Pearson Education.
Reference Books	
1	Design and Analysis of Algorithms, S. Sridhar, Oxford Univ. Press.
2	Design and Analysis of algorithms, Aho, Ullman and Hopcroft, Pearson Education,2008.
3	Foundations of Algorithms, R. Neapolitan and K. Naimipour, 4th edition, Jonesand Bartlett Student edition.

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

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

Course Objectives: The objective of this course is to:

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

Prerequisite: Basic Mathematics, Differential Calculus

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

CO1: Understand the key concepts and structure of optimization algorithms.

CO2: Interpret the various mathematical programming methods for optimization.

CO3: Identify the appropriate optimization technique and their mathematical formulationsreal-world problems.

CO4: Summarize basic steps in decision analysis and decision-making environments.

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

CONTENTS

UNIT-I	10 Hours
Introduction to optimization: Engineering application of Optimization, Formulation o design problems as mathematical programming problems. General Structure of OptimizationAlgorithms, Constraints, The Feasible Region.	
UNIT-II	**10 Hours**
Branches of Mathematical Programming: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming, Semi Definite Programming.	
UNIT-III	**12 Hours**
Optimization Algorithms: Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc. Real life Problems and their mathematical formulation as standardprogramming problems. Recent trends: Applications of ant colony optimization, geneticsand linear and quadratic programming in real world applications.	
UNIT-IV	**10 Hours**
Decision Making: Basic Steps in Decision Analysis, Decision-Making Environment Decision Making Under Uncertainty, Decision Making Under Risk, Utility Theory, DecisionTree, Group Decision Making: GDM Methods, Content-Oriented Methods, Multicriteri Decision Making.	

Text Books

1	Rao, S. S., "Engineering optimization: theory and practice", John Wiley & Sons, 4th Edition, 2009/Latest Edition.
2	Edwin K., P. Chong & Stanislawh. Zak., "An Introduction to Optimization", Wiley-Inter science, 2nd Edition, 2001/Latest Edition.
3	Andreas Antoniou, Wu- Sheng Lu, "Practical Optimization Algorithms and Engineering Applications", Springer, 2007/Latest Edition.
4	Ishizaka, Alessio, and Philippe Nemery, "Multi-criteria decision analysis: methods andsoftware", John Wiley & Sons, 2013/Latest Edition.

Reference Books

1	Dimitris Bertsimas, Robert Weismantel, "Optimization over integers Dynamic Ideas",2005/Latest Edition.
2	H. Paul Williams, "Logic and Integer Programming", Springer, 2009/Latest Edition.
3	Xu, Zeshui. "Uncertain multi-attribute decision making: Methods and applications", Springer, 2015/Latest Edition.
4	Tzeng, Gwo-Hshiung, and Jih-Jeng Huang. "Multi Attribute Decision Making: Methods and Applications", USA, CRC Press. 2016/Latest Edition.

NANO STRUCTURES AND MATERIALS IN ENGINEERING	
Course Code: BAS-202 Contact Hours: L-3 T-1 P-0 Course Category: OEC	Credits: 4 Semester: 4

Introduction:
The last two decades have seen a tremendous amount of research on nanomaterials. What is Nanotechnology? The art of manipulating the materials at nanoscale and tailoring their properties for a wider scope of applications is nothing but Nanotechnology. The renowned physicist and Nobel prize winner, Richard Feynman once said that *"there is plenty of room at the bottom"* during a conference of the American Physical Society. His comments were truly remarkable and fit well in the context of nanotechnology. A substantial number of new nano materials such as nanowires, quantum dots, polymers and fibers etc are making their way onto the market and are entering in all shapes and forms in everyday life. Not a single day passes without a press reporting on progress in this area. The course is aimed to make students familiarwith this area and learn some basics of the Nanotechnology.

Course Objectives:
- To develop an understanding of the fundamentals of Nanotechnology and variousproperties at nanoscale.
- To impart basic knowledge on various synthesis and fabrication techniques involved inNanotechnology.
- To give a general introduction to different classes of nanomaterials and their potentialapplications.
- To make the learner familiarize with various characterization techniques of nanomaterials.

Prerequisites: Basic understanding of Applied Physics Course.

Course Outcomes: Upon completion of this course, the students should be able to:
CO1: Understand basics of Nanotechnology and various size dependent phenomena's at nanoscale.
CO2: Learn various synthesis and fabrication techniques of nanomaterials.
CO3: Enhance knowledge of nanomaterials and their potential applications.
CO4: Familiarize with various characterization techniques and their use in study of variousproperties nanomaterials.

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

CONTENTS

UNIT-I	10 Hours
BASICS AND SCALE OF NANOTECHNOLOGY Introduction to nanoscale, Scientific revolution-nanotechnology, Classification of nanostructures zero, one, two and three dimensional nanostructures (Quantum wire, Quantum well, Quantum dot) Size Dependency in Nanostructures-quantum size effects in nanostructures, Surface to volumeratio, Fraction of surface atoms, Surface energy and surface stress, surface defects, Properties a nanoscale (optical, mechanical, electronic and magnetic).	
UNIT-II	**11 Hours**
NANOSCALE FABRICATION TECHNIQUES Top down and Bottom Up approaches, **Physical Methods:** Ball Milling, Thermal Evaporation, DC/RF Magnetron Sputtering,Molecular Beam Epitaxy (MBE). **Chemical Methods:** Chemical Reduction, Solgel Method and Sono chemical Routes, ChemicalVapor Deposition (CVD). **Nanofabrication:** Photolithography and its limitation-Electron-beam lithography (EBL) Nanoimprint, Soft lithography patterning.	
UNIT-III	**10 Hours**
NANOMATERIALS AND APPLICATIONS Carbon based nano materials (CNTs, graphene), Metal based nano materials (nanogold, nanosilve and metal oxides) Nanocomposites, Potential uses of nanomaterials in electronics, robotics computers, sensors, sports equipment, mobile electronic devices, vehicles and transportation – Medical applications of nanomaterials, Nanotoxicology challenges.	
UNIT-IV	**11 Hours**
CHARACTERIZATION OF NANOSTRUCTURES **Structural Analysis:** X-ray diffraction, SEM, FESEM, TEM, HRTEM, AFM, STM, Surfac enhanced Raman spectroscopy (SERS), X-ray Photoelectron Spectroscopy (XPS), Auger electronspectroscopy (AES), Rutherford backscattering spectroscopy (RBS). **Optical Characterizations:** UV-Vis, FTIR-Principals, Instrumentations and applications.	

Text Books

1	Pradeep T., "*A Textbook of Nanoscience and Nanotechnology*", 1st Edition, Tata McGrawHill Education Pvt. Ltd., 2012.
2	Hari Singh Nalwa, "*Nanostructured Materials and Nanotechnology*", 1st Edition, Academic Press, 2002.

Reference Books

1	Nabok A., "*Organic and Inorganic Nanostructures*", Artech House, 2005.
2	Dupas C., Houdy P., Lahmani M.*, "Nanoscience: Nanotechnologies and Nanophysics*",Springer-Verlag Berlin Heidelberg, 2007.
3	Masaru Kuno, Introductory Nanoscience: Physical and Chemical Concepts, CRC PressBook, 1st Edition Publisher: Garland Science; 2011.

OPTICAL ENGINEERING	
Course Code: BAS-204 Contact Hours: L-2 T-1 P-2 Course Category: OEC	Credits: 4 Semester: 4

Introduction: Optics is used in almost wide field of sciences. The lens and mirror are taught atprimary school level these days. Even basics like interference and diffraction have trickled down to school level though secondary classes. However the optics has advanced much beyondthese. The picture of a mobile camera is competing with many of the popular DLSR. Optics and advanced leaps and bounds. This subject is a glimpse to these advances.

Course Objectives: The aim of this course is make a student well advanced optics and that toofrom an engineer perspective.

Pre-requisite: Applied Physics-1 and Applied Physics -2.

Course Outcomes: Having successfully completed this course, the student will be able to
CO1: Comprehend how the modern optical instruments work.
CO2: Appreciate the importance of spectroscopy in the industry and medicine.

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

CONTENTS

UNIT-I	7 Hours
Frequency response of a diffraction-limited system under coherent and incoherent illumination OTF-effects of aberration and apodization. Techniques for measurement of OTF,comparison o coherent and incoherent imaging Diffraction by circular aperture, Gaussian beams. Image evaluation: Geometric OTF, its computation and measurement, Strehl ratio, spodiagram; definition of merit function Parabolic and Fresnel lens, Cooks Triplet and its derivatives; Double Gauss lens, Introductionto zoom lenses and aspherics.	
UNIT-II	**7 Hours**
Optical Components: Mirrors, prisms, gratings and filters; Sources, detectors and theircharacteristics. **Optical Instruments**: Infrared instrumentation, imaging, near-field imaging techniques Satellite cameras, Laser Doppler velocimetry Bio-medical applications of lasers, Laser tweezersand applications, Shack Hartmann Sensor and Moire, and Talbot interferometry fo measurement of optical performance parameters of the optical elements. **Eye and vision**: Visual system, sensitivity, acuity; Radiometry and Photometry: Radiometric quantities and their measurements, Photometric quantities, Radiation from a surface; Brightnessand luminous intensity distribution Optical detectors; Detector characteristics, Noiseconsiderations, single & multi-element detectors, CCDs.	
UNIT-III	**7 Hours**
Holography: Basics of holography, in-line and off-axis holography; transmission and reflectionholograms, Amplitude and phase holograms, Recording materials. Thick and thin holograms. **Lasers**: fiber lasers, gas lasers, Pulsed lasers: ns, ps, and fs lasers, excimer-, dye-, X-ray andfree-electron lasers; Semiconductor lasers: DH, QW, QCL, VCSEL, DFB and DBR lasers.	
UNIT IV	**7 Hours**
Spectroscopy: Laser spectroscopy, Spectroscopic instrumentation, Fourier transformspectroscopy; **Microscopy:** phase contrast microscopy and other simple applications; Confocal Microscope.**Other Miscellaneous Topics**: Adaptive optics; Wavefront sensing and correction, reconstruction.	

Text Books	
1	J. W. Goodman, Introduction to Fourier Optics, 2nd Edition, Mc Graw Hill, 1996.
2	P. Hariharan, Optical Holography Principles, techniques and applications, 2ndEdition,Cambridge University Press, 1996.
3	D. Malacara, Optical Shop Testing, 3rdEdition, Wiley,2007
4	E. Hecht, Optics, 4thEdition, Pierson, 2002.
Reference Books	
1.	A. K. Ghatak, Optics, 5th Edition, Mc Graw Hill, 2014.
2	B. K. Johnson, Optics and Optical instruments, Dover Publications, 1967.
3	F. A. Jenkins and H. E. White, Fundamentals of Optics, 4th Edition, McGraw Hill, 2001.
4	B. K. Johnson, Optics and Optical instruments, Dovers Publications Inc., 1960.

PRACTICAL CONTENT

Introduction: Optical Engineering Lab acquaints the students is a synchronization of theorywith experiments.

Course Objectives:
The aim of this course is to make the students learn Coherent and Incoherent imaging,Optical Transfer function and spectroscopy.

Pre-requisites: Applied Physics-1 and Applied Physics -2.

Course Outcomes: Having successfully completed this course, the student will be able to
CO1: Learn to work on a variety of instruments to be used later on.
CO2: Young graduates gains knowledge of interdisciplinary branches of the industry.

Pedagogy: Hands on experience on laboratory equipment's and software with self-explanatory lab manuals.

List of Experiments (Minimum Eight experiments to be performed)

1. Determination of point spread function of an optical system.
2. Determination of noise of a CCD camera.
3. Determination of spatial aberrations of an optical system.
4. Measurement of diffraction of a single slit and plotting of its intensity profile.
5. Measurement of diffraction of a circular aperture and plotting of its two dimensionalintensityprofile.
6. Experimental generation of a Gaussian beam.
7. Calculation of wave-front aberrations using Shack-Hartmann wavefront sensor.
8. Determination and comparison of field of view of different cameras.
9. Determination of intensity and wavelength using a CCD camera.
10. Determination of transmission and reflection spectrum of various filters.
11. Determination of radiation spectrum of various light sources.
12. Determination of numerical aperture of a microscope.
    Study the various characteristics of a compound confocal phase contrast microscope

OPTIMIZATION TECHNIQUES	
Course Code: BAS-206 Contact Hours: L-3 T-1 P-0 Course Category: OEC	Credits: 4 Semester: 4

Introduction: Having a sound foundation of applied Mathematics; students are well equippedto apply them in various fields including Optimization Techniques which provides a logical andsystematic approach for decision making.

Course Objective:

- To formulate mathematical models and to understand solution methods for real life optimaldecision problems.
- To emphasize the basic study of linear programming problem, Integer programming problem, Transportation problem, Two person zero sum games with economic applicationsand project management techniques using PERT and CPM.

Prerequisite: A basic course in calculus and matrices.

Course Outcomes: Upon Completion of this course, the students would be able to:

CO1: Have a strong foundation of formulating and solving linear programming problems.

CO2: Formulate and find optimal solution(s) of transportation and assignment problems

CO3: Analyze Project Management problems and their solutions using PERT and CPM

CO4: Solve two person zero-sum games

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

CONTENTS

UNIT I	12 Hours
Linear spaces, Subspaces, Basis and dimension, Formulation of linear programming (LP), convexset, Graphica method, LP in standard form, Solution of LP by simplex method, Big –M MethodTwo Phase Method, Exceptiona cases in LP.	
UNIT-II	**10 Hours**
Revised Simplex Method, Karmarkar's Interior Point Algorithm, Sensitivity analysis, Dualitytheory, Dual simplex method, Integer Programming: Branch and bound technique.	
UNIT-III	**10 Hours**
Transportation and Assignment Problem : Initial basic feasible solutions of balanced and unbalance transportation/assignment problems and their optimal solutions, Transhipmen Travelling Salesman Problem	
UNIT-IV	**10 Hours**
Project Management: Construction of networks, Network computations, Floats (free floats andtotal floats), Critical path method (CPM), Crashing. Game Theory: Two person zero-sum game, Game with mixed strategies, Graphical methodand solution by linear programming.	

Text Books	
1	Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra,1st Edition, Affiliated East West Press 1976.
2	Kambo N. S., Mathematical Programming Techniques, East-West Press Pvt. Ltd., 2008.
3	Chandra S., Jayadeva, Aparna Mehra, Numerical Optimization with Applications, NarosaPublishing House, 2009.
Reference Books	
1	Gilbert Strang, Linear Algebra and its Applications, 4th Edition, Cenage Learning, 2010.
2	Taha H.A., Operations Research-An Introduction, PHI, 2007.
3	Pant J. C., Introduction to optimization: Operations Research, Jain Brothers 2004.
4	Bazaarra Mokhtar S., Jarvis John J. and ShiraliHanif D., Linear Programming andNetwork flows, John Wiley and Sons, 1990.
5	Ravindran, A., Phillips, D.T. and Solberg, J.J., "Operations Research: Principles andPractice", John Wiley and Sons, NY, 2nd Edition, 1987.

OPERATIONS MANAGEMENT	
Course Code: BMA-211 Contact Hours: L-3 T-1 P-0 Course Category: OEC	Credits: 4 Semester: 4

Introduction: This course provides a general introduction to operations management. Operations management is the design and control of business processes, that is, the recurring activities of a firm. Along with finance and marketing, operations is one of the three primary functions of a firm. At the risk of being simplistic, one may say that marketing generates the demand, finance provides the capital, and operations produces the product or delivers the service. More generally, operations spans the entire organization: COOs are in charge of R&D, design/engineering, production operations, marketing, sales, support and service.

Course Objectives: This course considers the operations from a managerial perspective .

- To explain the performance measures of operations viz. productivity, quality andeffectiveness.
- Deliver important concepts such as location decision, facility layout, forecasting,production scheduling, inventory management, replacement analysis are discussed.
- Provide a fair understanding of the role of a Production / Operations Manager in businessprocesses.
- The students are to be provided hands on practical exposure on topics covered in thecourse.

Pre-Requisites: NIL

Course Outcomes: Having successfully completed this course, the student will be able to - **CO1:** Understand Productivity, efficiency and effectiveness, principles of management and organization structure;
CO2: Understand business environment and importance of production function;
CO3: Techniques to enhance value addition by method study;
CO4: Be able to plan and control production;
CO5: Manage inventory and be able to take replacement decisions;
CO6: The practical sessions will improve visualization of the concepts taught in theory.

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

CONTENTS

UNIT I	11 Hours
Introduction –Introduction to productivity, Multi Factor productivity, Principles omanagement, Organization structure. **Capacity Planning, Plant Location and Plant Layout** – Introduction, need for selecting asuitable location, Location Factors, Quantitative Method, Principles of Plant layout, Type of Layout – Product, Process, Fixes Position, Cellular Layout.	
UNIT II	**11 Hours**
Demand Forecasting-Need for demand forecasting, Techniques of forecasting, Time series analysis, Least Square Method, Moving Average, Exponential Method and Qualitative Techniques. Method Study- Introduction, Objectives Steps, Micromotion Study, Cycle graph and chronocycle graph, Therbligs and SIMO charts. Work Study – Objectives, Different Techniques, Standard Time, Allowances, Time studyNumerical, Performance Rating, Work sampling. Process and Product Life Cycle, Material Requirement Planning – Introduction, MRP objectives, Functions served by MRPProduction Planning and Control, Supply chain and Logistics Management, Production Scheduling.	
UNIT III	**10 Hours**
Inventory Management - Introduction, Reasons for Holding Inventories, Relevant Costs o Inventories, EOQ models, Quantity Discount Models, Safety Stock, Inventory control systemSelective Control of Inventory ABC analysis, VED analysis. Production Cost Concepts – Introduction, Cost of Production, Classification and analysis of Cost, break even analysis, Make and Buy.	
UNIT IV	**10 Hours**
Industrial Maintenance – Concepts of Maintenance, Organisation for Maintenance department, Types o Maintenance-Preventive, Breakdown and Corrective Maintenance Failure Analysis, Maintenance Performance Replacement policies of machines.	

Text Books	
1.	Martinich, J.S., Production and Operations Management: An Applied ModernApproach", John Wiley and Sons, New Delhi, 2008.
2.	Richard B. Chase, Nicholas J.A., Jacobs, F.R., "Production and Operation Management", Tata McGraw Hill, New Delhi, 1998.
3.	Ravi Shankar, "Industrial Engineering and Management", Galgotia Publications.
Reference Books	
1.	Paneerselvam, R., "Production and Operations Management", Prentice Hall India,2012.
2	Khanna, O.P., "Industrial Engineering and Management", Dhanpat Rai & Sons, 1985.

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

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

Course Objective:

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

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

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

CO1: Analyse the information content of a random variable from its probability distribution
CO2: Understand and relate the joint, conditional, and marginal entropies of variables interms of their coupled probabilities
CO3: Understand channel capacities and properties using Shannon's Theorems
CO4: Evaluate efficient codes for data on imperfect communication channels

Pedagogy: Classroom teaching is supported by hand-outs, PowerPoint slides, assignments andnotes.

CONTENTS

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

Text Books

1	R Bose, "Information Theory, Coding and Cryptography," McGraw hill Education, 3rdEdition, 2016.
2	Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols andStandards," Pearson Education Asia, 4th Edition, 2009.
3	K. Sayood, "Introduction to Data Compression," Elsevier, 5th Edition, 2017.

Reference Books

1	S Gravano, "Introduction to Error Control Codes," Oxford University Press, 2007.
2	Amitabha Bhattacharya, "Digital Communication," Tata McGraw Hill,1st Edition, 2017.
3	Cover and Thomas, "Elements of Information Theory," Wiley Series in Telecommunication and Signal Processing, 2nd Edition, 2006.

DISASTER MANAGEMENT	
Course Code: HMC-202 Contact Hours: L-1 T-0 P-2 Course Category: HMC	Credits: 2 Semester: 4

Introduction - Natural and technological hazards affect the everyday life as well as long- termdevelopment plans. For many decades the prevailing approach in dealing with disasters was focus on response and recovery, however lately pre-disaster actions to minimize the disaster risks are getting importance. The course introduces Disaster Management, focusing on naturaldisasters.

Course Objective:

- To increase the knowledge and understanding of the disaster phenomenon, its differentcontextual aspects, impacts and public health consequences
- To ensure knowledge, skills and abilities to analyse potential effects of disasters and thestrategies and methods for disaster reduction

Pre-requisite: None

Course Outcomes

CO1: Capacity to integrate knowledge and to analyse, evaluate and manage the different publichealth aspects of disaster events at a local and global levels

CO2: Capacity to describe, analyse and evaluate the environmental, social, cultural, economic, legal and organisational aspects, minimise risk, prepared community and develop capacities to mitigate disasters.

CO3: Capacity to work at the time of need, support community. To understand theoretically and practically different step of disaster management and relate their interconnections, with psychosocial, livelihood, logistics and Public Health aspects of the disasters

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

CONTENTS

UNIT-I	4 Hours
Concepts and definitions of disaster - hazard, vulnerability, resilience, risks, rehabilitation reconstruction, search and rescue before, during and after disasters. Disaster Profile of India – Mega Disasters of India and Lessons Learnt.	
UNIT-II	10 Hours
Categories of disasters -Natural disasters – earthquake, cyclone, landslide, flood, tsunami, he waves, cold waves, avalanches, Man-made disasters – fire, urban fire, forest fire, Chemica biological, radiological and nuclear disasters, armed conflict and civil strife**,** oil and Gasleakag Transport disasters Factors affecting Vulnerabilities, impact of Development projects such a dams, high rise constructions etc.	
UNIT-III	6 Hours
Geo-informatics in Disaster Management (RS, GIS, GPS and RS), Disaster CommunicationSystem (Early Warning and Its Dissemination), Use of ICT, mobile technology, alarms etc, Application of Drone.	
UNIT IV	8 Hours
Disaster Management Act 2005, Disaster Management National Policy, Disaster Managementcycle, Role of Government (local, state and national), Non-Government, Inter-Governmental and UNAgencies.	
Practical Component	
Demonstration of Cardiopulmonary Resuscitation (CPR) Demonstration of Search and RescueOperations, Earthquake Evacuation Drill Demonstration of Fire Drill	
Text Books	
1	Alexander David, Introduction in Confronting Catastrophe, Oxford University Press, 2000.
2	Kapur, Anu& others, Disasters in India Studies of grim reality, Rawat Publishers, Jaipur,2005.
3	MuktaGirdhar, Natural Disasters, Amy publication, Dariyaganj, New Delhi, 2019.
Reference Books	
1	Andharia J. Vulnerability in Disaster Discourse, JTCDM, Tata Institute of Social SciencesWorking Paper No. 8, 2008.
2	Govt. of India: Disaster Management Act 2005, Government of India, New Delhi.

Machine Learning	
Course Code: BAI-301 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 5

Introduction:
This course provides a concise introduction to the fundamental concepts in machine learning and popular machine learning algorithms. This course will cover the standard and most popular supervised learning algorithms along with the basic clustering algorithms. The course will be accompanied by hands-on problem solving with programming sessions.

Course Objective:

- To understand the problems and difficulties in machine learning.
- To study the strengths and weaknesses of machine learning techniques.
- To gain insights of the supervised and unsupervised learning.
- To apply machine learning approaches for solving real world problems.

Prerequisites: Calculus, Linear algebra, Probability and statistical concepts, Coding and comfort with data manipulation.

Course Outcomes: Upon successful completion of the course, students will be able to: **CO1:** Interpret the underlying problems and difficulties that machine learning faces, such asdata, model selection, complexity of the model, etc.
CO2: Discuss the strengths and weaknesses of many popular machine learning approaches.
CO3: Analyse the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and unsupervised learning.
CO4: Design and implement various machine learning algorithms in a range of real-world 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 beadopted.

CONTENTS

UNIT I	10 hours
Introduction: Goals and applications of machine learning, Types of Machine Learning:Supervised Learning, Unsupervised Learning, Machine Learning Cycle: Train-Test Split, Validation Data, K- Fold Cross Validation, Evaluation Metrics. Data Exploration and Pre- processing: Data Objects and Attributes; Statistical Measures, Visualization, Data Cleaning and Integration. Feature Extraction andReduction.	
UNIT II	**10 hours**
Supervised Learning Regression: Least Mean Square Regression; Ridge Regression and LASSO regression; Logistic Regression, Support Vector Machines, Kernels for learning non-linear functions, K-nearest-neighbor, Bayesian and Naïve Bayes Classifier, Decision Tree Learning.	
UNIT III	**10 hours**
Unsupervised Learning Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering, k-means partitional clustering, Hierarchical, and Density-based Clustering, Expectation maximization (EM) for soft clustering. Dimensionality Reduction: Linear Discriminant Analysis; Principal Component Analysis;	
UNIT IV	**10 hours**
Advanced Topics Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing, Ensemble Learning: Bagging, boosting, and stacking, Random Forests, Ensemble Classification including Adaboost, Active learning with ensembles.	
Text Books	
1	Han, J., Pei, J. and Tong, H., 2022. Data mining: concepts and techniques. Morgankaufmann
2	Daumé, H. III, "A Course in Machine Learning", 2015 (freely available online).
3	Mitchell, T. "Machine Learning", 1997 (freely available online)
Reference Books	
1	Shai Shalev-Shwartz and Shai Ben-David. "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014
2	Marsland, S., 2011. Machine learning: an algorithmic perspective. Chapman and Hall/CRC.

Cyber Security	
Course Code: BAI-303 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 5

Introduction:
Cyber security refers to the body of technologies, processes, and practices designed for computers, servers, mobile devices, electronic systems, networks, and data from malicious attacks. The importance of Cyber Security increases as the government, military, corporate, financial, and medical organizations deal with an enormous amount of data on computers and other devices.

Course Objective:

- To understand various threats, vulnerabilities and attacks and the motivation behind them.
- To gain insights of various security issues in cyber security.
- To study cryptographic concepts and their applications in network security.
- To explore various types of security standards compliances.

Pre-requisite: Computer Networks

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Analyze various cyber security threats and cyber-attacks in cyber space **CO2:** Explain the concept of Cybercrime and security issues in various services anddevices.
CO3: Describe the concept of how to ensure security of devices, and understand theory of fundamental cryptography and its application in network security.
CO4: List various defenses and security countermeasures in cyber security.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects or 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/ programmingassignments based on topics studied in previous lectures. Course will have a blend of theory andpractice for the benefit of students. Use of ICT, web based sources as well as blackboard teaching will be adopted.

CONTENTS

UNIT I	10 hours
Introduction: Cyber Security Concepts, Security Goals, Security Services and Mechanism, Vulnerabilities, Sources of Security Threats, Target assets, Vulnerabilities, Insider threats, Intruders and Hackers, Network threats: Active/Passive, Malicious Software, Virus, Trojan, Worms, Spywares, Rootkit, Ransomware, Adware, Backdoor, Bots, Social Engineering, Phishing, Key logging, Mail Bombs, Pornography, Intellectual Property Theft, Session Hijacking, ARP Spoofing, DoS, DDoS, Advanced Persistent Threat, Mobile Codes: Anonymity Networks, Proxy Servers, Surface, Deep and Dark Web.	
UNIT II	**10 hours**
Cyber Crime: Types of Cybercrime, Cyber attack methodology, Credit card fraud, Software Piracy and legal issues, Security issues in M-commerce e.g. mobile wallet, mobile payment m- banking, Identity Theft, Password Cracking, Spamming, Security and Privacy Issues in Social Networking Websites, Security issues in Cloud based Services, Security issues in Smart Phones, digital tablets andsmart Devices, Cyber Warfare, Cyber Terrorism and Hacktivism.	
UNIT III	**10 hours**
Device Security: Securing PC, Securing Smart Phone, Securing Laptops/Tabs, Securing Pen drives, Wi-Fi security, Browser security, Cloud Security, OS Security, Data Security, Database Security; **Cryptography:** basics, Symmetric vs asymmetric Cryptography, Key management, Message Authentication Code, Message Digest, Properties of message authentication code, Hash Function, Properties of Hash Function, Secured Hash Algorithm, Digital Signatures, Application of cryptography in network security: SSL/TLS, IPSec, SSH, Email Security, S/MIME, PGP.	
UNIT IV	**10 hours**
Defences, Security Countermeasures: Access Control, Secure Design Principles, Defense Models: The Lollipop Model, The Onion Model, Firewalls, IDS, IPS, Honey Pots, VPN, Network Admission Control (NAC), Trusted Computing and multilevel security, Physical and infrastructure security, Electronic Voting, Human factors : Security awareness, training, Emailand Internet use policies, Risk Management, Information Security Standards, Copyright, Software Licences, IPR, ISO/IEC 2700, HIPAA, COBIT, NIST, Indian IT ACT and Standards.	
Text Books	
1	W. Stallings and L. Brown, "Computer Security: Principles and Practice", 4th Edition, Pearson, Education, 2018
2	W. Stallings, "Network security essentials: Applications and Standards", 6th Edition,Pearson Education, 2018.
3	M. Ousley, "Information Security: The Complete Reference", 2nd Edition, McGraw Hill Education, 2013.
Reference Books	
1	M. Bishop, "Computer Security: Art and Science", 2nd Edition, Addison Wesley Professional, 2018.
2	W. Stallings, "Cryptography and Network security: Principles and Practice", 7th Edition, Pearson Education, 2017.

Deep Learning – I	
Course Code: BAI 305 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 5

Introduction: Deep Learning is an important branch of machine learning which uses neural network-based models for solving problems. Therefore, it is important to understand the fundamental concepts of deep learning and develop the ability to apply these concepts in solving problems in the domains of computer vision and natural language processing.

Course Objectives:

- To learn basic computational units inspired from biological systems (brain).
- To study various algorithms in deep learning for various domains.
- To understand fundamental machine learning concepts w.r.t. neural networks.
- To apply deep learning models to solve sequence and vision problems.

Pre-requisites: Machine Learning.

Course Outcomes: Upon successful completion of the course, students will be able to: **CO1:** Interpret the basic computational units inspired from biological systems (brain). **CO2:** Identify the deep learning algorithms which are more appropriate for various typesof learning tasks in various domains.
CO3: Define the fundamental machine learning concepts w.r.t. neural networks. **CO4:** Apply basic deep learning models to solve sequence-based problems and visionproblems.

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

CONTENTS

UNIT I	10 hours
Basic Computational Unit: Biological Neuron, Idea of computational units, McCulloch–Pitts unitand Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.	
UNIT II	**10 hours**
Foundations of Deep Learning: Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Gradient Descent, Back Propagation Learning, Architectural Design Issues. Learning Curves. Overfitting vs Under fitting, Regularization: L1, L2, Dropout, Data Augmentation.	
UNIT III	**10 hours**
Deep Neural Network: Deep Learning, Deep Neural Networks: Difficulty of training deep neural networks, Activation Function, Hyper parameters vs Parameters, Greedy layer wise training, Recurrent Neural Networks: Backpropagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs, Applications in Natural Language Processing.	
UNIT IV	**10 hours**
Applications: Convolutional Neural Networks. Filters, Pooling. Image Classification. Well known case studies: LeNet, AlexNet, VGG-16, ResNet, InceptionNet. Transfer Learning. Weight Initialization, Batch Normalization, Regularization. Applications in Vision, Speech, andAudio-Video.	
Text Books	
1	Richard O. Duda," Pattern classification, Wiley, 2022
2	Adam Gibson and Josh Patterson, "Deep Learning: A Practical approach", 2017
3	Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.
Reference Books	
1	Charu C. Aggarwal, "Neural Networks and Deep Learning", 2018
2	Duda, R.O. and Hart, P.E., Pattern classification. John Wiley & Sons, 2006

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:

- To introduce concepts in Automata theory and theory of computation
- To introduce different formal language classes and their relationships
- To introduce grammars and recognizers for different formal languages.

Pre-requisites: Basic concepts of mathematics.

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

CO1: To Understand properties of formal languages, automata, their equivalence, conversion techniques, concept of Context Free Grammars, and Pushdown Automata.

CO2: Understanding of the key results in algorithmic complexity, computability andSolvability of problems.

CO3: To Apply rigorously formal mathematical methods to prove propertiesof languages, grammars and automata.

CO4: Analyse 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. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT I	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
2	J. Ullman, J. Hopcroft "Introduction to Automata Theory, Languages and Computation", Pearson Education India; 3rd edition, 2008
Reference Books	
1	M. Sipser "Introduction to the Theory of Computation", Cengage; 3rd edition, 2014
2	C.K. Nagpal "Formal Languages and Automata Theory", Oxford University Press, 2015

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 actionsin 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 restof 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 would them as best professional which will create ethical vision and achieve harmony in life.

Pre-requisites: None

Course Outcomes: Upon successful completion of the course, students will be able to: **CO1:** Develop the capability of shaping themselves into outstanding personalities, througha value-based life.

CO2: Turn themselves into champions of their lives.

CO3: Take things positively, convert everything into happiness and contribute for thehappiness of others.

CO4: Become potential sources for contributing to the development of the society aroundthem and institutions / organizations they work in.

CO5: Shape themselves into valuable professionals, follow professional ethics and are ableto 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 willbe adopted.

CONTENTS

UNIT I	11 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	**10 hours**
Profession and Professionalism, Ethical Theories: Kohlberg's Theory, Gilligan's Theory, Feminist Consequentialism, Moral Dilemmas, Types of Enquiries, Uses of Ethical Theories, Engineering Profession, Engineering Professionals- Training, Skill Set, Life Skills, Engineering Ethics: Making Senses and Issues, Ethical Obligations of Engineers, Ethical Codes for Engineers.	
UNIT III	**11 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	**10 hours**
Ethics and Global Issues Ethics in Global Scenario, Multinational corporations, Environmentalethics, computer ethics, Business Ethics. Corporate Social responsibility, Weapons Development, Research Ethics.	

Text Books	
1	M. Govindarajan M., S. Natarajan, V.S. Kumar, "Engineering Ethics", Prentice Hall, 2004.
2	R. Subramaniam, "Professional Ethics", Oxford University Press, 2013.
3	R.R. Gaur, R. Sangal, G.P. Bagaria, "A Foundation Course in Human values and Professional Ethics", Excel Books Pvt. Ltd, 2009.
4	M. Martin, R. Schinzinger, "Ethics in engineering", McGraw-Hill, 1996.
5	A.N. Tripathi, "Human Values", 2 nd Edition, New Age International Publishers, 2004.
Reference Books	
1	B.P. Banerjee, "Foundation of Ethics and Management", Excel Books, 2005
2	Fleddermann, Charles D., "Engineering Ethics", Pearson Education, 2004.
3	Boatright, R. John, "Ethics and the Conduct of Business", Pearson Education, 2003.
4	S. Ranganathananda, "Universal Message of the Bhagwad Gits: An exposition of the Gitain the light of modern thought and modern needs," Vol. I-III, Advaita Ashrama Publication, 2000
5	Peter Singer, " Practical Ethics", Oxford University Press, 1993

Industrial Training/Internship	
Course Code: BAI-353 Contact Hours: - Course Category: DCC	Credits: 1 Semester: 5

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

Generic Elective Course	
Course Code: GEC-301 Contact Hours: Course Category: GEC	Credits: 2 Semester: 5

Introduction: A Generic Elective (GE) course is an inter-disciplinary course provided tothe students chosen generally from an unrelated discipline/subject and allowing thema chance at comprehensive education. Generic Electives (GE) are introduced as part of the CBCS. The students can choose their preference from a pool of papers from various disciplines/subjects. Elective courses do much more than filling in the gaps to fulfill thehigh 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 theymight not find in the classroom. The main purpose of the Elective course is to seek exposureto a new discipline/subject and to provide the students with an alternative option for desired fields.

Course objective:

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

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

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

CO1: Investigate future careers.

CO2: Allow diligent students to improve their knowledge and area of weakness.**CO3:** Help students build a strong resume that shows students willingness and curiosities to the officials and employers.

CO4: Electives take students into the real world that doesn't require academic papers or research. They not only learn to work independently, but they attain self- motivation, discipline, and confidence to achieve their goals.

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

Natural Language Processing	
Course Code: BAI- 302 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 6

Introduction: Natural language processing (NLP) refers to the branch of computer science and more specifically, the branch of artificial intelligence or AI—concerned with giving computers theability to understand text and spoken words in much the same way human being scan. NLP combines computational linguistics—rule-based modelling of human language with statistical, machine learning, and deep learning models. Together, these technologies enable computers to process human language in the form of text or voice data and to 'understand' its full meaning, complete with the speaker or writer's intent and sentiment.

Course Objectives:

- To learn the fundamentals of Natural language Processing and its algorithm.
- To understand machine translation and applications of NLP.
- Basic understanding of deep learning models for NLP.

Pre-requisite: Artificial Intelligence, Data structures and algorithms, programminglanguages

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Learn the fundamentals of Natural language Processing and its algorithm.
CO2: Understand machine translation and applications of NLP. **CO3:**
Provide basic understanding of deep learning models for NLP.**CO4:**
Apply the concept of NLP in the real domain.

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

CONTENTS

UNIT -I	10 Hours
Introduction to NLP: Characteristics of Natural Language, Language structure, Sentence Structure, Language analyzer, Lexicon, word formation, Morphology, syntax analysis (parsing), semantics, ambiguity, pragmatics and discourse.	
UNIT- II	**11 Hours**
NLP Algorithms: Understanding Corpus and data attributes, Corpus Formats CSV, JSON, XML, LibSVM, Operations on Text Corpus, Tokenisation, stop words, Term Frequency Inverse Document Frequency (TF-IDF), Text Analysis and word embedding using word2vec, doc2vec, GLoVe, Bag-of-words (BoW).	
UNIT-III	**11 Hours**
Machine Translation and Applications of NLP: Introduction to Machine Translation (MT), Approaches, Structure of Anusaraka: an Interlingua based MT system, Example/Analogy basedMT, Word/phrase based MT, Neural MT. Applications of NLP: Sentiment analysis, chatbots, conversational models (Question Answering system) for Digital Assistants	
UNIT- IV	**10 Hours**
Deep learning models for NLP: Neural Net based NLP models: Study of Convolutional Neural Network(CNN), Recurrent Neural Network(RNN), Long Short-Term Memory (LSTM) and Gated Recurrent Unit(GRU) using Natural Language Toolkit (NLTK)	

Text Books	
1	Daniel Jurafsky, James H. Martin,"Speech and Language Processing: An Introductionto Natural Language Processing", Computational Linguistics and Speech, Pearson Publication, 2014.
2	Thanaki, Jalaj, "Python natural language processing". Packet Publishing Ltd, 2017.
Reference Books	
1	Lawrence Rabiner And Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
2	Samuel Burns, "Natural Language Processing: A Quick Introduction to NLP with Python and NLTK" Independently Published, 2019
3	Bird, Steven, Ewan Klein, and Edward Loper. "Natural language processing with Python: analyzing text with the natural language toolkit." O'Reilly Media, Inc.", 2009.

Deep Learning - II	
Course Code: BAI- 304 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 6

Introduction: Deep Learning is the most popular branch of machine learning which uses neural network-based models for solving problems in a number of domains. Therefore, it is important that after understanding the fundamental concepts of deep learning in 'Deep Learning - I', more advanced concepts are taught so that students could apply them in problem solving to solve problems effectively.

Course Objectives:

- To learn advanced concepts in deep learning.
- To understand different methods of optimization in deep learning.
- To learn practical tips in training deep learning models.
- To know research methods in the field of deep learning.

Pre- requisites: Machine Learning.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Describe the advanced concepts in deep learning.
CO2: Explain different methods of optimization in deep learning.
CO3: Define practical tips in training deep learning models.
CO4: State research methods in the field of deep learning.

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

CONTENTS

UNIT -I	11 Hours
Advanced Concepts in Deep Learning: Review of Neural Networks, Regularization, BiasVariance, Batch Normalization, Weight Initialization Strategies, Learning vs Optimization,Early Stopping, Mini-Batch algorithm, Methods - Batch Gradient Descent (GD), GD with momentum.	
UNIT- II	**11 Hours**
Improved Optimization: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem inneural networks, Regularization methods (dropout, drop connect, batch normalization).	
UNIT-III	**10 Hours**
Deep Learning in Practice: Practical Tips for Training Deep Neural Networks, Performance Metrics, Baseline Methods, Data Requirements, Hyperparameter Tuning: Manual vs Automatic, Grid vs Random, Model based hyperparameter tuning.	
UNIT- IV	**10 Hours**
Research in Deep Learning: Autoencoders: Undercomplete vs Regularized. Representation Learning: Greedy Pretraining, Transfer Learning. Deep Generative Models: Generative Adversarial Networks (GANs). Explainability and Ethics.	
Text Books	
1	Ian Goodfellow, Yoshua Bengio and Aaron Courville,"Deep Learning" MIT Press,2016.
Reference Books	
1	Duda, R.O. and Hart, P.E., 2006. Pattern classification. John Wiley & Sons.

Digital Image Processing	
Course Code: BAI-306 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 6

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

Course Objective:

- To introduce the concepts of image processing and basic analytical methods to be used in image processing.
- To familiarize students with image enhancement and restoration techniques,
- To explain different image compression techniques.
- To introduce segmentation and morphological processing techniques.

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

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

CO1: Explain the fundamentals of digital image and its processing
CO2: Describe image enhancement techniques in spatial and frequency domain.
CO3: Define the mathematical modeling of image restoration and compression
CO4: Apply the concept of image segmentation, state object detection and recognition techniques.

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

CONTENTS

UNIT -I	**10 Hours**
Introduction and Digital Image Fundamentals: The origins of Digital Image Processing, Examples of Fields that Use Digital Image Processing, Fundamentals Steps in Image Processing,Elements of Digital Image Processing Systems, Image Sampling and Quantization, Some basic relationships like Neighbors, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations. Image Enhancement in the Spatial Domain: Some basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic and Logic operations, Basics of Spatial Filters, Smoothing and Sharpening Spatial Filters, Combining Spatial Enhancement Methods.	
UNIT- II	**11 Hours**
Filtering in the Frequency Domain: Introduction to Fourier Transform and the frequency Domain, Smoothing and Sharpening Frequency Domain Filters. Image Restoration: A model of The Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations.	
UNIT-III	**11 Hours**
Color Image Processing, Color fundamentals, Color Models, Pseudo color Image processing, Color Transforms, Smoothing and Sharpening, Color Segmentation Image Compression: fundamentals of compression, coding redundancy, Lossy and lossless compression, Spatial and temporal redundancy, Image compression models. Some basic compression methods. Image Segmentation: Detection of Discontinuities, Edge linking and boundary detection, Region Oriented Segmentation, Motion based segmentation.	
UNIT- IV	**10 Hours**
Representation and Description: Representation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description, Introduction to Morphology, Some basic Morphological Algorithms. Object Recognition: Patterns and Pattern Classes, Decision-Theoretic Methods, StructuralMethods.	

Text Books	
1	Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", 4th edition,Pearson, 2017.
2	A.K. Jain, "Fundamental of Digital Image Processing", 1st Edition, Pearson, 2015.
Reference Books	
1	B. Chanda and D. Dutta Majumder, "Digital Image Processing and Analysis," PHI, 2nd Edition, 2013.
2	Chris Solomon and Toby Breckon, "Fundamentals of Digital Image Processing: A Practical Approach with Examples in Matlab," Wiley Blackwell, 1st Edition, 2010.
3	Maria Petrou, and Costas Petrou, "Image Processing: The Fundamentals," Wiley Publications, 2nd Edition, 2010.

Cloud computing	
Course Code: BAI-308 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction: This course gives an insight into Cloud Computing and other related emerging Computing Technologies. It teaches various Cloud Computing Models and services and their current uses from industry perspective

Course Objective: To familiarize with the evolution, concept and deployment models of cloud computing, and to familiarize different services of cloud computing

Pre-requisite: Database systems.

Course Outcomes: Upon successful completion of the course, students will be able to: **CO1:** Learn the fundamentals of cloud computing, its evolution and deployment models. **CO2:** Demonstrate the use cases and applications of Cloud Computing
CO3: Describe the concept of Virtualization and its need in cloud computing.
CO4: Apply the Cloud Services in different aspects of a project

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

CONTENTS

UNIT -I	10 Hours
Introduction: Trends in Computing, Concept and Evolution of Cloud Computing Paradigm. Introduction to Cloud Computing, Benefits and challenges of cloud computing. Cloud Deployment Models: Public clouds, Private clouds, Community clouds, Hybrid clouds, Advantages of Cloud computing.	
UNIT- II	**11 Hours**
Cloud Architecture- Layers and Models Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, Service providers, challenges and risks in cloud adoption. Advantages of Cloud computing Case studies on cloud service providers – Amazon EC2, Google App Engine, Microsoft Azure	
UNIT-III	**11 Hours**
Virtualization: Virtualization Concept, Need of virtualization, Types of Virtualization. Storage virtualization, Compute/Processor virtualization, Network virtualization. Software Defined Networks, Network Function Virtualization.	
UNIT- IV	**10 Hours**
Best Practices and Similar Upcoming Technologies: Analysis of Case Studies when deciding to adopt cloud computing architecture, Cloud Security, Block chain, Containerization and Docker. Recent research in computing.	

Text Books	
1	Barrie Sosinky, "Cloud Computing". Wiley Publishing House, 2011.
2	Michael J. Kavis, "Architecting the Cloud: Design Decision for Cloud Computing". John Wiley & Sons, 2014.
3	Rajkumar Buyya &James Broberg ,"Cloud Computing: Principles and Paradigms (Wiley Series on Parallel and Distributed Computing)", Wiley-Blackwell, 2011.
Reference Books	
1	Anthony T.Velte, Toby J. Velte Robert Elsenpeter, "Cloud computing a practical approach", McGraw-Hill Osborne, 2009.
2	Thomas Erl, Ricardo Puttini, "Cloud Computing: Architecture", Prentice Hall, Pearson Publications, 2013. Concepts, Technology & Architecture", Prentice Hall, Pearson Publications, 2013.
4	G. Coulouris, J. Dollimore, T. and Kindberg, Distributed Systems: Concepts and Design Edition 5, Pearson Education , 2017

Blockchain Technologies	
Course Code: BAI-310 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction: Blockchain technology is a structure that stores transactional records, also knownas the block, of the public in several databases, known as the "chain," in a network connected through peer-to-peer nodes.

Course Objectives:

- To understand the history, types and applications of Blockchain.
- To acquire knowledge about cryptography and consensus algorithms.
- To deploy projects using blockchain technology.

Pre-requisite: Distributed systems.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Discuss the overview of Blockchain and its different categories.
CO2: Analyse the need of Blockchain in various domains.
CO3: Define cryptography and Consensus algorithms.
CO4: Design and build an Initial Coin Offerings (ICO) on Ethereum

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

CONTENTS

UNIT -I	10 Hours
Introduction to Blockchain: Distributed DBMS – Limitations of Distributed DBMS, Introductionto Block chain – History, Definition, Distributed Ledger, Blockchain Categories – Public, Private, Consortium, Blockchain Network and Nodes, Peer-to-Peer Network, Mining Mechanism, Generic elements of Blockchain, Features of Blockchain, and Types of Blockchain.	
UNIT- II	**11 Hours**
Blockchain Architecture: Operation of Bitcoin Blockchain, Blockchain Architecture – Block, Hash, Distributer P2P, Structure of Blockchain- Consensus mechanism: Proof of Work (PoW), Proof of Stake (PoS), Byzantine Fault Tolerance (BFT), Proof of Authority(PoA) and Proof of Elapsed Time (PoET)	
UNIT-III	**11 Hours**
Blockchains in Business and creating ICO: Public versus private and permissioned versus permission less blockchains- Privacy and anonymity in Ethereum- Why are privacy and anonymity important? - The Ethereum Enterprise Alliance- Blockchain-as-a-Service- Initial CoinOffering (ICO): Project setup for ICO implementation- Token contracts- Token sale contracts- Contract security and testing the code.	
UNIT- IV	**10 Hours**
Distributed Storage IPFS and Swarm: Ethereum Virtual Machine- Swarm and IPFS: Installing IPFS, hosting our frontend: Serving your frontend using IFPS, serving your frontend using Swarm, IPFS file uploader project: Project setup the web page	
Text Books	
1	Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization,and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018.
2	Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, "Blockchain By Example: A developer's guide to creating decentralized applications using Bitcoin, Ethereum, andHyperledger", Packt Publishing Limited, 2018.
Reference Books	
1	Andreas M. Antonopoulos , "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly Media Inc, 2015
2	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.

Quantum Computing	
Course Code: BAI-312 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

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

CO1: Describe the fundamentals of quantum mechanics in quantum computing.

CO2: Analyse the behaviour of basic quantum algorithms

CO3: Implement simple quantum algorithms and information channels in the quantumcircuit model

CO4: Describe the standard quantum algorithms in IBM Qiskit and state the benefits alongwith constraints of quantum computational models.

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 frompreviouslectures.
- 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.

CONTENTS

UNIT -I	**10 Hours**
Introduction to Quantum Computing, Postulates of Quantum Mechanics, Qubit-The smallest unit, Qubit- Bloch sphere representation, Multiple Qubit States and Quantum Gates, Quantum Gates, Quantum Circuits, No-Cloning Theorem and Quantum Teleportation, Bell's Inequality and it's Implications, Super Dense Coding.	
UNIT- II	**11 Hours**
Density Matrix, Bloch Sphere and Density Matrix, Measurement Postulates, Simple Algorithms, Deutsch Algorithm, Deutsch-Josza Algorithm, Bernstein-Vazirani Algorithm, Simon Problem, Grover's Search Algorithm, Shore's Factorization Algorithm	
UNIT-III	**11 Hours**
Quantum Fourier Transform, Period Finding and QFT, Implementing QFT, Implementing QFT-3 qubits, Shor's Factorization Algorithm, Shor's Factorization Algorithm- Implementation, Quantum Error Correction, Quantum Error Correction Three Qubit Code. Fault Tolerance	
UNIT- IV	**10 Hours**
Classical Information Theory, Shannon Entropy, Shannon's Noiseless Coding Theorem, Ven Neumann Entropy, EPR and Bell's Inequalities, Cryptography-RSA Algorithm, Quantum Cryptography, Experimental Aspects of Quantum Computing. Issues of Fidelity, Security and Scalability in Quantum Computing	

Text Books	
1	Vishal Sahni, "Quantum Computing ", McGrawHill, 2007
2	Eleanor Rieffel and Wolfgang," Quantum Computing: A Gentle Introduction", MITpress, 2011
3	Michael Nielsen and Isaac Chuang and, "Quantum Computation and Quantum Information", Cambridge University Press, 2013
References	
1	Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information", Cambridge University Press, 2002.
2	P. Kaye, R. Laflamme, and M. Mosca. *An Introduction to Quantum Computing*. Oxford University Press, 2007.
3	Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, WorldScientific, 2004

Compiler Design	
Course Code: BCS-306 Contact Hours: L-3 T-0 P-2 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:

- To introduce the concepts of language translation and compiler design.
- To impart the knowledge of practical skills necessary for constructing a compiler.

Pre-requisite: Basic Programming

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

CO1: Understand the concepts and different phases of compilation with compile time error handling.

CO2: Represent language tokens using regular expressions, context free grammar and finite automata and design lexical analyzer for a language.

CO3: Compare top down with bottom up parsers, and develop appropriate parser to produce parsetree representation of the input.

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.

CONTENTS

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	Aho A., M. S Lam, R. Sethi and D Ullman, "Compilers – Principles Techniques and Tools", Pearson Education India; 2nd edition (2013)
2	K. C. Louden, "Compiler Construction – Principles and Practice", Cengage Learning Indian Edition, 2006.
Reference Books	
1	A. I Hollub, Compiler Design in C, Pearson Education India; 1st edition (2015)
2	AW Appel, M Ginsburg, "Modern Compiler Implementation in C", Cambridge University Press, 2004.
3	K. Muneeswaran, "Compiler Design" ,Oxford University Press, Illustrated edition (2012)

Information Retrieval	
Course Code: BAI-314 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction: Information Retrieval aims to focus on various concepts of artificial intelligence for organizing & fetching data in Intelligent manner and fetching the information from the internet databases like search Engines in an intelligent and optimized manner. The Subject will introduce how to intelligently retrieve data from web sources so that the results of queries are exact and efficient.

Course Objective:

- To be familiar with different types of text, encoding and compressions.
- To be able to evaluate the search engines.
- To understand the text categorization, retrieving web information.

Pre-requisite: Knowledge of basic databases and algorithms

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Learn the concepts of text processing such as text-types and text encoding.
CO2: Analyse the performance of different search engines.
CO3: Discuss and relate the classification methods of the text and web information retrieval.
CO4: Describe and compare the various clustering models along with their real-world applications.

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

CONTENTS

UNIT -I	10 Hours
Introduction to Information Retrieval: The nature of unstructured and semi-structured text. Inverted index and Boolean queries. Text Indexing, Storage and Compression: Text encoding: tokenization, stemming, stop words, phrases, index optimization. Index compression: lexicon compression and postingslists compression. Gap encoding, gamma codes, Zipf's Law. Index construction. Postings size estimation, merge sort, dynamic indexing, positional indexes, n-gram indexes.	
UNIT- II	**11 Hours**
Retrieval Models: Boolean, vector space, TFIDF, Okapi, probabilistic, language modeling, latent semantic indexing. Vector space scoring. The cosine measure. Efficiency considerations. Document length normalization. Relevance feedback and query expansion. Rocchio.	
UNIT-III	**11 Hours**
Performance Evaluation: Evaluating search engines. User happiness, precision, recall, Fmeasure. Creating test collections: kappa measure, interjudge agreement. Text Clustering: Clustering versus classification. Partitioning methods. k-means clustering. Mixture of gaussians model. Hierarchical agglomerative clustering. Clustering terms using documents	
UNIT- IV	**10 Hours**
Text Categorization and Filtering: Introduction to text classification. Naive Bayes models. Spam filtering. Vector space classification using hyperplanes; centroids; k Nearest Neighbors. Support vector machine classifiers. Kernel functions. Boosting. Web Information Retrieval: Hypertext, web crawling, search engines, ranking, link analysis, PageRank.	
Text Books	
1	Ricardo Baeza-Yate, Berthier Ribeiro-Neto, "Modern Information Retrieval", Pearson Education, 2nd edition, 2010.
2	Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze,"Introduction to Information Retrieval", 2008
3	Christopher D. Manning and Prabhakar Raghavan, Introduction to Information Retrieval, Cambridge Press, 2008.
Reference Books	
1	Daniel Jurafsky and James H. Martin, "Speech and Language Processing", Pearson, 2nd edition, 2008.
2	David A. Grossman, Ophir Frieder, "Information Retrieval: Algorithms, and Heuristics", Springer, 2012
3	Charles T. Meadow, Bert R. Boyce, Donald H. Kraft, "Text Information Retrieval Systems", Emerald Group Publishing Limited; 3rd edition 2007

Recommender Systems	
Course Code: BAI-316 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction: In the current age of information overload, recommender systems offer personalizedaccess for users to efficiently search information and make choices online. This course introduces recommender systems' major concepts, methodologies, evaluation design, and user experiences. A variety of real-world applications are included, such as those deployed in e-commerce sites and social networks.

Course Objective:

- To understand the basic concepts such as user preference and prediction.
- To learn variety of typical recommendation approaches.
- To understand system evaluation design and metrics
- To get the knowledge of human roles in system implementation and user-centered evaluation.

Pre-requisite: Data structures and basic knowledge of programming languages like C, C++.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Describe basic concepts and framework of recommender systems.
CO2: Explain a variety of approaches for building recommender systems.
CO3: Define system evaluation methods from both algorithmic and users' perspectives
CO4: Discuss the applications of recommender systems and apply in various domains.

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

CONTENTS

UNIT -I	10 Hours
Introduction: Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system. Collaborative Filtering: User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems.	
UNIT- II	**11 Hours**
Content-based recommendation: High level architecture of content-based systems,Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms. Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders	
UNIT-III	**11 Hours**
Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design:Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies. Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centred metrics.	
UNIT- IV	**10 Hours**
Recommender Systems and communities: Communities, collaboration and recommender systems in personalized web search, Social tagging recommender systems, Trust and recommendations, Group recommender systems.	

Text Books	
1	Jannach D., Zanker M. and FelFering A.," Recommender Systems: An Introduction", Cambridge University Press, 2011
2	Ricci F., Rokach L., Shapira D., Kantor B.P., "Recommender Systems Handbook", Springer, 2011
3	Manouselis N., Drachsler H., Verbert K., Duval E., "Recommender Systems For Learning", Springer, 2013
Reference Books	
1	Michael D. Ekstrand, John T. Riedl, and Joseph A. Konstan, "Collaborative Filtering Recommender Systems", Now Publishers Inc, 2011.
2	Aggarwal, Charu C, "Recommender Systems: The Textbook", Springer 2016.

Semantic Web	
Course Code: BAI-318 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction: The Semantic Web is a vision about an extension of the existing World Wide Web, which provides software programs with machine-interpretable metadata of the published information and data. It aims to enrich the Web with a layer of machine-interpretable metadata so that computer programs can predictably derive new information.

Course Objective:

- To introduce the basic concept of web and its terminologies.
- Understanding RDF, RDFS, OWL, SPARQL.
- Familiar with current trends and applications of Semantic Web.

Pre-requisite: Computer Networks, basic programming knowledge.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Comprehend the basic concepts of the semantic web along with its technologies and development.
CO2: Explain the Semantic Web fundamental concepts, issues, architecture andtechnologies.
CO3: Describe the various technologies of Semantic Web focusing on RDF,Ontology andSparql.
CO4: State the latest trends and applications of Semantic Web in real-world applications.

Pedagogy:

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

CONTENTS

UNIT -I	**10 Hours**
Review of Internet and Web: History, Internet protocols and services, OSI Seven layer model, terms and terminologies, concepts like WWW, W3C, ISP, DNS, Search Engines etc. HTML and it'stags, various web development issues and technologies.Web 1.0 and Web 2.0	
UNIT- II	**11 Hours**
Semantic Web: Limitations of Web 2.0, Need of Web 3.0, Sir Tim Berners LEE vision and contributions, Semantic Web vision and roadmap, Semantic web fundamental concepts and issues,Semantic Web architecture layered cake and technologies, XML basics and metadata, Jorge Cardoso Survey, scientific American article 2001.	
UNIT-III	**11 Hours**
RDF, Ontology and SPARQL: Overview of various technologies of Semantic Web withfocus on pillar technologies. Semantic Web standards, RDF basics and examples, RDFS, Ontology and its issues, OWL, Ontology design and development, using Ontology editor Protégé, benefits and challenges of Ontologies, SPARQL and its concerns, Exporting SPARQL query using tools like Protégé, Twinkle etc	
UNIT- IV	**10 Hours**
Applications and upcoming trends: An overview of various Semantic Web Services and applications, Semantic Annotation, Information Extraction and Retrieval, Semantic Search, Semantic Agents and Search Engines, Semantic Social Networks, Web Intelligence, SWoT, Chatbots, Web Data Analytics.	

Text Books	
1	RajendraAkerkar, "Foundations of the Semantic Web:XML,RDF and Ontology" ,Oxford, 2009.
2	Karin Breitman and Marco, "Semantic Web: Concepts, Technologies and Applications", Springer. 2009,
3	Berners-LEE, Godel and Turing, "Thinking on the Web", Wiley, 2006.
Reference Books	
1	John Hebeler, Mathew Fisher and Ryan Blace, "Semantic Web Programming", Wiley,2011
2	Krotzsch and Rudolph, "Foundations of Semantic Web Technologies", SRC Press, 2009.
3	Grigoris Antoniou and Paul Groth, "A Semantic Web Primer", MIT Press, 2012.

Advanced Machine learning	
Course Code: BAI-320 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction: Machine learning (ML) is a branch of artificial intelligence (AI) that enables computers to "self-learn" from training data and improve over time, without being explicitly programmed. Machine learning algorithms are able to detect patterns in data and learn from them, in order to make their own predictions.

Course Objectives:

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

Pre-requisite: Knowledge of programming.

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

CO1: Describe and differentiate the various ML techniques with their real-worldapplications.

CO2: Discuss class imbalance problem and various ways to handle the problem.

CO3: Explain the concept of Neural Networks and the activation functions.

CO4: Design an end-to-end application in Python that uses these machine learningtechniques and evaluate the performance of the algorithms.

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

CONTENTS

UNIT -I	10 Hours
Visualization & Data Pre-processing: Feature Engineering- synthetic minority oversampling technique (SMOTE), Data objects and attribute types: nominal, binary, ordinal numeric, Feature Selection Techniques, Correlation Analysis, Principal component Analysis, data cleaning- handling missing values, noisy data.	
UNIT- II	**11 Hours**
Review of Supervised Machine learning: Support Vector Machine, kernel methods-Radial Basis Function (RBF), Spline, Polynomial kernel, Decision Tree, imbalance problem, improving performance using Ensemble learning- Bagging, Boosting, XGBoost, AdaBoost, Regularization(L1 & L2), Ridge, Lasso, ROC AUC, Handling class imbalance using data augmentation.	
UNIT-III	**11 Hours**
Review of Unsupervised machine learning: K-medoids cluster technique, Evaluation of unsupervised learning, elbow method, cluster tendency- Hopkins statistic, extrinsic and intrinsicmeasures- BCube precision and recall, Silhouette Coefficient, self-organizing maps	
UNIT- IV	**10 Hours**
Artificial Neural Networks: Gradient descent, stochastic gradient descent, backpropagation, Transfer learning: methods and applications, Active learning, reinforcement learning, semi- supervised learning, adversarial attacks on machine learning algorithms, Reusing machinelearning models. Case studies and applications: Recommender Systems, Banking & Finance, social media, Cyber security, Health care sector etc.	
Text Books	
1	Jiawei Han, Micheline Kamber, Jian Pei, "Data mining Concepts and Techniques", Morgan Kaufmann, 3rd edition, 2011
2	Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman and Hall/CRC, 2nd edition, 2014
3	Tom Mitchell, "Machine Learning," McGraw Hill, 2017
4	S. Rajasekaren and G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic andGenetic Algorithms: Synthesis and Applications", Prentice Hall, 2003
Reference Books	
1	Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory To Algorithms" 3rd edition, 2015
2	Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, 4th edition,2020

Data Warehousing and Business Intelligence	
Course Code: BAI-322 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 6

Introduction: Data warehousing is a method of organizing and compiling data into one database, whereas data mining deals with fetching important data from databases. Data mining attempts to depict meaningful patterns through a dependency on the data that is compiled in the data warehouse.

Course Objective: The objective of the subject is to facilitate the student with the basics of Data Warehouse and Data Mining, to study algorithms and computational paradigms that allow computers to find patterns and regularities in databases, perform prediction and forecasting, and generally improve their performance through interaction with data.

Pre-requisite: Database systems.

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

CO1: Understand the distinctive features of database, data warehouse and different schema supported by data warehouses.

CO2: Define different data pre-processing and data quality techniques for data analysis.

CO3: Explain insights, monitor performance and improve decision making.

CO4: Interpret and implement various data mining approaches like association, classificationand clustering in real-world domains.

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

CONTENTS

UNIT -I	10 Hours
Introduction to Data Warehousing: Overview, Difference between Database System and Data Warehouse, The Compelling Need for data warehousing, Data warehouse – The building Blocks: Defining Features, data warehouses and data marts, overview of the components, Three tier architecture, Metadata in the data warehouse. Data pre-processing:Data cleaning, Data transformation ETL Process. ETL tools. Defining the business requirements: Dimensional analysis, information packages – a new concept, requirements gathering methods, requirements definition: scope and content.	
UNIT- II	**11 Hours**
Principles of Dimensional Modelling: Objectives, From Requirements to data design, Multi-Dimensional Data Model, Schemas: the STAR schema, the Snowflake schema, fact constellation schema. OLAP in the Data Warehouse: Demand for Online Analytical Processing, limitations of other analysis methods, OLAP definitions and rules, OLAP characteristics, major features and functions, hyper cubes. OLAP Operations: Drill-down and roll-up, slice-and-dice, pivot or rotation, OLAP models, overview of variations, the MOLAP model, the ROLAP model, ROLAP versus MOLAP, OLAP implementation considerations. Query and Reporting, Executive Information Systems (EIS), Data Warehouse and Business Strategy.	
UNIT-III	**11 Hours**
Data Mining Basics: What is Data Mining, Data Mining Defined, The knowledge discovery process (KDD Process), Data Mining Applications- The Business Context of Data Mining, DataMining for Process Improvement, Data Mining as a Research Tool, Data Mining for Marketing,Benefits of data mining, Major Data Mining Techniques: Classification and Prediction: Issues Regarding Classificationand Prediction, Classification by Decision Tree Induction, KNN Algorithm.	
UNIT- IV	**10 Hours**
Cluster detection, K- means Algorithm, Outlier Analysis, memory-based reasoning, link analysis, Mining Association Rules in Large Databases: Association Rule Mining, genetic algorithms, neural networks. Data mining tools.	

Text Books	
1	Paul Raj Poonia, ―Fundamentals of Data Warehousing‖, John Wiley & Sons, 2004.
2	Kamber and Han, ―Data Mining Concepts and Techniques‖, Hart Court India P. Ltd.Elsevier Publications Second Edition, 2001
Reference Books	
1	W. H. Inmon, "Building the operational data store", 2nd Ed., John Wiley, 1999
2	Pang- Ning Tan, Michael Steinbach, Anuj Karpatne and Vipin Kumar, Introduction toData Mining, Pearson, 2021

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 Objectives:

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

Pre-requisite: Communication skills.

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

CO1: Understand the nature of management and describe the functions of management·
CO2: 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.
CO5: Discover and understand the concept of motivation, leadership, power and conflict.**CO6**: Understand the foundations of group behavior and the framework for organizationalchange and development.

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

CONTENTS

UNIT -I		**7 Hours**
Introduction: Concept, Nature, Process and Significance of Management; Managerial levels, Development of Management Thought: Classical, Neo-Classical, Behavioral, Systems and Contingency Approaches.		
UNIT- II		**7 Hours**
Planning: Nature, Scope and Objectives of Planning; Types of plans; Planning Process; Organizing: Nature, Process and Significance; Principles of an Organization; Span of Control; Types of an Organization.		
UNIT-III		**7 Hours**
Staffing: Concept, Nature and Importance of Staffing. Motivating and Leading: Nature and Importance of Motivation; Types of Motivation; Leadership: Meaning and Importance; Traits of a leader.		
UNIT- IV		**7 Hours**
Controlling: Nature and Scope of Control; Types of Control; Control Process; Control Techniques– Traditional and Modern; Effective Control System.		
Text Books		
1	S.P. Robbins, "Fundamentals Management: Essentials Concepts Applications", Pearson Education, 2014.	
2	Gilbert, J.A.F. Stoner and R.E. Freeman, "Management", Pearson Education, 2014. H. Koontz, "Essentials of Management", McGraw Hill Education, 2012.	
References		
1	C. B. Gupta, "Management Concepts and Practices", Sultan Chand and Sons, 2014	
2	W. Ghillyer, "Management- A Real World Approach", McGraw Hill Education, 2010.	
3	K. Mukherjee, "Principles of Management", McGraw Hill Education, 2012.	

Marketing Management	
Course Code: HMC- 304 Contact Hours: L-2 T-0 P-0 Course Category: HMC	Credits: 2 Semester: 6

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

Course Objectives:

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

Pre-requisite: Basic economics

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

CO1: Understand the concept of marketing and related concepts.
CO2: An in-depth understanding to various elements marketing mix for effective functioningof 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.

CONTENTS

UNIT -I		**7 Hours**
Introduction to Marketing: Nature, Scope and Importance of Marketing, Basic concepts, Marketing Environment.		
UNIT- II		**7 Hours**
Product: Product Levels, Product Mix, Product Strategy, Product Development, Product Lifecycle and Product Mix Pricing Decisions.		
UNIT-III		**7 Hours**
Place: Meaning & importance, Types of Channels, Channels Strategies, Designing and Managing Marketing Channel.		
UNIT- IV		**7 Hours**
Promotion: Promotion Mix, Push vs. Pull Strategy; Promotional Objectives, Advertising- Meaning and Importance, Types, Media Decisions, Promotion Mix, Personal Selling-Nature,Importance and Process.		
Text Books		
1	P. Kotler, P.Y. Agnihotri and E.U. Haque, "Principles of Marketing- A South Asian Perspective", Pearson Education, 2012.	
2	T. Ramaswamy and S. Namkumar, "Marketing Management Global Perspective: Indian Context", McMillan, Delhi, 2013.	
References		
1	R. Saxena, "Marketing Management", McGraw Hill Education, 2012	
2	C.W. Lamb, J.F. Hair, C. McDaniel, D. Sharma, "MKTG: a South Asian Perspectivewith Coursemate", Cengage Learning, 2016.	
3	R. Winer, "Marketing Management", Pearson Education, 2012.	

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 economicenvironment. 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 financialdecisions and resolving financial problems.

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

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

Pre-requisite: Basic economics

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

CO1: Understand the overall role and importance of the finance function for decision-making.
CO2: Recommend whether and why a particular investment should be accepted or rejectedby 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:** Analyse the complexities associated with management of cost of funds in the capitalstructure.
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.

CONTENTS

UNIT -I		**7 Hours**
Financial Management Definition, scope, objectives of Financial Management, Functions ofa 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. Costof Capital: Concept, Importance and Classification.		
UNIT-III		**7 Hours**
Capital Budgeting: Concept, Importance and Appraisal Methods: Pay Back Period, Accounting, Rate of Return, Net Present Value Method (NPV), Profitability Index, and IRR.Capital Rationing.		
UNIT- IV		**7 Hours**
Working Capital Management: Operating cycle, Working Capital Estimation, Inventory Management: EOQ Problem.		
Text Books		
1	M.Y. Khan and P.K. Jain, "Financial Management", McGraw Hill Education, 8 thEdition, 2018.	
2	I. M. Pandey, "Financial Management", Vikas Publishing House, 2015.	
Reference Books		
1	S. Kapil, "Financial Management", Pearson Education, 2012.	
2	C. Prasanna, "Financial Management: Theory and Practice", McGraw Hill, 2017.	
3	S.N. Maheshwari, "Financial Management: Principles and Practice", Sultan Chand, LN,2019.	

Human Resource Management	
Course Code: HMC- 308 Contact Hours: L-2 T-0 P-0 Course Category: HMC	Credits: 2 Semester: 6

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

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

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

Pre-requisite: Soft skills

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

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

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

CONTENTS

UNIT -I	7 Hours
Human Resource Management: Introduction to Concept and Functions of HRM, Role, Status and Competencies of HR Manager, HR Policies, Evolution of HRM. Emerging Challengesof Human Resource Management.	
UNIT- II	**7 Hours**
Human Resource Planning: Human Resource Planning- Quantitative and Qualitative dimensions; Recruitment – Concept and sources; (E-recruitment, recruitment process outsourcing etc.); Selection – Concept and process; test and interview; placement induction.Job analysis – job description and job specification.	
UNIT-III	**7 Hours**
Training and Development: Concept and Importance; Identifying Training and DevelopmentNeeds; Designing Training Programs; Role Specific and Competency Based Training; Evaluating Training Effectiveness; Performance appraisal: nature and objectives; Modern Techniques of performance appraisal.	
UNIT- IV	**7 Hours**
Human Resource Development: Orientation Program; Requisite of an effective Program,Evaluation of Orientation Program. Strategic HRM: HRD audit, ethics and CSR.	

Text Books	
1	G. Dessler. "A Framework for Human Resource Management", Pearson Education,2017, 15th Edition.
2	D. A. Decenzo, S. P. Robbins, S. L. Verhulst, "Human Resource Management", WileyIndia Private Limited, 2015.
Reference Books	
1	Bohlendar and Snell, "Principles of Human Resource Management", Cengage Learning,2013.
2	B. Becker, M. Huselid, D. Ulrich, "The HR Scorecard", 1 st edition, Harvard Business Review Press, 2001.

RECENT TRENDS IN AI	
Course Code: BAI-415 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 7

Introduction: AI- a revolutionary world, has entirely captured our day-to-day lives. It is the unique combination of minds and the machines. With the past couple of years, there occurredgradual increase in Artificial Intelligence, spreading its root in almost all the fields. New inventions and advancements have been done which are based on AI.

Course Objectives:

- Learn and understand the fundamentals of AI including its architecture and algorithms.
- Analyze AI enabling technologies and role of AI in Information Technology.
- To gain insights of Artificial Intelligence in Computer Vision.
- To understand and explore various applications of AI.

Prerequisite: Machine Learning, Artificial Intelligence.

Course Outcomes: Upon successful completion of this course, students will be able to:
CO1: Identify and discuss the algorithms, tools and architecture in AI.
CO2: Interpret and analyze the role of AI in context to Data Mining and Information Technology.
CO3: Examine and investigate the role and applications of Computer Vision in AI.
CO4: Demonstrate the applications of AI in Security and Intrusion Detection, Smart AI etc. withrespect to real-world scenarios.

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 beadopted.

CONTENTS

UNIT-I	10 Hours
Artificial Intelligence (AI): Futuristic Issues and Applications, Artificial Intelligence Architecture,Tools, Techniques and Technologies in AI, AI Enabling Technologies, AI for Data Mining and Knowledge Discovery, Role of AI in Information Technology. Recent Language models i.e., BERT, Encoder-Decoder Models, GPT Models, etc.	
UNIT-II	**10 Hours**
AI in Computer Vision, Generative Adversarial Network (GAN) and it's Applications, SmartTransportation & Smart Vehicles using AI. Smart Grid Computing & Technologies with AI	
UNIT-III	**12 Hours**
AI in Blockchain, Secure trading, Ethereum, Virtual Currencies, Supply chain operations, AI based Security and Intrusion Detection, Future Prospects and major challenges.	
UNIT-IV	**10 Hours**
Application of AI in Supply Chain Management, Geographical Information System through Artificial Intelligence, Smart City with AI, Applications of AI in Healthcare Industry, AI in Future Communications and Computing.	

Text Books

1.	S. Kanimozhi Suguna, M. Dhivya, Sara Paiva," Artificial Intelligence (AI) Recent Trends and Applications", Ist Edition, CRC Press, 2021/ Latest Edition
2.	Marco Fernandez, "Artificial Intelligence-Emerging Trends and applications,"Intech Open, 2018/ Latest Edition

Reference Books

1	Stuart Russell, Peter Norvig ," Artificial Intelligence: A Modern Approach", Pearson, 4thEdition,
2	Dr. Jagreet Kaur, Navdeep Singh Gill, "Artificial Intelligence and Deep Learning for DecisionMakers", BPB Publications,
3	Stuart J. Russel and Peter Norvig. "Artificial Intelligence – A Modern Approach" 4th/Latest Edition, Pearson Education, 2020.

BIG DATA ANALYTICS	
Course Code: BIT-407 Contact Hours: L-3 T-0 P-2 Course Category: DCC	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, predictiveand prescriptive, based on their data assets. Collection, storage and retrieval of data assets andprocessing 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 managingand processing such data.

Course Objectives:

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

Prerequisite: Essential: Distributed Systems, Data warehouseDesirable:
NoSQL Databases

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

CO1: Perform data gathering of large data from a range of data sources.
CO2: Critically analyse existing Big Data datasets and implementations, takingpracticality, 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 variousstructure 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 penand 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.

CONTENTS

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 streamData; 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-perm storage, settingup '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 andservices, 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 datasystems, Manning Publications/Latest Edition
3.	Erl T. Khattak W., Buhler P., Big Data Fundamentals: Concepts, Drivers & Techniques, ThePearson Service Technology Series from Thomas ERL/Latest Edition
Reference Books	
1.	DT Editorial Services, Big Data, Black Book, Dreamtech Press/Latest Edition

MULTIMODAL DATA ANALYSIS	
Course Code: BAI-417 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 7

Introduction: Multimodal Data Processing is a vibrant multi-disciplinary research field whichaddresses some of the original goals of artificial intelligence by integrating and modeling multiple communicative modalities, including linguistic, acoustic, and visual messages.

Course Objectives:

- Understand the fundamentals of Multimodal data, text processing techniques and languagemodels.
- Gain insights of the concepts in Speech processing.
- Appreciate the different techniques of Digital image and video processing.
- Analyze and apply the concept of co-learning.

Prerequisite: Machine Learning.

Course Outcomes: Upon successful completion of this course, students will be able to:
CO1: Identify and explain the idea of multimodal data processing along with its applications in textprocessing.
CO2: Locate and describe various terminologies in Speech processing.
CO3: Interpret and analyze different digital image and video processing approaches.
CO4: Demonstrate the need of Conventional multi-modal learning and co-learning.

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.

CONTENTS

UNIT-I	10 Hours
Introduction: Introduction to Multimodal data and applications, Multimodal Representation: two broadapproaches, Joint and Coordinated. Challenges of multimodal data, Data collection & cleaning. Text Processing: Text normalization, Lemmatization, Morphology, Sub word tokenization; Text processing and statistics: TFIDF, BM-25, Zipf's law, Hipf's law; Language models and smoothing techniques; Vector space models.	
UNIT-II	**10 Hours**
Speech Processing: Speech production and perception, Acoustic and articulatory phonetics; Short- term analysis: Need and windowing, Energy, Zero-crossing rate, Autocorrelation function, Fourier transform, Spectrogram; Short-term synthesis: Overlap-add method; Cepstrum analysis: Basis and development, mel-cepstrum.	
UNIT-III	**12 Hours**
Digital Image and Video Processing: Point processing, Neighborhood processing, Enhancement, Edge detection, Segmentation, Feature descriptors, Restoration, Morphological operations, Imagetransforms, Spatial and temporal data handling.	
UNIT-IV	**10 Hours**
Multi-modal learning and associated challenges: Applications and challenges from fusing two or more modalities such as vision, language, audio, graphs, biomedical signals, Development of shallow and deep networks for multimodal learning. Multi-modal processing and learning with applications: Image captioning, visual questioning answering system, automatic commentary generation, cognitive state estimation, recommendation system. Other Modalities: Biomedical signals, and Conventional multi-modal learning, co-learning etc.	

Text Books	
1	R. C. Gonzalez, R. E. Woods, "*Digital Image Processing",* Pearson, Prentice-Hall, 4th Edition, 2017/Latest Edition
2	R. Klette, "*Concise Computer Vision: An Introduction into Theory and Algorithms",* Springer, Latest Edition, 2014/Latest Edition
3	L. R. Rabiner, R. W. Schafer, "*Introduction to Digital Speech Processing",* Now Publishers Inc, Latest Edition, 2007/Latest Edition
Reference Books	
1	D. Jurafsky, J.H. Martin, *"Speech and Language Processing"*, 3rd ed. Jan 2022/Latest Edition
2	A But, A Miasnikov, G Ortolani, "Multimodal Deep Learning with Tensorflow: Translate mathematics into robust TensorFlow applications with Python", Packt Publishing Limited, 2019/Latest Edition
3	M Yang, B Rosenhahn, V Murino, "Multimodal Scene Understanding: Algorithms, Applications and Deep Learning", Academic Press Inc, 2019/Latest Edition
4.	Stuart J. Russel and Peter Norvig. Artificial Intelligence – A Modern Approach. 4th/Latest Edition, Pearson Education, 2020.

COMPUTER VISION	
Course Code: BAI-403 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 7

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 understand basic concepts of data driven approach of image processing.
- To appreciate the well-known computer vision computation pipelines.
- To understand techniques for processing text inside images.
- To develop an understanding of advanced computer vision problems and their solutions.

Pre-requisites: Introduction to Python.

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

CO1: Understand basic concepts of data driven based image processings.
CO2: Analyze well known computer vision processing architectures.
CO3: Understand the working of image captioning systems.
CO4: Apply advanced concepts in computer vision to solve problems.

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

CONTENTS

UNIT I	**10 hours**
Computer Vision: Overview, History, Key Problems, Challenges. Data Driven Approach: KNN. Linear Classification. Loss Function and Optimization, Stochastic Gradient Descent, Numerical Computations.Neural Networks and Backpropagation.	
UNIT II	**10 hours**
Convolutional Neural Networks: Architecture Overview. Types of Layers - Convolution, Pooling, FullyConnected. Parameter Sharing. Well known case studies: LeNet, AlexNet, VGG-16, ResNet, InceptionNet. Transfer Learning. Weight Initialization, Batch Normalization, Regularization.	
UNIT III	**10 hours**
Text in Image: Language Model, RNNs, Image Captioning, Vision & Language. Attention Models: Self-Attention, Soft vs Hard Attention. Transformer: Key, Value, Query, Encoder-Decoder. Transformers for Image Recognition	
UNIT IV	**10 hours**
Advanced Vision: Data Augmentation, Semantic Segmentation, Object Detection, Face Recognition usingSiamese Networks, Generative Models, Adversarial Networks, Biases in Image Datasets.	

Text Books	
1	S. Khan, H. Rahmani, "A Guide to Convolutional Neural Networks for Computer Vision",, Morgan & Claypool Publishers, 2018.
2	Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2016.
Reference Books	
1	S. J. D.Prince, "Computer vision: Models, Learning and Inference", 1st Edition, Cambridge UniversityPress, 2012.
2	L. G. Shapiro, and G.C.Stockman, "Computer Vision", 1st Edition/ Latest Edition, Pearson PrenticeHall, 2001.
3	R. Klette, "Concise Computer Vision: An Introduction into Theory and Algorithms", 1st Edition/Latest Edition, Springer Nature, 2014.
4	R. Szeliski, "Computer Vision: Algorithms and Applications", 1st Edition/ Latest Edition, Springer,2011.

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PATTERN RECOGNITION	
Course Code: BAI-407 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 7

Introduction: Pattern recognition is the process of recognizing patterns by using a machine learning algorithm. Pattern recognition can be defined as the classification of data based on knowledge already gained or on statistical information extracted from patterns and/or their representation

Course Objectives:

- Learn the fundamentals of pattern recognition**.**
- Ability to understand the relevance of Pattern recognition to classical problems.
- Understand and identify pattern recognition's problems.
- Understand various applications of Pattern recognition.

Prerequisite: Discrete Mathematics and Probability & Random Variables.

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

CO1: Understand and recognize the fundamentals of pattern recognition along with its applications.
CO2: Apply and analyze the different statistical and neural approaches in pattern recognition
CO3: Identify and formulate the pattern recognition problems.
CO4: Design and implement the recent applications of pattern recognition.

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.

CONTENTS

UNIT-I	10 Hours
Introduction to pattern recognition and its applications: Applications of pattern recognition in imageanalysis, speech processing, video analysis, text mining, unstructured data analysis. Prominent algorithms and methods of pattern recognition. Traditional and state-of-the-art techniques of patternrecognition. Recent advancements of pattern recognition	
UNIT-II	**10 Hours**
Statistical and neural approaches: Minimum-error-rate classification, Classifiers, Discriminant functions Decision surfaces, Normal density and discriminant functions, discrete features Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case. Linear Discriminants: Separability, Perceptron, Support Vector Machines.	
UNIT-III	**12 Hours**
Non-Parametric Techniques: Kernel Density Estimators, Parzen Window, Nearest Neighbor Methods. Component Analysis and Dimension Reduction, The Curse of Dimensionality, PrincipalComponent Analysis, Fisher Linear Discriminant, Locally Linear Embedding.	
UNIT-IV	**10 Hours**
Advanced topics and applications: Graphical models: State-Space Models, Hidden Markov Models,Dynamic Bayesian Networks, Bias-Variance Dilemma, Jacknife and Bootstrap Methods, search and optimization problems.	

Text Books	
1.	Bishop, C. M., "Pattern Recognition and Machine Learning ", Latest Edition, Springer, 2011/Latest Edition.
2.	Duda, R.O., Hart, P.E., and Stork, D.G., "Pattern Classification", Latest Edition, Wiley, 2007/Latest Edition.
3.	S. Marsland, Machine Learning: An Algorithmic Perspective, Chapman & Hall/CRC, LatestEdition, 2014/ Latest Edition.
Reference Books	
1	Koller, D. and Friedman N., "Probabilistic Graphical Models" , Latest Edition, MIT Press,2009/ Latest Edition.
2.	N. Cristianini and J. Shawe-Taylor," An Introduction to Support Vector Machines", Cambridge University Press, Latest Edition, 2000/ Latest Edition.
3.	NPTEL COURSE : Pattern Recognition and Application: https://onlinecourses.nptel.ac.in/noc19_ee56/preview

SOFTWARE TESTING	
Course Code: BIT 403 Contact Hours: L-3 T-0 P-2 Course Category: DEC	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 thesystem 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 fundamentalcomponent 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 Outcomes: Upon successful completion of this course, students will be able to:

CO1: Understand the process of applying tests to software and the fundamental components of atest case.
CO2: Use different testing techniques to create test cases.
CO3: Select Test Cases and explain verification methods to prove the correctness of theprogram.
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 classroom teaching will be adopted.

CONTENTS

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 ofModern 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	**12 Hours**
Introduction to Object Oriented Testing, State Based Testing, Class Testing, Web Testing, Issues inObject Oriented Testing, Regression testing, Selection of test cases, reducing the number of test cases, Prioritization guidelines.	
UNIT-IV	**10 Hours**
Software Verification Methods, SRS Verification, SDD Verification, Source Code Reviews, Software Project Audit, Debugging Process and Approaches, Software Testing Metrics, Metric usedin 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", Pearsons, 2nd Edition 2008/ LatestEdition

CONVERSATIONAL AI	
Course Code: BAI-409 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 7

Introduction: The goal of this course is to introduce students to current methods and recent advances in conversational artificial intelligence (AI) and provide hands-on experience building a conversational AI system. The course will introduce students to basic components of a dialogue system, with an emphasis on conversational (vs. task-oriented) systems.

Course Objectives:

- Learn fundamentals of conversational AI and different platforms.
- Understand the process of designing, assembling and managing an AI.
- Perform Testing and assessing the AI assistant.
- Understand the maintenance process for AI assistant.

Pre-requisite: Programming experience with Python, Machine learning.

Course Outcomes: Upon successful completion of this course, students will be able to:
CO1: Identify and understand the foundations of Conversational AI.
CO2: Identify and elaborate the designing flow of effective conversational AI assistant.
CO3: Perform training and testing on AI assistant and compare testing methodologies.
CO4: Formulate and deploy an AI assistant and analyze the challenges associated with it.

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 beadopted.

CONTENTS

UNIT-I	10 Hours
Foundations: Introduction to Conversational AI, AI assistants and their platforms, types of AI assistants, AI assistant platforms, Primary use cases for AI assistant technology, self-service assistant, agent assist, classification and routing. Building Conversational AI: User's Intent, Utterance, response, entity, combining intents andentities, contextualizing a response by using entities, responding with process flow, detecting low confidence, implementing confidence detection and the two-strikes rule.	
UNIT-II	**10 Hours**
Designing Effective processes and Dialogue: Designing, Assembling, managing the design processand cross cutting design aspects. Dialogue, Reprompting, Disambiguation and Escalation Building a AI Assistant: AI assistant use cases, Conversational AI success metrics, Command interpreter success metrics, Event classifier success metrics.	
UNIT-III	**12 Hours**
Training and Testing: Training an AI Assistant, finding training data, Assessing the assistant, testing an AI Assistant for accuracy, testing single utterance, multiple utterances, comparing testingmethodologies.	
UNIT-IV	**10 Hours**
Maintenance: Deployment and Management, Wild west approach, types of environments to run tocode: Development, Test, Production and after first production deployment. Improving Assistant: Metrics, analysis of classifiers, finding gaps in the training data.	
Text Books	
1.	Andrew R. Freed, "Conversational AI", Manning Publications, September 2021/Latest Edition.
2.	Michael McTear, "Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots", Morgan & Claypool Publishers, 2020/Latest Edition.
Reference Books	
1.	Xiaoquan Kong, Guan Wang, "Conversational AI with Rasa", Packt Publishing, 2021/LatestEdition
2.	https://just-ai.com/blog

PARALLEL AND DISTRIBUTED AI	
Course Code: BAI-411 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 7

Introduction: Parallel and Distributed AI uses a parallel system for computing. Many "nodes"or learning agents, independent of each other, are located at geographically diverse places. Parallel processing allows the system to use all computational resources to their fullest extent.

Course Objectives:

- Understand the concepts of Distributed Artificial Intelligence.
- Understand different reasoning systems.
- Learn different organizational structures and frameworks for problem solving.
- Learn various applications of parallel and distributed AI.

Prerequisite: Distributed Systems.

Course Outcomes: Upon successful completion of this course, students will be able to:
CO1: Identify and recognize the problem solving procedures in context with Parallel andDistributed AI.
CO2: Illustrate and elaborate the working of Parallel, Distributed and connectionist models ofAI.
CO3: Interpret and analyze the frameworks for solving problems in the domains of Paralleland Distributed AI.
CO4: Apply and demonstrate the idea of distributed AI in real world- scenarios.

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.

CONTENTS

UNIT-I	10 Hours
Distributed AI, Intelligent Agents, Problem Solving Using DAI, Beyond Classical Search,Adversarial Search, Constraints Satisfaction Problem, Decision Procedures.	
UNIT-II	**10 Hours**
Parallel and Distributed AI: Psychological Modeling, Parallelism in Reasoning Systems, DistributedReasoning Systems: Coordination and Cooperation. Connectionist Models: Introduction: Hopfield Networks Connectionist AI and Symbolic AI.	
UNIT-III	**12 Hours**
Cooperation through Communication in a Distributed Problem-Solving Network, Instantiating Descriptions of Organizational Structures, The Architecture of the Agora Environment, Test Beds forDistributed AI Research, Frameworks for Real-Time Distributed Cooperative Problem Solving.	
UNIT-IV	**10 Hours**
A Connectionist Encoding of Sematic Networks, Examples of Context Free Recognizers, DAI for Document Retrieval, Manufacturing Experience with the Contract Net, Participant Systems, Distributed Artificial Intelligence. Applications.	

Text Books	
1	Satya Prakash Yadav, Dharmendra Prasad Mahato, Nguyen Thi Dieu Linh," Distributed Artificial Intelligence A Modern Approach", Ist Edition, 2020, CRC Press/Latest Edition
2	Roger Lee, "software engineering, artificial intelligence, networking and parallel/distributedcomputing", Springer Nature Switzerland AG, 2021/Latest Edition
Reference Books	
1	Stuart Russell and Peter Norvig" Artificial Intelligence A Modern Approach", PEARSONEducation, 3rd Edition, 2010/Latest Edition
2	N. P. Padhy –" Artificial Intelligence and Intelligence Systems", OXFORD publication,2005/Latest Edition
3	McClelland, J. L., Rumelhart, D. E., & PDP Research Group. (1986). Parallel distributedprocessing (Vol. 2, pp. 20-21). Cambridge, MA: MIT press.
4	Vega, F. F., & Cantú-Paz, E. (Eds.). (2010). Parallel and Distributed Computational Intelligence (Vol. 269). Springer.

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 projectmanagement activity, and to complete a specific project in time with the available budget.

Course Objectives:

- 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 andsequencing them for a software project.
- To learn planning and estimation and scheduling of software project activity components,resources and durations.

Prerequisite: Knowledge of Software Engineering, Basic Programming Course

Course Outcomes: 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 ITproject 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 managementstrategy.

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 beadopted.

CONTENTS

UNIT-I	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	**10 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 toOrganize 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	**12 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; Sixthedition, 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, secondedition, 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.

CREATIVITY, INNOVATION AND ENTREPRENEURSHIP	
Course Code: HMC-402 Contact Hours: L-3 T-0 P-0 Course Category: HMC	Credits: 3 Semester: 8

Introduction: This course explores the dynamic intersection of creativity, innovation, and entrepreneurship within the field of Artificial Intelligence (AI). Students will learn how to harness AI technologies to foster innovation and entrepreneurship, while also developing creative problem-solvingskills critical for AI-related ventures.

Course Objectives

- To understand disruptive AI technologies and their potential impact on industries.
- To understand ethical issues related to AI development and deployment.
- To understand intellectual property (IP) rights and protections for AI innovations.
- To understand strategies for scaling AI ventures and expanding into new markets.

Pre-requisites: Basic understanding of Artificial Intelligence concepts.

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

CO1: Understand creative thinking and problem-solving skills within the AI context.

CO2: Discuss about ethical considerations and responsible AI development.

CO3: Demonstrate how to navigate IP challenges in the AI industry.

CO4: Formulate strategies for building AI-based entrepreneurial ventures.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
Creative Thinking and Problem-Solving in AI: Techniques for fostering creativity in AI projects,Creative problem-solving frameworks and Brainstorming AI-driven business ideas. Innovation in AI: The innovation process in AI, Disruptive AI technologies and their impact.	
UNIT - II	10 Hrs
Ethical Considerations in AI: Ethical AI development principles, Discussion on AI bias, fairness,and transparency and Case studies on ethical AI dilemmas. AI Entrepreneurship: Introduction to entrepreneurship in the AI domain, Identifying AI-basedbusiness opportunities and Developing a business model canvas.	
UNIT - III	10 Hrs
Intellectual Property and AI: Protecting AI innovations through patents and copyright, Licensing AI technologies and Case studies on AI IP disputes. AI and Social Impact: AI for social good initiatives, Responsible AI development anddeployment and Measuring the societal impact of AI ventures.	
UNIT - IV	10 Hrs
Scaling AI Ventures: Strategies for scaling AI startups, International expansion and global markets. Challenges and opportunities in AI growth.	

Text Books	
1	Kai-Fu Lee, “Ai Superpowers: China, Silicon Valley, And The New World Order”, Houghton Mifflin Harcourt Publishing Company, 2018/ Latest Edition.
2	H. James Harrington, “Creativity, Innovation, and Entrepreneurship: The OnlyWay to Renew Your Organization ”, Productivity Press, 2018/ Latest Edition
Reference Books	
1	Edwin Catmull and Amy Wallace, “Creativity, Inc.: Overcoming the Unseen Forces ThatStand in the Way of True Inspiration", Random house, 2014/Latest Edition.
2	Internet Sources: https://www.entrepreneur.com/growing-a-business/how-entrepreneurial-creativity-leads- to-innovation/430221 https://realbusiness.co.uk/creativity-innovation-entrepreneurship-related
3.	NPTEL Course: Innovation, Business Models and Entrepreneurship https://onlinecourses.nptel.ac.in/noc21_mg63/preview

AUGMENTED REALITY AND VIRTUAL REALITY	
Course Code: BAI-402 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction

Augmented Reality and Virtual Reality are fast growing fields with many potential applications for theindustry, the medical sector, and the general public. This course is designed to give historical and modern overviews and perspectives on virtual reality. It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems.

Course Objectives

- To learn the fundamentals of sensation, perception, and perceptual training.
- To understand the scientific, technical, and engineering aspects of augmented and virtual reality systems.
- To learn the Evaluation of virtual reality from the lens of design.
- To learn the technology of augmented reality and implement it to have practical knowledge.

Pre-requisites: Proficiency in programming languages such as C++, JAVA.

Course Outcomes: Upon successful completion of the course, students will be able to: **CO1:** Understand the various fundamental techniques for the design and development of VRand AR Systems.

CO2: Describe how VR and AR systems work.

CO3: Demonstrate the use of particular designs for AR and VR experiences.

CO4: Analyze the benefits and drawbacks of specific AR and VR techniques.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
Introduction : Introduction to Augmented-Virtual and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR ,VR and MR, Challenges with AR, AR systemsand functionality, Augmented reality methods, visualization techniques for augmented reality. VR systems: VR as a discipline, Basic features of VR systems, Architecture of VR systems, VR hardware: VR input hardware: tracking systems, motion capture systems, data gloves, VR output hardware: visual displays.	
UNIT - II	10 Hrs
Stereoscopic Vision & Haptic rendering: Fundamentals of the human visual system, Depth cues, Stereopsis, Retinal disparity, Haptic sense, Haptic devices, Algorithms for haptic rendering and parallax, Synthesis of stereo pairs, Pipeline for stereo images. VR software development : Challenges in VR software development, Master/slave and Client/server architectures, Cluster rendering, Game Engines and available sdk to develop VRapplications for different hardware (HTC VIVE, Oculus, Google VR).	
UNIT - III	10 Hrs
3D interaction techniques: 3D Manipulation tasks, Manipulation Techniques and Input Devices,Interaction Techniques for 3D Manipulation. AR software development: AR software, Camera parameters and camera calibration, Marker-based augmented reality, AR Toolkit.	
UNIT - IV	10 Hrs
Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.	

Text Books

1	Steven M. LaValle, “Virtual Reality”, Cambridge University Press, 2023/ LatestEdition.
2	George Mather, “Foundations of Sensation and Perception”, Psychology Press, 2016/LatestEdition.
3	Jason Jerald, “The VR Book: Human-Centered Design for Virtual Reality”, Morgan & Claypool Publishers,2015/ Latest Edition.
4	Alan B. Craig, “Understanding Augmented Reality, Concepts and Applications”, Morgan Kaufmann, 2015/ Latest Edition.

Reference Books

1	Tony Parisi, “Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop”, Web, and Mobile, O'Reilly Media, 2015/ Latest Edition.
2	Internet Sources: http://lavalle.pl/vr/
3.	NPTEL Course: Foundation Course on Virtual Reality and Augmented Reality https://elearn.nptel.ac.in/shop/iit-workshops/completed/foundation-course-on-virtual- reality-and-augmented-reality/

SOCIAL MEDIA ANALYTICS	
Course Code: BAI-404 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction

This course will introduce concepts and approaches to mining social media data. It focuses on obtainingand exploring those data, mining networks, and mining text from social platforms. Students will learn how to apply previously learned data mining concepts to a domain that will likely be familiar to all of them: social media. Students will learn to explore, model, and predict with network and textual data from existing social platforms.

Course Objectives

- To understand the fundamentals and need of Social media Analytics.
- To define the insights of network evolution and web analytics tools.
- To understand social network structures and identify key influencers, communities, andpatterns within social media networks.
- To learn the ability to work collaboratively on social media analytics projects, often inmultidisciplinary teams.

Pre-requisites: Natural Language Processing and Data Science.

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

CO1: Explain the concepts of social media analytics and its significance.

CO2: Discuss the fundamentals of Random graphs and network evolution.

CO3: Apply creative and social skills required for analyzing the effectiveness of social media.

CO4: Demonstrate skills by approaching social media analytics challenges.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
Introduction to Social Media Analytics (SMA): Social media landscape, Need for SMA; SMA in Small organizations; SMA in large organizations; Application of SMA in different areas Network fundamentals and models: The social networks perspective - nodes, ties and influencers, Social network and web data and methods. Graphs and Matrices- Basic measures for individuals and networks. Information visualization	
UNIT - II	10 Hrs
Making connections: Link analysis. Random graphs and network evolution. Social contexts:Affiliation and identity. Web analytics tools: Clickstream analysis, A/B testing, online surveys, Web crawling andIndexing. Natural Language Processing Techniques for Micro-text Analysis	
UNIT - III	10 Hrs
Facebook Analytics: Introduction, parameters, demographics. Analyzing page audience. Reach and Engagement analysis. Post- performance on FB. Social campaigns. Measuring and Analyzing social campaigns, defining goals and evaluating outcomes, Network Analysis. 9 (LinkedIn, Instagram, YouTube Twitter etc. Google analytics. Introduction. (Websites).	
UNIT - IV	10 Hrs
Processing and Visualizing Data, Influence Maximization, Link Prediction, Collective Classification, Applications in Advertising and Game Analytics, Introduction to Python Programming, Collecting and analyzing social media data; visualization and exploration.	

Text Books

1	Subodha Kumar and Liangfei Qiu," Social Media Analytics and Practical Applications", Routledge, 2022/Latest Edition.
2	Selay Ilgaz Sumer, Nurettin Parilti, "Social Media Analytics in Predicting Consumer Behavior", Routledge, 2023/Latest Edition.
3	Matthew Ganis and Avinash Kohirkar, "Social Media Analytics", Pearson Education India, 2016/ Latest Edition.
4	Marshall Sponder, "Gorah F. Khan, Digital analytics for marketing", Routledge, 2017/Latest Edition.

Reference Books

1	Jim Sterne, "Social Media Metrics". Wiley, 2010/ Latest Edition.
2	Internet Sources: 1. https://gtl.csa.iisc.ac.in/indous-symposium/slides/Krishnapuram%20Social%20Media%20Analytics.pdf 2. https://searchbusinessanalytics.techtarget.com/definition/social-media-analytics
3.	NPTEL Course: Social Network Analysis https://onlinecourses.nptel.ac.in/noc22_cs117/preview

AI FOR GAMES	
Course Code: BAI-406 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction

This course introduces students to the principles and techniques of artificial intelligence (AI) as appliedto game development. Students will learn how to create intelligent non-player characters (NPCs) and design game systems that respond dynamically to player actions. The course will cover topics such as path finding, decision-making, behavior trees, and machine learning in the context of game development.

Course Objectives

- Understand the fundamental concepts of AI in game development.
- Learn the AI-driven behaviors for game NPCs.
- Understand behavior trees for complex NPC behaviors.
- Understand advanced topics in AI, including machine learning and procedural contentgeneration in games.

Pre-requisites: Basic programming skills.

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

CO1: Understand the role of artificial intelligence in the game development.

CO2: Explain the path finding algorithms and navigation techniques.

CO3: Apply the fundamentals for the integration of AI systems into popular game engines.

CO4: Create intelligent NPCs and dynamic gameplay experiences.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
Introduction to AI in Games: Overview of AI in game development, Historical perspective and milestones, Role of AI in modern games. Path finding Algorithms: A* algorithm and its variants, Navigation meshes and Implementing pathfinding in games.	
UNIT - II	10 Hrs
Decision-Making for NPCs: Finite state machines (FSMs), Utility theory and decision theory and Implementing NPC decision-making	
UNIT - III	10 Hrs
Behavior Trees: Introduction to behavior trees, Designing and implementing behavior trees andCombining decision-making and behaviors. Game AI and Data Structures: Data structures for efficient AI processing, Spatial partitioningtechniques and Optimizing AI for real-time performance	
UNIT - IV	10 Hrs
Advanced Topics: Machine learning in games, Procedural content generation and Naturallanguage processing in game dialogue. AI in Game Development Tools: Integration of AI in popular game engines (e.g., Unity or UnrealEngine) and Hands-on projects using game engine AI tools.	

Text Books

1	Ian Millington, “AI for Games”, CRC Press, 2019/Latest Edition.
2	Paul Roberts, “Artificial Intelligence In Games”, Routledge 2023/Latest Edition.

Reference Books

1	Georgios N. Yannakakis and Julian Togelius,”Artificial Intelligence and Games”,Springer International Publishing, 2019/ Latest Edition.
2	Internet Sources: https://www.gamedesigning.org/gaming/ai-in-gaming/ https://pianalytix.com/role-of-artificial-intelligence-in-gaming/ https://towardsdatascience.com/how-to-teach-an-ai-to-play-games-deep-reinforcement-learning-28f9b920440a
3.	NPTEL Course: Algorithmic Game Theory https://nptel.ac.in/courses/106105237

MULTI-AGENT SYSTEMS	
Course Code: BAI-408 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction

This course explores the theory, algorithms, and practical applications of multi-agent systems. Studentswill learn about autonomous agents, their interactions, and the design principles behind multi-agent systems in various domains, including robotics, economics, and social sciences. The course emphasizesboth theoretical foundations and hands-on implementation.

Course Objectives

- To define what multi-agent systems are and understand their significance in variousdomains.
- To understand the comparison and contrast different agent architectures, includingreactive and deliberative architectures.
- To understand the coordination mechanisms such as negotiation, cooperation, andcompetition.
- To understand the design and develop multi-agent systems tailored to specific applicationareas.

Pre-requisites: Basic knowledge of computer science and algorithms.

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

CO1: Understand the fundamental concepts of multi-agent systems and their recent trends.**CO2:** Explain co-ordination and communication mechanisms within Multi-agent Systems. **CO3:** Analyze and evaluate interactions in multi-agent environments.

CO4: Illustrate and apply various applications of Multi-agent Systems.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
Introduction to Multi-agent Systems: Definition of agents and multi-agent systems, Key concepts: agents, environments, interactions, and autonomy and Historical overview and applications indifferent domains. Agent Architectures: Reactive and deliberative agent architectures, BDI (Belief-Desire-Intention) agents and Practical implementations of agent architectures.	
UNIT - II	10 Hrs
Communication and Coordination: Communication in multi-agent systems, Coordination mechanisms: negotiation, cooperation, and competition and Agent communication languages(ACLs) and protocols. Game Theory and Multi-agent Decision-Making: Introduction to game theory, Strategic interactionamong agents and Nash equilibrium and its applications.	
UNIT - III	10 Hrs
Reinforcement Learning for Multi-agent Systems: Multi-agent reinforcement learning (MARL), Algorithms: Q-learning, Deep Q-Networks (DQN), and policy gradient methods and Applications inrobotics and game playing	
UNIT - IV	10 Hrs
Applications of Multi-agent Systems: Robotics and swarm robotics, Economics and market-based approaches and Social sciences and modeling human behavior. Research Trends and Emerging Topics: Current research areas in multi-agent systems and Ethical considerations and societal impacts.	

Text Books

1	Indradip Banerjee, Shibakali Gupta and Siddhartha Bhattacharyya,"Multi Agent Systems: Technologies and Applications towards Human-Centered", Springer, 2022/Latest Edition.
2	M. Wooldridge," An Introduction to Multi Agent Systems", John Wiley & Sons Inc.,2009/ Latest Edition.
3	Kevin Leyton-Brown and Yoav Shoham." Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations",Cambridge University Press, 2008/ Latest Edition.

Reference Books

1	Gerhard Weiss," Multiagent Systems – A Modern Approach to Distributed Artificial Intelligence (Intelligent Robotics & Autonomous Agents Series)", First/ Latest Edition,MIT Press, 2000
2	Internet Sources: https://www.turing.ac.uk/research/interest-groups/multi-agent-systems https://www.aiforanyone.org/glossary/multi-agent-system https://link.springer.com/chapter/10.1007/978-3-642-14435-6_1

SECURITY AND PRIVACY FOR BIG DATA ANALYTICS	
Course Code: BAI-410 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction

This course is designed to provide students with a comprehensive understanding of the security and privacy challenges associated with big data analytics. Emphasis will be placed on developing skills and knowledge necessary to design, implement, and manage secure big data analytics systems while safeguarding user privacy.

Course Objectives

- Define and explain the core concepts of big data analytics.
- Examine the architecture of big data systems and identify points for integrating security measures.
- Evaluate secure storage solutions for big data.
- Investigate techniques for preserving user privacy during data mining activities.

Pre-requisites: Big Data Analytics.

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

CO1: Understand the fundamentals of Big Data Analytics.

CO2: Apply security measures into Big Data Architectures.

CO3: Analyze various security measures to data processing frameworks**.**

CO4: Design vulnerability assessments and security audits to proactively address securityweaknesses.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
Introduction to Big Data Analytics and Security: Definition of Big Data Overview of Big DataAnalytics Importance of Security in Big Data Common Security Challenges in Big Data Analytics Fundamentals of Security and Privacy: Basics of Information Security Privacy Principles andRegulations Legal and Ethical Considerations in Big Data Analytics	
UNIT - II	10 Hrs
Architectural Framework for Secure Big Data Analytics: Big Data Architecture Overview Integrating Security into Big Data Architecture Role of Cloud Computing in Securing Big Data Data Encryption and Access Control: Encryption Techniques for Big Data Access Control Mechanisms Key Management in Big Data Systems	
UNIT - III	10 Hrs
Securing Big Data Storage and Processing: Secure Storage Solutions Securing Data Processing Frameworks (e.g., Hadoop, Spark) Data Integrity and Availability Privacy-Preserving Techniques in Big Data Analytics: Privacy-Preserving Data Mining Homomorphic Encryption Differential Privacy	
UNIT - IV	10 Hrs
Threats and Vulnerability Assessment: Identifying Threats to Big Data Systems ConductingVulnerability Assessments Security Auditing and Monitoring Incident Response and Recovery: Developing Incident Response Plans Handling Security Incidentsin Big Data Analytics Recovery Strategies for Big Data Systems.Case Studies	

Text Books

1	Mamoun Alazab and Maanak Gupta," Trust, Security and Privacy for Big Data",Routledge, 2022/Latest Edition
2	Kim H. Pries and Robert Dunnigan," Big Data Analytics A Practical Guide for Managers", Routledge, 2015/Latest Edition.
3	Viktor Mayer-Schonberger and Kenneth Cukier," Big Data: A Revolution That Will Transform How We Live, Work, and Think", Houghton Mifflin Harcourt, 2013/LatestEdition.
4	Charu C. Aggarwal and Philip S. Yu, "Privacy-Preserving Data Mining", Springer, 2008/Latest Edition.

Reference Books

1	Jason T. Luttgens, Matthew Pepe and Kevin Mandia, " Incident Response & Computer Forensics", McGraw Hill, 2014/Latest Edition
2	Mary E. Ludloff and Terence Craig, " Privacy and Big Data", O'Reilly Media,2011/Latest Edition
5	Internet sources: https://www.informatica.com/in/resources/articles/what-is-big-data-privacy.html https://www.turing.com/resources/big-data-security
6	NPTEL Course: Big Data Computing https://onlinecourses.nptel.ac.in/noc20_cs92/preview

INTERNET OF THINGS	
Course Code: BAI-412 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

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 comprehensivein 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 andinternet environment.
- Design and program own IoT devices by using real IoT communication protocols.
- Analyze the data generated from the IoT devices..

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

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

CO1: Understand and explain IoT tools and IoT Applications using smart sensor devices andcloud systems.

CO2: Understand various uses and risks related to IoT devices.

CO3: Illustrate the role of Big data analytics in IoT.

CO4: Develop IoT solutions and examine risks related to IoT devices.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
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 Hrs
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 andCloud Computing, Standards, Cloud Providers and Systems, Architecture.	
UNIT - III	10 Hrs
Data Analytics for IoT: Introduction, Machine Learning, Big Data Analytics Tools andTechnology,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 MonitoringCase Study, Tools for IoT: Chef, Chef Case Studies, Puppet, Puppet Case Study – Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator.	
UNIT - IV	7 Hrs
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 IoTtools, 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	Harry G. Smeenk, “Internet of Things for Smart Buildings”, Packt PublishingLimited, 2023/Latest Edition.
2	A. Bahga, V. Madisetti, “Internet of Things: A Hands-on Approach”,Universities Press, 2015/Latest Edition
3	R. Kamal, “Internet of Things: Architecture and Design Principles”, McGraw Hill Educationprivate limited, 2017/Latest Edition

Reference Books

1	D. Uckelmann, M. Harrison, “Architecting the Internet of Things”, Springer, 2011/ Latest Edition.
2	O. Hersent, D. Boswarthick, O. Elloumi, “The Internet of Things – Key applications and Protocols”,Wiley, 2012/ Latest Edition.
3.	H. Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press,2015/ Latest Edition
4	NPTEL Course: Introduction To Internet Of Things https://onlinecourses.nptel.ac.in/noc22_cs53/preview

COGNITIVE COMPUTING	
Course Code: BAI-414 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction

This course introduces students to the principles and applications of cognitive computing, a multidisciplinary field that combines artificial intelligence, machine learning, and neuroscience to create intelligent systems. The course covers foundational concepts, algorithms, and applications of cognitive computing, preparing students to understand and contribute to the development of advanced intelligent systems.

Course Objectives

- Define cognitive computing and elucidate its core components.
- Investigate machine learning techniques applied in cognitive systems.
- Learn computer vision for cognitive systems, speech recognition, and audio processing,and learn how to integrate sensor data for enhanced cognitive capabilities.
- Analyze the application of cognitive computing in industries such as healthcare, finance,and smart cities, understanding its impact on analytics and decision-making.

Pre-requisites: Artificial intelligence and Machine learning,

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

CO1: Understand the concepts of Cognitive models and their architectures.

CO2: Apply and analyze various machine learning algorithms in cognitive computing.

CO3: Examine and integrate sensor data in Cognitive computing.

CO4: Demonstrate the cognitive computing concepts to practical scenarios.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

<table>
<tr><td colspan="2">UNIT- I</td><td>10 Hrs</td></tr>
<tr><td colspan="3">Introduction to Cognitive Computing: Definition and Evolution of Cognitive Computing KeyComponents: AI, Machine Learning, Natural Language Processing Historical Perspectives and Milestones in Cognitive Computing
Cognitive Models and Architectures: Overview of Cognitive Architectures Connectionist Models: Neural Networks and Deep Learning Symbolic Models: Rule-Based Systems and Expert Systems</td></tr>
<tr><td colspan="2">UNIT - II</td><td>10 Hrs</td></tr>
<tr><td colspan="3">Cognitive Computing Algorithms: Machine Learning for Cognitive Systems ReinforcementLearning in Cognitive Computing Evolutionary Algorithms and Swarm Intelligence
Natural Language Processing (NLP) in Cognitive Computing: Basics of Natural Language Processing NLP for Understanding and Generating Human-Like Text Sentiment Analysis andLanguage Models</td></tr>
<tr><td colspan="2">UNIT - III</td><td>10 Hrs</td></tr>
<tr><td colspan="3">Perception and Sensing: Computer Vision in Cognitive Computing Speech Recognition and Audio Processing Integrating Sensor Data for Cognitive Systems
Human-Computer Interaction (HCI) in Cognitive Computing: Principles of HCI Designing User Interfaces for Cognitive Systems Multimodal Interaction: Combining Voice, Gesture, and Touch</td></tr>
<tr><td colspan="2">UNIT - IV</td><td>10 Hrs</td></tr>
<tr><td colspan="3">Cognitive Applications in Industry: Healthcare and Cognitive Computing Finance and CognitiveAnalytics Smart Cities and Cognitive Technologies
Ethical and Social Implications of Cognitive Computing: Privacy Concerns in Cognitive SystemsBias and Fairness in Cognitive Algorithms Ethical Design and Responsible AI</td></tr>
<tr><td colspan="3">Text Books</td></tr>
<tr><td>1</td><td colspan="2">Michael Negnevitsky , “Cognitive Computing: A Practical Guide”, Pearson,2019/Latest Edition</td></tr>
<tr><td>2</td><td colspan="2">Vint Cerf and Peter Fingar, “Cognitive Computing: A Brief Guide for Game Changers”Meghan Kiffer Pr, 2015 / Latest Edition</td></tr>
<tr><td>3</td><td colspan="2">Shahram Ebadollahi, Kathleen McKeown and Ronnie Mitra, “Cognitive Computing and the Future of Health Care”, IBM Redbooks, 2016/Latest Edition.</td></tr>
<tr><td colspan="3">Reference Books</td></tr>
<tr><td>1</td><td colspan="2">Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson, 2022/Latest Edition</td></tr>
<tr><td>2</td><td colspan="2">Pradeep Kumar Mallick, Prasant Kumar Pattnaik, Amiya Ranjan Panda and Valentina Emilia Balas, “Cognitive Computing in Human Cognition”, Springer,2020/Latest Edition.</td></tr>
<tr><td>3</td><td colspan="2">NPTEL Course: Cognition and its computation
https://nptel.ac.in/courses/108105185</td></tr>
</table>

AI IN HEALTHCARE	
Course Code: BAI-416 Contact Hours: L-3 T-0 P-2 Course Category: DEC	Credits: 4 Semester: 8

Introduction

This course explores the intersection of artificial intelligence and healthcare, focusing on the applications, challenges, and ethical considerations of AI technologies in healthcare settings. Students will gain an understanding of AI techniques, data analysis, and their role in improving patient care, diagnostics, and healthcare management.

Course Objectives

- To understand artificial intelligence, its history, its various subfields and overview of thehealthcare industry, its challenges, and the potential for AI to address these challenges.
- To understand about the importance of healthcare data, including electronic health records(EHRs), medical imaging data, and patient-generated data.
- To understand how AI can be used to build clinical decision support systems that assisthealthcare professionals in making better treatment decisions.
- To understand emerging trends in AI and healthcare, and encourage students to explorepotential research opportunities in the field.

Pre-requisites: Basic knowledge of machine learning concepts.

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

CO1: Understand the fundamentals of artificial intelligence as applied to healthcare.

CO2: Evaluate the impact of AI on clinical decision-making, diagnostics, and patientoutcomes.

CO3: Analyze the ethical and privacy considerations in AI healthcare applications.

CO4: Develop the critical perspective on the current state and future trends of AI inhealthcare.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
Introduction to AI in Healthcare: Overview of AI and machine learning in healthcare, Historical perspective and milestones, Role of AI in modern healthcare. Capabilities and limitations of AI in healthcare. Time series and non-time series data, data sourcing, Data enrichment, Advantages and Challenges in observational data, Geographic and demographic variation in medical data.	
UNIT - II	10 Hrs
Clinical Decision Support System (CDSS): Introduction to CDSS and AI - powered diagnostics, case studies of AI - driven CDSS applications and Ethical consideration in CDSS. Classification, regression, clustering for healthcare applications. Bias and error in medical data, analyse of data from IOT body sensors, Automated diagnosis processes, treatment protocol development. Disease Detection using Tabular medical data	
UNIT - III	10 Hrs
Predictive modelling, Early detection, Cancer detection using tabular data, Risk estimation in medical insurance, Medical imaging, MRI, CT Scan, ECG, EEG etc., Handling hyper-dimensional medical images, Multimodal data analysis. Medical Imaging and AI:, Medical image Analysis using AI, Medical image segmentation and classification. Natural Language processing (NLP) for medical data analysis, Electronic health record (HER).	
UNIT - IV	10 Hrs
Ethical & Privacy consideration : Ethical guidelines for AI in healthcare, privacy issues, HIPAA compliance, patient data protection. Drug Development Analysis, Drug discovery, modelling drug-drug interactions, Pandenic spread predictive, infection pattern identification, computer vision system for physiotherapy, pose estimation, Gait Analysis.	

Text Books

1	Adam Bohr and Kaveh Memarzadeh, “Artificial Intelligence in Healthcare”, Academic Press, 2020/ Latest Edition.
2	Tianhua Chen, Jenny Carter, Mufti Mahmud and Arjab Singh Khuman, “Artificial Intelligence in Healthcare: Recent Applications and Developments”, Springer Nature, 2022/ Latest Edition.

Reference Books

1	Kerrie L. Holley and Siupo Becker M.D., “AI-First Healthcare”, O'Reilly Media, Inc., 2021/ Latest Edition.
2	Internet Sources: https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/transforming-healthcare.html
3.	Coursera Course: AI in Healthcare Specialization https://www.coursera.org/specializations/ai-healthcare

QUANTUM COMPUTING	
Course Code: BCS-410 Contact Hours: L-3 T-1 P-0 Course Category: DEC	Credits: 4 Semester: 8

Introduction

This course aims at introducing the fundamental theory and concepts of quantum computation and itsmethods, in particular algebra, complex vector and quantum mechanics.

Course Objectives

- Understand the basic principles, algorithms, and applications of quantum computing.
- Learn the basic areas of quantum computing including algebra of complex vector spaces,quantum information and cryptography and quantum mechanics.
- To understand the mathematical background for carrying out the optimization associatedwith quantum computation learning.
- To learn some familiarity with current research problems and research methods inquantum computing by working on a research or design project.

Pre-requisites: Discrete mathematics, Data structures and algorithms, programming languages

Course Outcomes: Upon successful completion of the 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 differentdomains.

CO4: Design and analyze quantum algorithms incorporating noise and error correction.

Pedagogy

The teaching-learning of the course would be organized through lectures, assignments, case studies/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 ofICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	10 Hrs
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	10 Hrs
Quantum Circuits: single qubit gates, multiple qubit gates, design of quantum circuits, classical gates, quantum gates. Quantum Information and Cryptography: Comparison between classical andquantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem. Asymmetric and symmetric encryption, quantum key distribution.	
UNIT - III	10 Hrs
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 Hrs
Noise and error correction: Graph states and codes, Quantum error correction, faulttolerant 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	Quantum Computing: An Applied Approach. Jack D. Hidary. Springer, 2019/ LatestEdition.
2	Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press, 2002/ Latest Edition.
3	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/ LatestEdition.
4	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, 2010/ Latest Edition.
2	An Introduction to Quantum Computing. Phillip Kaye, Raymond Laflamme, MicheleMosca. Oxford University Press Inc., New York, 2007/ Latest Edition.
3	Internet sources: https://scienceexchange.caltech.edu/topics/quantum-science-explained/quantum-computing-computers
4	NPTEL courses: Introduction to Quantum Computing: Quantum Algorithms and Qiskit,IBM and IITM : https://nptel.ac.in/courses/106106232