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 I

Code	Subject	L-T-P	Credits	Category
BAI-101	Intelligent Systems	3-0-0	3	DCC
BAI-103	Computer Organization and Architecture	3-0-2	4	DCC
BAI-110	Programming with Python	3-0-2	4	DCC
BAS-107	Applied Physics	3-0-2	4	ASH
BAS-109	Applied Mathematics	3-1-0	4	ASH
HMC-110	Communication Skills	3-1-0	4	HMC
		Total	23	

SEMESTER II

Code	Subject	L-T-P	Credits	Category
BAI-102	Object Oriented Programming using Java	3-0-2	4	DCC
BAI-104	Introduction to Data Science	3-0-2	4	DCC
BAI-106	Database Management Systems	3-0-2	4	DCC
BAI-108	IT Workshop	1-0-2	2	DCC
BAS-106	Environmental Science	2-1-2	4	ASH
BAS-108	Probability and Statistics	3-1-0	4	ASH
		Total	22	

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	Nano Structures & Materials in Engineering	3-1-0	4
BAS-204	Optical Engineering	3-0-2	4
BAS-206	Optimization Techniques	3-1-0	4
BEC-210	Elements of Information Theory	3-1-0	4
BMA-210	Operations Management	3-1-0	4
BAI-206	Introduction to Data Science (for other Dept.)	3-0-2	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-410	Recent Trends in AI	3-0-2	4	DCC
BIT-407	Big Data Analytics	3-0-2	4	DCC
BAI-401	Multimodal Data Processing	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	BIT-316	Computer Vision	3-0-2	4
	BAI-407	Pattern Recognition	3-0-2	4
	BIT-403	Software Testing	3-0-2	4
Departmental Elective -IV	BAI-409	Conversational AI	3-0-2	4
	BAI-411	Parallel and Distributed AI	3-0-2	4
	BIT-413	Software Project Management	3-1-0	4

SEMESTER VIII

Subject	Code	L-T-P	Credits	Cat.
Creativity, Innovation and Entrepreneurship	HMC-401	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	Augmented Reality and Virtual Reality	3-0-2	4
	BAI-404	Social Media Analytics	3-0-2	4
	BAI-406	AI for Games	3-0-2	4
	BAI-408	Multi-agent Systems	3-0-2	4
		…		
Departmental Elective-VI	BAI-410	Internet of Things	3-0-2	4
	BAI-412	Embedded Systems	3-0-2	4
	BAI-414	Bioinformatics and Computational Genomics	3-0-2	4
	BAI-416	AI in Healthcare	3-0-2	4
		…		

INTELLIGENT SYSTEMS	
Course Code: BAI-101 Contact Hours: L-3 P-0 C-0 Course Category: DCC	Credits: 3 Semester: 1

Introduction

The field of computer science has continuously evolved to build intelligent systems. The design and development of intelligent systems grounded in the field of artificial intelligence is becoming quite popular in Computer Science. The fundamental question 'Can intelligent systems mimic humans and surpass them in all kinds of work?' has kept computer scientists occupied for many decades in the past, and will continue to occupy them in future. This course is a gentle introduction to the field of intelligent systems.

Course Objectives

- Understand the basic building blocks of Intelligent Systems.
- Appreciate some of the approaches to build Intelligent Systems.
- Understand the importance of application of Intelligent Systems in different domains.

Pre-requisites: None

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

CO1: Identify & explain the different characteristics and structure to design intelligent systems.

CO2: Learn and relate the different data-driven approaches to build intelligent systems.

CO3: Demonstrate the applicability of Intelligent systems with different technologies.

CO4: Apply the technologies of Intelligent systems in real-time applications.

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 of ICT, web-based sources as well as flipped class room teaching will be adopted.

CONTENTS

UNIT- I	7 Hrs
Intelligence, Intelligent Systems, Characteristics of Intelligent Systems, Knowledge vs Intelligence, Knowledge Representation, Reasoning, Deductive vs. Inductive vs. Abductive Reasoning, Propositional Logic, Inference Foundations of AI, Intelligent Agents, Structure of Intelligent Agent. Environment of Intelligent Agent. Case Studies.	
UNIT - II	7 Hrs
Importance of Data, Dataset, Introduction to Data driven approaches, Introduction to Machine Learning, Training and Testing, Various approaches to intelligent system, Pattern recognition and classification,	
UNIT - III	7 Hrs
Domains of Intelligent Systems – Computer Vision, Natural Language Processing, Speech Processing, Mobile Robotics, Internet of Things (IoT), Intelligent IoT Applications, Drones, Intelligent Web Applications	
UNIT - IV	7 Hrs
Intelligent Applications – Agriculture, Healthcare, Education, Smart Cities, Autonomous Vehicle.	

Text Books	
1	Stuart J. Russel and Peter Norvig. Artificial Intelligence – A Modern Approach. 4th/Latest Edition, Pearson Education, 2020.
2	Deepak Khemani, A First course on Artificial Intelligence –McGraw Hill India, 2013
3	Peter Flach, The Art and Science of Machine Learning, Cambridge University Press, 2012.
Reference Books	
1	Josh Patterson, Adam Gibson. Deep Learning: A Practitioner's Approach. O'Reilly Media, 2017.
2	Gregory Dudek and Michael Jenkin. Computational Principles of Mobile Robotics. Cambridge University Press, 2012.

COMPUTER ORGANIZATION AND ARCHITECTURE	
Course Code: BAI-103 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 1

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

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

Pre-requisite: Fundamentals of computers and digital logic.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Define different number systems, binary addition and subtraction, 2's complement representation and operations with this representation.
CO2: Understand the theory and architecture of the central processing unit.
CO3: Analyse some of the design issues in terms of speed, technology, cost, performance.
CO4: Interpret and analyze the concepts of pipelining, memory management and interrupt handling.

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
Digital Logic Circuit: Basic Logic functions, Synthesis of logic functions using basic and universal gates, Boolean Algebra Properties, Flip-Flops, Registers, Shift- Registers, Counters, Decoders, Multiplexers, Functional Unit of computer system. Data Representation: Data types, R & (R-1)'s Complements, Fixed-Point representation, Floating point representation. Register Transfer and Micro operations: Register transfer language, register transfer, Bus and Memory transfer, Arithmetic Micro operations, Logic Micro operations, Shift Microoperations	
UNIT-II	**10 Hours**
Basic Computer Organisation and Design: Instruction Codes, Computer Instructions, Timing and Control, Instruction Cycle, Memory Reference Instructions, Input-Output and Interrupt. Micro programmed Control: Control Memory. Central Processing Unit: Stack Organization, Instruction Formats, Addressing Modes, Program Control, Reduced Instruction Set Computer: RISC characteristics, CISC characteristics. Performance and Metrics	
UNIT-III	**10 Hours**
Pipelining and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipelining, Instruction Pipelining, RISC Pipelining, Vector Processing, Array Processors. Computer Arithmetic: Addition and Subtraction, Multiplication Algorithms, Division Algorithms, Floating- Point Arithmetic Operations.	
UNIT-IV	**10 Hours**
Input-Output Organization: Peripheral Devices, Input-Output interface, Asynchronous data transfer, Modes of transfer, Priority Interrupt, Direct Memory Access. Memory organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware.	
Text Books	
1.	M. Morris Mano, Computer System Architecture, PHI, 3rd/Latest Edition
2.	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, 5th/Latest Edition, McGraw Hill.
3.	Martin S, Computer Organization, PHI publication, 2012
Reference Books	
1.	William Stallings, Computer Organization and Architecture, 6th/Latest Edition, Pearson/PHI.
2.	John L. Hennessy and David A. Patterson, Computer Architecture a quantitative approach, 4th Edition (Kindle)

PROGRAMMING WITH PYTHON	
Course Code: BAI-110 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 1

Introduction: Python is a versatile programming language, suitable for projects ranging from small scripts to large systems. It is widely used in many scientific areas for data exploration. This course will be useful for both text and data processing.

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Course Objective:

- To know the basics of algorithmic problem solving for reading and writing Python programs.
- To develop Python programs with conditions and loops.
- To use Python data structures –- lists, tuples dictionaries.
- To define Python functions and call them.
- To do input/output with files in Python

Prerequisite: Nil

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

CO1: Learn the basic syntax & structure of python programming language.
CO2: Implement the manipulation of string files, iterable objects using functions.
CO3: Interpret and apply exception handling for error free execution of python programs.
CO4: Write simple GUI interfaces for a program to interact with users, and to understand the event-based GUI handling principles in python.

Pedagogy
Lectures will be imparted along with hands-on lab sessions and the latest real-world case studies where python can be used.

CONTENTS

UNIT-1	10 hours
The Structuring Programming Principle, Program Structuring, Stepwise refinement, Introduction to Python programming language, The concept of data types, variables, assignments, immutable variables, numerical types, arithmetic operators, Data and Expressions, Literals, Variables and Identifiers, Understanding error messages, Conditions, Boolean Logic, Logical Operators, ranges, Control statements: if-else, loops (for, while);	
UNIT-2	**10 hours**
Strings and text files; manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab separated); String manipulations: subscript operator, indexing, slicing a string, Lists, Tuples, and Dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries; Function, Execution of A Function, Keyword and Default Arguments, Scope Rules.	
UNIT-3	**10 hours**
Exception, Testing and Debugging: Handling if exceptions to handle the code cracks, handling and helping file operations, coding with the exceptional handling and testing Anonymous method, Properties, Indexers, Exception Handling	
UNIT-4	**10 hours**
Python packages: Simple programs using the built-in functions of packages like matplotlib, numpy, pandas etc., Graphical user interfaces; Tkinter introduction, Tkinter and Python Programming, event-driven programming paradigm; creating simple GUI; buttons, labels, entry fields, dialogs; widget attributes - sizes, fonts, colors layouts, nested frames.	
Textbooks	
1. C. Dierbach, Introduction to Computer Science Using PYTHON: A Computational Problem-Solving Focus (1st Edition), Wiley, 2015.	
2. Let Us Python, Yashavant Kanetkar, BPB Publishers, 2019, 1st edition	
Reference Books	
1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist (2nd Edition), O'Reilly, 2016.	
2. Martin C. Brown, Python: The Complete Reference (4th Edition), McGraw-Hill, 2018.	

APPLIED PHYSICS	
Course Code: BAS-107 Contact Hours: L-2T-1 P-2 Course Category: BAS	Credits: 4 Semester: 1

Introduction: Physics is a subject that is continuously evolving with latest research. The scientific principles of physics are basis of various devices, applications and technological breakthrough. This Applied Physics course has been designed to cover the wide ranging topics of the physics that have direct impact on technological advancements. In this course you will learn various concepts of modern and device-oriented physics that will enhance your ability to apply fundamentals to various applications.

Course Objectives:
To introduce the students with the wide-ranging topics of the modern physics such as electromagnetic theory, quantum mechanics, optics, and its applications in the form of lasers and optical fiber communication. These topics form the underlying principles of various technologies.

- To impart an in-depth knowledge of everyday systems and phenomena surrounding them and explain the underlying physics.
- To enhance the ability of students to apply physics fundamentals to various modern applications for societal benefits.
- To develop a quantitative aptitude for solving engineering problems.
- To perform and interpret experiments using modern tools, techniques and write effective lab reports to various engineering problems, with an understanding of the limitations

Pre-requisites: None

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

CO1: Gain knowledge of different concepts in Optics and optical devices.

CO2 : Understand the laws of Electromagnetic(EM) theoryand solve engineering problems, based on propagation of EM waves in different media.

CO3 : Explain the basic principles and laws of Quantum Mechanics and examine the quantum mechanical behavior of a particle in a 1-D box.

CO4: Describe the principles of LASER and optical fibers and study their modern-day applications.

Pedagogy: Classroom teaching which focuses upon relating the textbook concepts with real world phenomena, supplemented with periodic tutorial classes to enhance the problem-solving ability. The students would perform experiments to develop a deeper insight into the underlying principles of Physics.

CONTENTS

UNIT-1	8 Hours

OPTICS

Coherent Sources, Temporal and Spatial Coherence, Interference due to Division of wave-front and Division of Amplitude, Interference in Parallel Thin Films, Fresnel Diffraction at Straight Edge, Fraunhofer Diffraction due to Single Slit, N Slits, Diffraction Grating (absent spectra, maxima, resolving and dispersive power of grating (Formula only without derivation)

Polarization, Malus Law, Brewster Law, Double Refraction, Nicol Prism, Production of Plane, Elliptically and Circularly Polarized Light.

UNIT-2	8 Hours

ELECTRO MAGNETIC THEORY

Introduction to gradient divergence, curl, Gauss divergence theorem and Stoke's theorem (without proof). Electromagnetic Waves, Electromagnetic spectrum, Equation of Continuity, Maxwell's Equations, Poynting Theorem (No Derivation), Propagation of Electromagnetic Waves in Free Space, Dielectric and Conducting Medium (Qualitative), Skin Depth.

UNIT-3	7 Hours

QUANTUM MECHANICS

Origin of Quantum Mechanics, De Broglie Hypothesis, Heisenberg Uncertainty Principle, Postulates of Quantum Mechanics, Wave Function and Properties, Group and Phase velocity, Time Independent Schrodinger Wave Equation, Particle in 1-D Box.

UNIT-4	5 Hours

LASER AND OPTICAL FIBER COMMUNICATION

Stimulated and Spontaneous Emission, Principle of LASER, Einstein's A and B Coefficients, Components of LASER, He-Ne LASER.

Optical Fibers, Step Index and Graded Index Fibers, Numerical Aperture, Acceptance angle, Pulse Dispersion in Optical Fibers, Schematic of optical fiber communication.

Textbooks

1	H. K. Malik and A. K. Singh, "Engineering Physics", 2nd Edition, Mc Graw Hill Ed, 2017.
2	M. C. Jain, "Textbook of Engineering Physics", 1st Edition, Vol. I and II, Phi Learning Pvt Limited, 2009.
3	G. Aruldhas, "Engineering Physics", Phi Learning Pvt Limited 2010.
4	Abhijit Nayak, "Engineering Physics", S K Kataria and sons, 2011
5	M N Avadhanulu, P G Kshirsagar and TVS Arun Murthy, "A Textbook of Engineering Physics", S Chand Publishing, 11th Edition, 2018.

Reference Books	
1	Wilson and J.F.B Hawkes, "Optoelectronics", 3rd Edition, Prentice Hall Europe, 1998.
2	F. K. Richtmyer, E. H. Kennard, and J. N. Cooper, "Introduction to Modern Physics" 6th Edition, Tata Mc Graw Hill, 1997.
	D.J. Griffith, "Introduction to Electrodynamics ",4thEdition, Pearson Education India Learning Private Limited, 2015.
3	Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury, "Concepts of Modern Physics", 7th Edition, Mc Graw Hill,2015 Eugene Hecht and A.R. Ganesan, "Optics",5th Edition, Pearson Education, 2019.
4	William H. Hayt and J. A Buck, 6th Edition, "Engineering Electromagnetism", 2001.
5	Ajoy K. Ghatak, "Optics", 7th Edition, McGraw Hill Education India Private Limited, 2020.
6	David J Griffiths and Darrell F. Schroeter, "Introduction to Quantum Mechanics", 3rd Edition, Cambridge University Press India Pvt Ltd, 2019.

APPLIED MATHEMATICS	
Course Code: BAS-109 Contact Hours: L-3 T-1 P-0 Course Category: BAS	Credits: 4 Semester: 1

Introduction: Mathematics is used in almost every field of engineering be it computer science and information technology wherein it may be used in modeling, machine learning, image processing etc., or by electrical engineers for signal processing, control engineering or by mechanical engineers for design, modeling, manufacturing etc. But the problem faced by engineers is to how to apply the basic mathematical concepts in engineering problem which they would be dealing in coming years. The course covers the various topics of engineering mathematics such as matrices, sequences and series, calculus of functions of more than one variable and vector calculus.

Course Objective:

- The students will be made familiar with the concepts of matrices, sequences and series.
- To provide students with skills and knowledge of calculus of functions of several variables and vector calculus which would enable them to devise solutions for given situations they may encounter in day to day engineering problems.

Prerequisite: Fundamentals of matrices, calculus of functions of single variable, vectors.

Course Outcomes (CO)

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

CO1: Determine rank, inverse, eigen values and eigen vectors of a matrix and apply them in engineering problems.

CO2: Find the basis and dimension of vector spaces and apply the concept of vector spaces using linear transform. Also, understand the concept of Laplace Transforms and solve initial and boundary value problems using Laplace transforms.

CO3: Evaluate partial derivatives and find the maxima/minima for functions of two or more variables to solve applied problems in engineering.

CO4: Understand gradient, directional derivatives, divergence and curl. Use Greens', Stokes, Gauss theorems to evaluate multiple integrals.

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

CONTENTS

UNIT-I	08 Hours
Inverse of a matrix by elementary transformations, Rank of a matrix (Echelon & Normal form), Linear dependence, Consistency of linear system of equations and their solution, Characteristic equation, Eigen values and eigen vectors, Cayley-Hamilton Theorem (without proof)..	
UNIT-II	**12 Hours**
A brief Introduction to Vector Spaces, Subspaces, Rank and Nullity, Linear Transformations Laplace Transforms: Defn, Laplace transforms of some standard functions, inverse Laplace transforms, Convolution theorem. Fourier Series: Fourier Series, Fourier Series of even and odd functions, Fourier Series of functions having arbitrary periods, half range expansion. Fourier Transforms: Fourier transform, Sine and Cosine transforms	
UNIT-III	**12 Hours**
Differential Calculus: Functions of several variables: Limits, continuity and differentiability, Successive differentiation, Leibnitz theorem, Partial differentiation, Euler's Theorem for homogenous equations. Composite functions, Change of variables, Taylor's and Maclaurin's Series, maxima and minima, Lagrange's method of undetermined multiplier.	
UNIT-IV	**10 Hours**
Vector Calculus : Vector point functions, Gradient, Divergence and Curl and their physical interpretation, Line integrals, Multiple Integrals, Change of order of integration, Surface and Volume integrals, Green's, Gauss Divergence and Stoke's theorems (without proof).	

1.	D. G. Zill and W. S. Wright, "Advanced Engineering Mathematics", 6th Edition, The Jones and Bartlett Learning Publishers, 2016.
2.	Jain R. K. and Iyengar S. R. K., "Advanced Engineering Mathematics", 5th Edition, Narosa Publishing House Pvt. Ltd.2016.
3.	Grewal, B. S. , "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2017.
4.	Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press
Reference Books	
1.	George B. Thomas Jr., Ross L. Finney, "Calculus and Analytic Geometry", 9th Edition, Pearson Education India, 2010

2.	Greenberg M., "Advanced Engineering Mathematics", 2nd Edition, Pearson Education, 1998.
3.	KreyszigE. , "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, 2010.

COMMUNICATION SKILLS	
Course Code: HMC-110 Contact Hours: L-3 T-1 P-0	Credits: 4 Semester: Odd

Introduction: This course facilitates communication skills development by exposing the students to various nuances of effective communication. The course provides an in-depth understanding of several key concepts of Communication like importance and functions of communication, barriers to communication, active listening, group discussions, presentation skills etc. The course also provides valid inputs on the *ethical* dimension of communication to enable the students to be ethical communicators.

The highlight of the course is special emphasis on Employment Communication i.e. job application and resume writing along with preparing and appearing for Interviews and Group Discussions. The students will also be acquainted with various forms of business correspondence used in organizations on a regular basis like agenda and minutes of meetings, business letters, reports etc.

Course Objectives:

- To enable students to evaluate their personal communications styles and improve upon it.
- To help the students understand the contemporary trends in communication.
- To facilitate the students in becoming aware of different communication theories and their application.
- To encourage students to develop/create their own unique style of communication.

Pre-requisites: None

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

CO1: Evaluate and analyze their personal communication style while adapting their communication to better expression of their ideas at workplace.

CO2: Enhance their knowledge of contemporary trends for effective Communication.

CO3: Effective comprehension and application of different Communication theories.

CO4: Synthesis their own unique communication style.

Pedagogy: Apart from interactive class teaching, various individual and group assignments are given. Group discussions, JAMs, role plays and presentations are conducted in class to enable students to practically apply the theories learnt during the course.

CONTENTS

UNIT-I	10 Hours
Introducing Communication: Importance and function of Communication, Communication Cycle, Characteristics and Types of Communication, Channels and Medium of Communication, 7 C's of Communication, Barriers to Communication. Ethics of Communication (plagiarism, language sensitivity towards gender, caste, race, disability etc.	
UNIT-II	**11 Hours**
Everyday Communication: Non-Verbal Language (Symbols, Appearance, Paralanguage and Body Language, Proxemics, Chronemics), Listening Skills (Importance, Barriers, Essentials of Good Listening), Communication Skills (greetings, introducing, making requests, asking and giving permission, offering help and giving instructions and directions etc.), Understanding Telephone Skills (handling calls, leaving a message, asking and giving information and instructions etc.), Net Etiquettes.	
UNIT-III	**11 Hours**
Presentations & Employment Communication: Classroom Presentations (purpose, types, preparing and presenting – use of visual aids/ power point presentations), Group Discussion (purpose, strategies, guidelines etc.), Job Application (Resume and Cover Letter), Interview Skills (purpose, types of interviews, guidelines and preparing for facing the interviews). Presentation, Group discussion and Mock interview practice should be undertaken in class.	
UNIT-IV	**10 Hours**
Writing on the Job: Formal and Informal Writing, Basics of Paragraph Writing**,** Email Writing, Letters at the workplace, Meeting documentations (Agenda and Minutes of meeting etc.), Report Writing (characteristics, types, structure of formal report).	
Text Books	
1.	M. Raman and S. Sharma. Technical Communication: Principles and Practice, 3rd Edition, Oxford University Press, 2011.
2.	M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill Publications, 2005.
Reference Books	
1.	Lewis and Hedwig, Body Language: A Guide for Professionals, New Delhi, Response Books, 2000
2.	Sides and H. Charles, How to Write & Present Technical Information, Cambridge, CUP, 1999.
3.	S. Kumar and P. Lata. Language and Communication Skills for Engineers, Oxford University Press, 2018.
4.	Hasson, Gill. Brilliant Communication Skills. Pearson Education, 2012.

OBJECT ORIENTED PROGRAMMING USING JAVA	
Course Code: BAI-102 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 2

Introduction:

Java Programming is one of the most widely used programming language among developers and are preferred over other languages. This course introduces students to object-oriented concepts and its implementation in Java Language. The objective is to provide students with the use of the Java programming language for writing complex and stand-alone applications at the Intermediate level.

Course Objectives:

- To understand object oriented programming concepts, and apply them in solving problems.
- To introduce the principles of inheritance and polymorphism; and demonstrate how they relate to the design of abstract classes
- To introduce the implementation of packages and interfaces
- To introduce the concepts of exception handling and multithreading.
- To introduce the design of Graphical User Interface using applets and swing controls.

Prerequisite: Any programming knowledge

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

CO1: Understand the basic principles of object-oriented programming and to solve real world problems using OOP techniques with Java.
CO2: Able to learn the java programming principles in the development of small to medium-sized application programs.
CO3: Interpret and apply exception handling for error free execution of JAVA programs.
CO4: Demonstrate an introductory understanding of graphical user interfaces, multithreaded programming, and event-driven programming.

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
An Overview of Java, Data types, Variables and Arrays, operators, expressions, control statements. Object-oriented thinking- A way of viewing world – Agents and Communities, messages and methods, Responsibilities, Classes and Instances, Class Hierarchies- Inheritance, Method binding, Overriding and Exceptions, Summary of Object-Oriented concepts. Java buzzwords, Introducing classes, Methods and Classes, String handling.	
UNIT II	**10 Hours**
Inheritance– Inheritance concept, Inheritance basics, Member access, Constructors, Creating Multilevel hierarchy, super uses, using final with inheritance, Polymorphism-ad hoc polymorphism, pure polymorphism, method overriding, abstract classes, Object class, forms of inheritance- specialization, specification, construction, extension, limitation, combination, benefits of inheritance, costs of inheritance. Packages- Defining a Package, CLASSPATH, Access protection, importing packages.	
UNIT III	**10 Hours**
Interfaces- defining an interface, implementing interfaces, Nested interfaces, applying interfaces, variables in interfaces and extending interfaces. Stream based I/O(java.io) – The Stream classes-Byte streams and Character streams, Reading console Input and Writing Console Output, File class, Reading and writing Files, Random access file operations, The Console class, Serialization, Enumerations, auto boxing, generics. Exception handling – Fundamentals of exception handling, Exception types, Termination or resumptive models, Uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws and finally, built- in exceptions, creating own exception sub classes.	
UNIT IV	**10 Hours**
Multithreading- Differences between thread-based multitasking and process-based multitasking, Java thread model, creating threads, thread priorities, synchronizing threads, inter thread communication. Event and GUI programming : Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing.	
Text Books	

1	Java The complete reference, Herbert Schildt, McGraw Hill Education (India) Pvt. Ltd., 11th/Latest Edition, 2020
2	Understanding Object-Oriented Programming with Java, T. Budd, Pearson Education, Latest Edition
3	Core Java Volume-I Fundamentals, Eight Edition, Horstmann & Cornell, Pearson Education, 2020
Reference Books	
1	Introduction to Java Programming (Comprehensive Version), Daniel Liang, 10th/Latest Edition, Pearson, 2018
2	Programming in Java, Sachin Malhotra & Saurabh Chaudhary, Oxford University Press, 1st/Latest Edition, 2018

INTRODUCTION TO DATA SCIENCE	
Course Code: BAI-104 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 2

Introduction:
This course serves as an introduction to the basics of Data Science including programming for Data Analytics, File Management and Data Visualization. The course aims to understand the underlying core concepts and emerging technologies in data science. The foundation is laid for big data applications ranging from social networks to medical and business informatics.

Course Objectives:
- To learn the Data Science concepts and its various Applications
- To understand the Data Science processes including Data Wrangling, Data Exploration and Data Visualization
- To explore various Packages and Libraries in Python for Mathematical Computing

Prerequisite: Python Programming

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

CO1: Understand the basic principles and ethics of data science to process the data.
CO2: Explore different data preprocessing and manipulating techniques.
CO3: Use the visualization techniques to translate analytical data into visual results.
CO4: Analyze data using Tableau for designing various visual features like Carts, Graphs, Plots and others.

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
Data Science Overview, Evolution of Data Science, Data Science Roles, Tools for Data Science, Applications of Data Science Data Science Process Overview, Defining Goals, Retrieving Data, Data Preparation, Data Exploration, Data Modeling, Presentation Data Science Ethics, Doing good Data Science, Owners of the Data, Valuing different aspects of Privacy, Getting Informed Consent, The Five Cs of Data Science, Diversity, Inclusion, Future Trends in Data Science.	
UNIT-II	**12 Hours**
Mathematical Computing with Python (NumPy):Working with NumPy Arrays, Data Types, Array Creation, Indexing and Slicing, Numerical Operations on Arrays, Array Functions, Data Processing using Arrays**,** Loading and Saving Data, Saving an Array, Loading an Array, Numpy Random Numbers Data Manipulation with Pandas: Data Wrangling, Data Exploration, Cleaning Data, Filtering, Merging Data, Reshaping Data, Data Aggregation**,** Reading and Writing Files, Loading and Saving Data with Pandas	
UNIT-III	**10 Hours**
Data Visualization in Python, Understanding Data Visualization, Creating different Visualization like Bar Charts, Line Plot, Area Plots, Histograms, Pie Charts, Box Plots, Scatter Plots, Time Series plots, Figures and Subplots, Plotting Functions with Pandas .	
UNIT-IV	**10 Hours**
Data Visualization using non programming tools like Tableau. Work with Filter, Parameters, Sets. Arithmetic and logical table. Data visualization techniques such as heat map, tree map, Pareto. Interactive dashboards, story interfaces, and how to share your work.	

Texts Books:	
1.	Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Introducing Data Science, Manning Publications Company, 1st/Latest Edition (2016).
2.	Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly Media, 2017
3.	Joshua N. Milligan, Learning Tableau 2020: Create effective data visualizations, build interactive visual analytics and transform your organization, Packt Publishing Limited, 4th/Latest Edition (2020).
Reference Books	
1.	Prateek Gupta, Data Science with Jupyter, BPB Publication, 1st/Latest Edition (2017)
2.	Joel Grus, Data Science from Scratch, O'Reilly, 2nd/Latest Edition (2019)
3.	Cathy O'Neil, Rachel Schutt, Doing Data Science, Straight Talk from the Frontline, O' Reilly, 1st/Latest Edition (2013)

DATABASE MANAGEMENT SYSTEMS	
Course Code: BAI-106 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 2

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

Course Objectives:
- To introduce the concepts of Database Management Systems
- To design the relational databases by applying normalization techniques to normalize the database
- Strong practice in SQL programming through a variety of database problems.
- Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access and recovery from failures.
- To write PL/SQL programs using Cursors, Exception, Procedures, Functions and Triggers

Pre-requisites:
Concepts of basic Mathematics and Programming

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

CO1: Comprehend major DBMS components, their functions and to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.
CO2: Construct and interpret SQL commands to create tables and indexes, insert/update/delete data, and query data in a relational DBMS.
CO3: Describe the concept of normalization, Transaction, concurrency, Recovery and Query processing.
CO4: Implement DBMS concepts through procedures, functions and triggers.

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
Overview of Concepts and Conceptual Database Design, Characteristics of the Database, DBMS Architecture, File System vs Database System, Database Administrator and Database Users, Data Models, Schemes and Instances, Data Independence, Database Languages and Interfaces, Data Models	
UNIT-II	**11 Hours**
Entity-Relationship Model, Strong and Weak Entity Sets, Generalization, Specialization, and Aggregation, Relational Model, Languages and Systems: Relational Model Concepts, Relational Model Constraints, Translating your ER Model into Relational Model, Relational Algebra. SQL: A Relational Database Language, Data Definition/Manipulation/Control in SQL, Specifying Constraints and Indexes in SQL, View and Queries in SQL, Practicing SQL commands	
UNIT-III	**11 Hours**
Relational Database Design: Functional Dependencies & Normalization for Relational Databases, Functional Dependencies, Normal Forms (1NF, 2NF, 3NF, BCNF, 4NF, 5NF), Lossless Join and Dependency Preserving Decomposition, Multivalued Dependency, Join Dependency. Transaction Management: Transaction Concept and State, ACID Properties, Concurrency Control: Lock-Based Protocols, Timestamp-based Protocols, Recovery from Transaction Failures, Log based Recovery, Checkpoints, Deadlock Handling	
UNIT-IV	**10 Hours**
Query Processing: Query Processing Overview, Measures of Query Cost. Introduction to Object Oriented and Object Relational Data Models Database Programming: Exceptions, Cursors, Procedures, Functions, Triggers	

Text Books	
1	Elmasri Ramez and Navathe Shamkant, Fundamentals of Database System, Pearson, 6th/Latest Edition (2017).
2	Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw Hill, 6th/Latest Edition (2013)
3	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill, 3rd/Latest Edition (2003)
Reference Books	
1	Ceri and Pelagatti, Distributed Databases: Principles & Systems, McGraw-Hill, (2017)
2	Conolly & Begg, Database Management Systems, Pearson Education Asia, 5th/Latest Edition (2010)

IT WORKSHOP	
Course Code: BAI-108 Contact Hours: L-1 T-0 P-2 Course Category: DCC	Credits: 2 Semester: 2

Introduction: IT Workshop is a practical course where students will learn programming with R. R is capable of handling mathematical and statistical manipulations. It has its own programming language as well as built-in functions to perform any specialized task.

Course Objectives:

- To introduce students to the statistical package R for data analysis.
- To use R to perform descriptive statistics including graphics, perform basic inferential statistical analyses including regression analysis, read and write data files,
- To perform basic data manipulations (eg, creating new variables, merging data sets), write and use R script files, use R packages, write and use R functions, and perform basic programming in R.

Pre-Requisites: Fundamentals of Mathematics background.

Course Outcomes: Upon successful completion of the course, students will be able to:
CO1: Learn the fundamentals and usage of R software.
CO2: Understand the basic syntax and structure of R language.
CO3: Explore different data preprocessing and analytical techniques.
CO4: Use the visualization techniques to translate the analytical data into visual results.

Pedagogy: The teaching-learning of the course would be organized mainly through lectures, and practical sessions in lab. 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
An overview of R language: Basic fundamentals, installation and use of software, data editing, use of R as a calculator, functions and assignments. Getting R and Running R, R Packages Expressions, Objects, Symbols, Functions Special Values	
UNIT II	**11 Hours**
Constants, Numeric vectors, Character Vectors, Operators. R Syntax, Data Structure in R (Matrices, Arrays, Factors, Data frames), Attributes, Symbols and Environment, Functions, Loading, Saving, and Editing Data in R, Combining Datasets, Transformations, Binning Data	
UNIT III	**10 Hours**
Subsets, Summarizing Functions, Data Cleaning. Analyzing Data, Probability Distribution, Continuous Data , Discrete Data, T-test Design, Anova Test Design, Introduction to Regression, Linear model, Smoothening	
UNIT IV	**10 Hours**
Graphics and Plots: Scatter Plots, Bar Charts, Pie Charts, Three-dimensional Data, Plotting Distribution, Customizing Charts, Basic Graphic Functions, Common Arguments for Chart Functions.	

Text Books:

1	Long, James D., and Paul Teetor. R Cookbook: Proven Recipes for Data Analysis, Statistics, and Graphics. O' Reilly Media, 2019.
2	Christian Heumann, Michael Schomaker and Shalabh, Introduction to Statistics and Data Analysis - With Exercises, Solutions and Applications in R, Springer, 2016
3	Pierre Lafaye de Micheaux, Rémy Drouilhet, Benoit Liquet, The R Software-Fundamentals of Programming and Statistical Analysis, Springer 2013

Reference Books:

1	Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters, A Beginner's Guide to R (Use R), Springer 2009
2	Hadley Wickham, ggplot2 Elegant Graphics for Data Analysis, Springer 2016
3	Internet Sources: www.nptel.ac.in

ENVIRONMENTAL SCIENCES	
Course Code: BAS-106 Contact Hours: L-2 T-1 P-2 Course Category: BAS	Credits: 4 Semester: 2

Introduction: A scientific study of the natural world and how it is influenced by people. It Surveys environmental studies, examining ecological, socioeconomic, and technological factors that influence the quality of life on Earth.

Course Objectives:

- Environmental science prepares students for career success in environmental monitoring and remediation, natural resources and conservation, public health, industrial environmental management.
- The curriculum is so designed that the students get an in-depth knowledge of the environment and various issues arising due to mismanagement of resources.

Pre-requisites: None

Course Outcomes: Having successfully completed this course,

CO1: Students will be able understand about the availability and sustainable use of natural resources and concept of ecosystems and biodiversity.

CO2: Students will understand and evaluate the transnational character of environmental problems, their sources, sinks and control strategies along with their short-term and long term impacts to humans. Students will also learn to apply green methodologies to find solutions to address various environmental issues.

CO3: Students will understand the concept of fuel technology and implement their interpretative skills to evaluate the usage and application of alternate energy sources for sustainability.

CO4: Young graduates would understand the interconnected and interdisciplinary branches like Toxicology, synthesis and applications of Eco friendly polymers and demonstrate an integrative approach to environmental issues with a focus on sustainability.

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

CONTENTS

UNIT-I	6 Hours
Natural Resources, Conservation and Management: Forest resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and overutilization of surface and ground water, floods, drought, conflicts over water. Mineral resources: Environmental effects of extracting and using mineral resources. Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Energy resources: Growing energy needs renewable and non-renewable energy sources. Resource Management-Concept of Sustainable development, Environmental Management Systems, Environmental Impact Assessment, Biodiversity- conservation and threats.	
UNIT-II	**8 Hours**
Environmental Pollution and Control: Air Pollution: Types of air pollutants; Source, effects, sink & control of common air pollutants (CO, oxides of nitrogen & sulphur, hydrocarbons and particulates), Photochemical smog, acid rain, greenhouse effect, global warming, Carbon dioxide sequestration and the concept of Carbon Credits Water Pollution: Classification of pollutants and their sources, Waste water treatment (Primary, secondary and tertiary treatment), Impact of water pollution on hydrological ecosystems. Solid and Hazardous Waste Pollution: Classification, waste treatment and disposal methods: Sanitary landfill, thermal processes, chemical and biological processes, disposal methods for nuclear waste, nuclear disaster (case study), disposal methods for e-waste. Green Technology And Green Chemistry: Introduction to concept of Green Technology and Zero Waste Technology, Green Chemistry & its basic principles, Atom Economy, evaluation of feedstock, reaction types, methods, reagents and solvents.	
UNIT-III	**8 Hours**
Fuels and Alternate Energy Sources: Classification, Calorific value of fuels (gross and net), Dulong's formula, Determination of calorific value of fuels using bomb's calorimeter, Determination of calorific value of fuels using Boy's Gas Calorimeter (Numericals). Liquid fuels-petroleum chemical composition, fractional distillation, Cracking – Thermal & catalytic cracking, Octane &Cetane numbers with their significance. Analysis of flue gases (Orsat's Apparatus)-(Numericals), Combustion of fuels. Use of alternate energy sources including solar energy harnessing (photovoltaics), wind energy, hydroenergy, geothermal energy, ocean energy, biodiesel, power alcohol, biomass energy.	
UNIT IV	**6 Hours**
Chemical Toxicology and Eco-Friendly Polymers : Toxicology: terminology & toxic effects, chemical interactions, impact of toxic chemicals on enzymes, Biochemical effects of arsenic, mercury, lead, chromium, & cadmium. PolymersIntroduction: Functionality of monomer, polymerization, degree of polymerization, Number average and weight average molecular weight of polymers. Environmental degradation of polymers: Biodegradable, Photo-biodegradable polymers, Hydrolysis &	
Hydro-biodegradable polymers Biopolymers & Bioplastics.	

Text Books	
1	RanuGadi, Sunita Rattan, SushmitaMohapatra. A Text book of Environmental Studies (with experiments), 4th Ed., S.K. Kataria& Sons, 2014.
2	S. Rattan, "Applied Chemistry", S.K.Kataria& Sons, 2013.
3	S.S.Dara, D.D.Mishra. A Textbook of Environmental Chemistry and Pollution Control (With Energy, Ecology, Ethics and Society) S. Chand and Company Pvt. Ltd. (India), 2011.
Reference Books	
1	Richard T. Wright, Environmental Science, 9thEdition, Pearson Education, 2007.
2	Gerard Kiely, Environmental Engineering, special Indian edition The McGraw-Hill Companies, 2007.
3	E. Barucha, Textbook of Environmental Studies for Undergraduate Courses, Universities Press (India) Pvt. Ltd., 2005.
4	C.N. Sawyer, P.L. McCarty, and G.F. Parkin, "Chemistry for Environmental Engg. and Science", 5th Ed., The McGraw-Hill Companies, 2003.
5	R. Rajagopalan, Environmental studies from crisis to cure, 3rd edition, Oxford University Press., 2016.

PROBABILITY AND STATISTICS	
Course Code: BAS 108 Contact Hours: L-3 T-1 P-0 Course Category: BAS	Credits: 4 Semester: 2

Students will learn fundamental rules of Probability, discrete and continuous distributions, and statistical methods most commonly used in Computer Science and & Engineering.

Course Objectives:

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays animportant role in real life problems.

Course Outcomes: On completion of the course, the student should be able to:

CO1. Recall the basics of probability and apply it to determine total and conditional probabilities.

CO2. Understand the concepts of Random variable, different discrete and continuous probability distributions and use it to solve the statistical situations.

CO3. Evaluate the correlation between two variables and analyze statistical data using MS-Excel.

CO4. Determine probabilities of making errors in hypothesis testing and draw conclusions using critical values.

Prerequisite: NIL

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

CONTENTS

UNIT – I: PROBABILITY AND RANDOM VARIABLES	14 Hours
Concept of probability, additive and multiplicative law of probability, total and conditional probabilities, Baye's theorem. Measures of central tendency, dispersion, kurtosis, moments. Random Variables, density and distribution functions, mathematical expectation, variance, standard deviation and moment generating function.	
UNIT – II: TWO – DIMENSIONAL RANDOM VARIABLES	**8 Hours**
Jointly distributed random variables, Marginal and conditional distributions, Expected values, Covariance and Correlation. Central limit theorem (for independent and identically distributed random variables).	
UNIT – III: PROBABILITY DISTRIBUTIONS AND REGRESSION	**10 Hours**
Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions. Linear Correlation, Correlation Coefficient, Rank Correlation Coefficient, Regression.	
UNIT –IV: APPLIED STATISTICS	**10 Hours**
Formation of Hypothesis, Test of significance: Large sample test for single proportion, Difference of proportions, Single mean, Difference of means, and standard deviations. Test of significance for small samples: t- Test for single mean and difference of means, t-test for correlation coefficients, F- test for ratio of variances, Chi-square test for goodness of fit and independence of attributes.	
Case Study / Implementation of above concepts using Excel.	

Text Books

1.	Montgomery, Douglas C., and George C. Runger. "Applied Statistics and Probability for Engineers", Seventh Edition. John Wiley & Sons, 2018.
2.	Sheldon Ross M., Introduction to Probability and Statistics for Engineers and Scientists, Academic Press, 6thEdtion, 2020.
3.	Rukmangadachari E., and Keshava, Reddy E. Probability and Statistics, Pearson Education India, 2015.
4.	Ravichandran J., Probability and Statistics for Engineers. Wiley India, 2010.

Reference Books

1.	Devore, Jay L. "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage, 2010.
2.	Scheaffer, Richard, Madhuri Mulekar, and James McClave. Probability and Statistics for Engineers. Nelson Education, 2010.
3.	Meyer, Paul L. Introductory Probability and Statistical Applications. 2nd Edition, Oxford and IBH publishing, 1965.
4.	Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, S Chand Publications, 11th Edition, 2002

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, knowledge representation 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 different tools.

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. Turing Test. Uninformed Search Strategies, Informed Search Strategies, Heuristics. Solving problems by searching, BFS, DFS, Issues in design of Intelligent Search Algorithms.	
UNIT-II	**10 Hours**
Knowledge Representation: Knowledge Representation using predicate logic, Rule Based Systems, Ontology, WordNet and Concept Net as Knowledge representation tools Programming with Prolog/Lisp. Text Feature Extraction - BoW Model, TF-IDF. Word Embeddings - 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 & Big Data Analytics Applications. Ethics in AI.	

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

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

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

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

Course Objectives:

- To introduce and understand the fundamental notions in discrete mathematics
- To understand basic concept of an algorithm and its application in combinatorial mathematics
- To introduce the basic properties of graphs and trees and model simple applications
- 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 logical connectives and its validation

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

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

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

Pedagogy: The teaching-learning of the course would be organized through lectures, 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 of necessity 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 of mathematical induction. Functions, mappings, injection and surjections, composition of functions, inverse functions, special functions; Peono postulates, pigeonhole principle; recursive function theory. **Size of a set:**Finite and infinite sets, countable and uncountable sets, Cantor's diagonal argument and the power set theorem, Schröder-Bernstein theorem.	
UNIT III	**12 Hrs**
Algebraic structures and Morphisms: Algebraic structures with one binary operation - semigroups, monoids and groups, subgroups and their properties, congruence relation and quotient structures. Free and cyclic monoids and groups, permutation groups, substructures, normal subgroups. Algebraic structures with two binary operations - rings, integral domains and fields. Boolean algebra and Boolean ring.	
UNIT IV	**10 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 Combinatorial Mathematics, 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 Mathematical Structures, 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 to Computer 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 will combine 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 Project Delivery.

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 Software Requirement Document
CO3: Apply appropriate software architectures and patterns to carry out high level design of a system and be able to critically compare alternative choices, evaluate the quality and maintenance of the software through software testing.
CO4: 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-based sources 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 and Techniques, Functional testing, Structural testing, Debugging and testing tools, SW/HW reliability, Reliability concepts and models, Reliability allocation, Software Maintenance: Introduction to SW Maintenance and types, SW Maintenance models: Re-engineering & Forward Engineering.	
UNIT-IV	**10 Hours**
Software Project Planning: Role of Software Project Planning, Estimation method, Estimation of Effort & Schedule, Software Metrics: Introduction to Size metrics, Data structure metrics, information flow metrics, entropy-based measures, metric analysis. Basic COCOMO, Intermediate COCOMO, Detailed COCOMO, Quality Planning, Planning Parameter, Quality Defect Removal Cycle, Role of Risk Analysis.	
Text Books	
1	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, McGraw Hill, 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 and classificationof 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 various applications.
- 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 in Device applications.

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

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

Pedagogy: 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

<table>
<tr><td>UNIT-I</td><td>4 Hours</td></tr>
<tr><td colspan="2">Introduction to materials: Importance of Material science and Engineering, Classification of Materials: Metallic, Ceramic, Polymeric, Electronic and Composite Materials.</td></tr>
<tr><td>UNIT-II</td><td>16 Hours</td></tr>
<tr><td colspan="2">PROPERTIES OF MATERIALS
Electronic Materials: Fermi energy and Fermi–Dirac distribution function – Variation of Fermi level with temperature in intrinsic and extrinsic semiconductors – Hall effect.
Superconducting Materials: Normal and High temperature superconductivity, Applications.
Dielectric Materials: Polarization mechanisms in dielectrics, Frequency and temperature dependence of polarization mechanism, Piezoelectric properties.
Magnetic Materials: Types of Magnetism: Diamagnetism, Paramagnetism, Ferromagnetism, Anti-ferromagnetism, Ferrimagnetism, Classification of magnetic materials based on spin, Hard and soft magnetic materials, Spintronics (GMR).</td></tr>
<tr><td>UNIT-III</td><td>10 Hours</td></tr>
<tr><td colspan="2">MODERN ENGINEERING AND BIOMATERIALS
Photonic Materials: LED – LCD – Photo conducting materials, Photo detectors, Photonic crystals and applications.
Smart materials: – Shape memory alloys, Chromic materials (Thermo, Photo and Electro),– Composite Materials.
Bio-materials: Metallic implant materials (stainless steel, cobalt-based and titanium-based alloys) – Polymeric implant materials.</td></tr>
<tr><td>UNIT-IV</td><td>10 Hours</td></tr>
<tr><td colspan="2">MATERIALS CHARACTERIZATION
Structural Analysis: X-ray diffraction, SEM, TEM, AFM- Principals, Instrumentations and applications.
Optical Characterizations: UV-Vis, FTIR-Principals, Instrumentations and applications
Thermal Analytical Techniques: TGA, DTA, DSC-Principals, Instrumentations and applications.</td></tr>
<tr><td colspan="2">Text Books</td></tr>
<tr><td>1</td><td>William D. Callister, Materials Science and Engineering: An Introduction, 8th Edition Edition, John Wiley & Sons, 2010.</td></tr>
<tr><td>2</td><td>Sam Zhang, Lin Li, Ashok Kumar, “Materials Characterization Techniques”, 1st Edition, CRC Press, 2008.</td></tr>
<tr><td>3</td><td>T. Pradeep, “A Text Book of Nanoscience and Nanotechnology”, Tata McGraw Hill, New Delhi, 2012.</td></tr>
<tr><td colspan="2">Reference Books</td></tr>
<tr><td>1</td><td>Elements of X–ray Diffraction, B. D. Cullity, S.R. Stock, 3rd Edition, Pearson,2001</td></tr>
<tr><td>2</td><td>R. F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, 2nd Edition, Springer,2016.</td></tr>
</table>

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

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

Course Objectives:

- To motivate the students to understand and learn various numerical techniques to solvemathematical problems representing various engineering, physical and real life problems.
- 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 computations and 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

Text Books

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

Reference Books

1	Gerald C.F and Wheatley P.O., Applied Numerical Analysis, 8th Edition, Pearson Education, 2011.
2	Chappra S.C., Numerical Methods for Engineers, 7th Edition, McGraw-Hill Higher 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 in industry focussed on how to adopt and apply various methods of measurement. It enlightens the students about the various errors, calibration, sensors, accuracy of measurements thus to help in standardising the methods

Course Objectives:

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

Pre-Requisites: NIL

Course Outcomes: Having successfully completed this course, the student will be able to
CO1: Understand Measurement Process and various techniques
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 measuring system and functional elements, units of measurement, static and dynamic performance characteristics of measurement devices, calibration concept of error, Types and sources of error, statistical analysis of errors. **Sensors and Transducers:** Types of sensors, types of transducers and their characteristics, Difference b/w Open loop and Closed loop measurement system, Signal conditioning unit, indicating unit, static characteristics i.e. accuracy, precision, sensitivity, resolution, linearity. **Measurement of flow:** Methods of flow measurement, hot wire anemometer, ultrasonic flow meter.	
UNIT II	**11 Hours**
Measurement of pressure: Elastic and indirect type pressure transducers. Measurement of very low pressures. **Strain measurement:** Types of strain gauges and their working, temperature Compensation. **Measurement of force and torque:** Different types of load cells, elastic transducers, pneumatic and hydraulic systems. **Temperature measurement:** Thermocouples, pyrometers.	
UNIT III	**10 Hours**
Metrology and Inspection: Sources of error, Standards of linear measurement, line and end standards, Limit fits and tolerances, Interchangeability and standardization. **Length Standards:** Line standards, end standards, transfer from line standards to end standards, Numerical based on-line standards, slip gauges – its use and care, methods of building different heights using different sets of slip gauges. **Linear and angular measurements devices and systems Comparators:** Types of Gauges, Limit Gauge, Snap Gauge, Receiving Gauge, Taylor's Principle of Gauge Design.	
UNIT IV	**10 Hours**
Measurement of geometric forms like straightness, flatness, roundness, Tool maker's microscope,profile project autocollimator. **Interferometry:** principle and use of interferometer, optical flat. Measurement of screw threads andgears. **Surface texture:** quantitative evaluation of surface roughness and its measurement, Comparators,Feature inspection Form Tolerance Inspection. Tolerance Stack Analysis, CMM, working and features.	
Text Books	
1.	A.K. Tayal, "Instrumentation and Mechanical Measurement", Galgotia Publications Pvt. Ltd., 2003..
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 number system

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

CO1: Understand basic electronic devices such as diodes, BJT & FET transistors

CO2: Understand various applications of Op-Amp

CO3: Analyse logic processes and implement logical operations using combinational logic circuits

CO4: Design sequential circuits

Pedagogy: 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 collector (CC) configurations, definition of α and β, saturation, regions of operation of transistor biasing methods. Amplifiers: CE, CC, CE amplifier circuits and their comparisons, RC coupled amplifier, Frequency response, Gain-bandwidth, and Darlington pair,	
UNIT-II	**10 Hours**
Field Effect Transistor: Introduction, JFET characteristics, Depletion & enhancement MOSFET, CMOS. Operational amplifier: Characteristics of ideal Op-Amp, Inverting & non-inverting amplifier, Differential amplifier, Adder & Subtractor, Integrator, Differentiator, Instrumentation amplifier, Schmitt trigger, Astable multivibrator.	
UNIT-III	**10 Hours**
Digital electronics: Analog & digital signals, Logic gates, Boolean algebra. Standard representation of logical functions, K-map representation and simplification of logical functions, Don't care conditions, X-OR & X-NOR simplification ofK-maps. Combinational circuits: Multiplexers, Demultiplexers, Decoders & Encoders, Adders & Subtractor, Code converters, Comparators, Decoder/drivers for display devices, A/D and D/A converters.	
UNIT-IV	**10 Hours**
Flip Flops: S-R, J-K, D & T Flip-flops, Excitation table of a flip-flop, Race around Condition Sequential circuits: Shift registers, Ripple counter, Design of synchronous counters and Sequence detectors, Sequence generators	

Text Books	
1	Morris Mano, "Digital Design", PHI, 5th edition, 2013.
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 Edition 2014.
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 of computernetworks.
- Familiarize the students with the standard models for the layered approach to communicationbetween 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 the OSI 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 routing mechanisms.

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

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
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 multiple access 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-Packet Switched 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 transport Protocols –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 Higher Education, 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 theircommunication.
- To learn the mechanisms involved in memory management in contemporary OS.
- To gain knowledge on OS architecture, mutual exclusion algorithms, deadlockdetection algorithms etc.
- To know the components and management aspects of concurrency management.

Pre-requisite: Analysis of algorithms, algorithm design techniques, programming knowledgein C, 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 process synchronization techniques and device management strategies.

CO4: To understand management of I/O and different file handling & directory implementation 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 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 Operating System, **Types of O.S:** Simple Batch, Multi-programmed Batched, Time-Sharing, Personal-computer, Parallel, Distributed, Real-Time Mobile **Operating-System Structures:** Layered Architecture, System Calls, System Programs, System Structure, Virtual Machine **Processes:** Process Concept, Process Scheduling, Operations on Processes, Cooperating Processes, Inter-process Communication, Threads, Multithreaded Programming. **CPU Scheduling:** Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Real-Time Scheduling	
UNIT-II	**11 Hours**
Process Synchronization: Background, Critical-Section Problem, Synchronization Hardware Semaphores, Classical Problems of Synchronization, Critical Regions, Monitors. **Memory Management:** Background, Logical versus Physical Address space, Swapping Contiguous allocation, Fragmentation, Paging, Segmentation, Segmentation with Paging **Virtual Memory:** Demand Paging, Page Replacement, Page-replacement Algorithms Performance of Demand Paging, Allocation of Frames, thrashing. **Deadlocks:** System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock	
UNIT-III	**10 Hours**
Device Management: Techniques for Device Management, Dedicated Devices, Shared Devices, 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 of approaches such as searching, sorting etc.
- Introduction, learning and analysis of greedy paradigms.
- Introduction, learning and analysis of dynamic programming and back tracking
- Introduction, learning and analysis of computational complexity and branch & bound.

Pre-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 using Divide and Conquer strategy.

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

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

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

Pedagogy: 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

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

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 etcare 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 reportingon progress in this area. The course is aimed to make students familiar with this area and learn some basics of the Nanotechnology.

Course Objectives:
- To develop an understanding of the fundamentals of Nanotechnology and various properties at nanoscale.
- To impart basic knowledge on various synthesis and fabrication techniques involved in Nanotechnology.
- To give a general introduction to different classes of nanomaterials and their potential applications.
- 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 various properties 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 volume ratio, Fraction of surface atoms, Surface energy and surface stress, surface defects, Properties at 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, Chemical Vapor 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, nanosilver 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, Surface enhanced Raman spectroscopy (SERS), X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy (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 McGraw Hill 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 Press Book, 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 at primary 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 beyond these. 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 too from 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 of coherent and incoherent imaging. Diffraction by circular aperture, Gaussian beams. Image evaluation: Geometric OTF, its computation and measurement, Strehl ratio, spot diagram; definition of merit function Parabolic and Fresnel lens, Cooks Triplet and its derivatives; Double Gauss lens, Introduction to zoom lenses and aspherics.	

UNIT-II	7 Hours
Optical Components: Mirrors, prisms, gratings and filters; Sources, detectors and their characteristics. **Optical Instruments**: Infrared instrumentation, imaging, near-field imaging techniques, Satellite cameras, Laser Doppler velocimetry Bio-medical applications of lasers, Laser tweezers and applications, Shack Hartmann Sensor and Moire, and Talbot interferometry for 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; Brightness and luminous intensity distribution; Optical detectors; Detector characteristics, Noise considerations, single & multi-element detectors, CCDs.	

UNIT-III	7 Hours
Holography: Basics of holography, in-line and off-axis holography; transmission and reflection holograms, 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 and free-electron lasers; Semiconductor lasers: DH, QW, QCL, VCSEL, DFB and DBR lasers.	

UNIT IV	7 Hours
Spectroscopy: Laser spectroscopy, Spectroscopic instrumentation, Fourier transform spectroscopy; **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 theory with 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 dimensional intensityprofile.
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 equipped to apply them in various fields including Optimization Techniques which provides alogical and systematic approach for decision making.

Course Objective:

- To formulate mathematical models and to understand solution methods for real life optimal decision problems.
- To emphasize the basic study of linear programming problem, Integer programming problem, Transportation problem, Two person zero sum games with economicapplications and 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), convex set, Graphical method, LP in standard form, Solution of LP by simplex method, Big –M Method, Two Phase Method, Exceptional cases in LP.	
UNIT-II	**10 Hours**
Revised Simplex Method, Karmarkar's Interior Point Algorithm, Sensitivity analysis, Duality theory, Dual simplex method, Integer Programming: Branch and bound technique.	
UNIT-III	**10 Hours**
Transportation and Assignment Problem : Initial basic feasible solutions of balanced and unbalanced transportation/assignment problems and their optimal solutions, Transhipment, Travelling Salesman Problem	
UNIT-IV	**10 Hours**
Project Management: Construction of networks, Network computations, Floats (free floats and total floats), Critical path method (CPM), Crashing. Game Theory: Two person zero-sum game, Game with mixed strategies, Graphical method and 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, Narosa Publishing 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 and Network flows, John Wiley and Sons, 1990.
5	Ravindran, A., Phillips, D.T. and Solberg, J.J., "Operations Research: Principles and Practice", 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 and effectiveness.
- 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 business processes.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: NIL

Course Outcomes: Having successfully completed this course, the student will be able to -
CO1: Understand 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 of management, Organization structure. **Capacity Planning, Plant Location and Plant Layout** – Introduction, need for selecting a suitable location, Location Factors, Quantitative Method, Principles of Plant layout, Types 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 chrono cycle graph, Therbligs and SIMO charts. Work Study – Objectives, Different Techniques, Standard Time, Allowances, Time study Numerical, Performance Rating, Work sampling. Process and Product Life Cycle, Material Requirement Planning – Introduction, MRP objectives, Functions served by MRP Production Planning and Control, Supply chain and Logistics Management, Production Scheduling.	
UNIT III	**10 Hours**
Inventory Management - Introduction, Reasons for Holding Inventories, Relevant Costs of Inventories, EOQ models, Quantity Discount Models, Safety Stock, Inventory control system Selective 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 of 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 Modern Approach", 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 decide upon the coding technique to be used for a particular application and measurement of the channel capacity. The concepts of information theory are widely used in research.

Course Objective:

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

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

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

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

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

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

CO4: Evaluate efficient codes for data on imperfect communication channels

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

CONTENTS

UNIT-I	12 Hours
Information theory: Information rate, Entropy, Joint and conditional entropies, Kraft McMillan inequality, Mutual information - Discrete memory less channels – BSC, BEC – Channel capacity, Shannon limit, Source coding theorem, Shannon-Fano coding.	
UNIT-II	**10 Hours**
Huffman coding, Extended Huffman coding, Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm Channel, Linear Predictive coding, Introduction to Audio coding, Perceptual coding, Masking Techniques, Introduction to Speech Coding, Channel Vocoder.	
UNIT-III	**10 Hours**
Error control coding, Block codes-Definitions and Principles, Hamming weight, Hamming distance, Minimum distance decoding, Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation.	
UNIT IV	**10 Hours**
Convolution codes, Code tree, Trellis, State diagram, Error control coding, Turbo coding - Principle of Turbo coding, Video Compression - Principles I,B,P frames, Motion Estimation, Motion Compensation.	
Text Books	
1	R Bose, "Information Theory, Coding and Cryptography," McGraw hill Education, 3rd Edition, 2016.
2	Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards," 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- term development 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 natural disasters.

Course Objective:

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

Pre-requisite: None

Course Outcomes

CO1: Capacity to integrate knowledge and to analyse, evaluate and manage the different public health 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 andpractically 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, heat waves, cold waves, avalanches, Man-made disasters – fire, urban fire, forest fire, Chemical biological, radiological and nuclear disasters, armed conflict and civil strife**,** oil and Gasleakage Transport disasters Factors affecting Vulnerabilities, impact of Development projects such as dams, high rise constructions etc.	
UNIT-III	6 Hours
Geo-informatics in Disaster Management (RS, GIS, GPS and RS), Disaster Communication System (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 Management cycle, Role of Government (local, state and national), Non-Government, Inter-Governmental and UN Agencies.	
Practical Component	
Demonstration of Cardiopulmonary Resuscitation (CPR) Demonstration of Search and Rescue Operations, 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 Sciences Working 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 as data, 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 and Reduction.	
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. Morgan kaufmann
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 and devices.
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/ programming assignments based on topics studied in previous lectures. Course will have a blend of theory and practice for the benefit of students. Use of ICT, web based sources as well as blackboard teaching will be adopted.

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 and smart 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, Email and 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 types of 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 vision problems.

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 unit and 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, and Audio-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 and Solvability of problems.

CO3: To Apply rigorously formal mathematical methods to prove properties of 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 actions in performing the duty to the family, organization, and to the society.

Course Objectives:
To facilitate the development of a Holistic perspective among students towards life, profession and happiness, based on a correct understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Value based living in a natural way. To inculcate Ethics and Human Values into the young minds and develop moral responsibility and 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, through a value-based life.
CO2: Turn themselves into champions of their lives.
CO3: Take things positively, convert everything into happiness and contribute for the happiness of others.
CO4: Become potential sources for contributing to the development of the society around them and institutions / organizations they work in.
CO5: Shape themselves into valuable professionals, follow professional ethics and are able to solve their ethical dilemmas.

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

CONTENTS

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

Course objective:

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

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

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

CO1: 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 the ability to understand text and spoken words in much the same way human beingscan. NLP combines computational linguistics—rule-based modelling of human language withstatistical, 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' itsfull 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, programming languages

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

CONTENTS

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

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 usedin 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, Structural Methods.	

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 known as 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, Introduction to 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 Coin Offering (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, and Hyperledger", 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 multiple possible states. Building up on the digital binary logic of bits, quantum computing is built on the basis of interacting two-level quantum systems or 'qubits' that follow the laws of quantum mechanics. Addressability of the quantum system and its fragility to fidelity are the major issues of concern, which if addressed appropriately, will enable this new approach to revolutionize the present form of computing. The aim of quantum computing is to do computation using the quantum mechanical effects.

Course Objective:

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

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

Course 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 quantum circuit model

CO4: Describe the standard quantum algorithms in IBM Qiskit and state the benefits along with 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 fromprevious lectures.
- Course will have a blend of theory and lab practice for the benefit of students.
- Use of ICT, web based sources as well as blackboard teaching will be adopted.

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", MIT press, 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, World Scientific, 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 parse tree 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: Introduction to Translators (interpreter, compiler & cross-compiler), Phases of compilation and overview, Introduction to GCC. Lexical Analysis (scanner): Regular language, finite automata, regular expression and their applications to lexical analysis, from regular expression to finite automata, Implementation of lexical analyzers, lexical -analyzer generator, LEX- compiler, Formal grammars and their application to syntax analysis, ambiguity, YACC.	
UNIT- II	**11 Hours**
Syntax Analysis (Parser): Context- free language and grammar, Basic Parsing Techniques: Parsers, Top down parsing, Shift reduce parsing, operator, operator grammar, operating precedence parsing, predictive parsers. LL(1) grammar, LR(0), SLR(1), LR(1), LALR(1) grammars and Bottom-up parsing, ambiguity and LR parsing, LALR(1) parser generator (yacc, bison).	
UNIT-III	**11 Hours**
Syntax-directed Translation: Syntax-directed Translation schemes, Implementation of Syntax-directed Translators, Intermediate code, postfix notation, Parse trees & syntax trees, three address code, quadruple & triples, translation of assignment statements, Boolean expressions, statements that alter the flow of control, postfix translation, translation with a top-down parser. Semantic Analysis: Attribute grammar, syntax directed definition, evaluation and flow of attribute in a syntax tree.	
UNIT- IV	**10 Hours**
Symbol Table: Data structure for symbols tables, representing scope information, symbol attributes and management. Run-time environment: Procedure activation, parameter passing, value return, memory allocation and scope. Error Detection & recovery: Lexical phase errors, syntactic phase errors semantic errors. Error Detection & Recovery: Lexical Phase errors, syntactic phase errors semantic errors. Intermediate Code Generation: Translation of different language features, different types of intermediate codes. Code Improvement (Optimization): Analysis: control- flow, data -flow dependence etc., Code improvement local optimization, global optimization loop optimization, peep-hole optimization etc.	
Text Books	
1	Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools", Pearson Education, 2007.
2	Andrew N. Appel, "Modern Compiler Implementation in C", Cambridge University Press, 2007.
Reference Books	
1	Keith D. Cooper and Linda Torczon,"Engineering a Compiler", Elsevier, 2004.
2	Steven S. Muchnik," Advanced Compiler Design and Implementation", Elsevier, 2008.
3	Randy Allen and Ken Kennedy, "Optimizing Compilers for Modern Architectures", Elsevier, 2009.
4	John R. Levine, tony mason, Doug Brown," Iex& yacc," O'reily, 2nd Edition, 1992.

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 postings lists 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 personalized access 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 and technologies.
CO3: Describe the various technologies of Semantic Web focusing on RDF,Ontology and Sparql.
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 with focus 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-world applications.

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 learning techniques 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 intrinsic measures- 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 machine learning 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 and Genetic 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, classification and 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, Data Mining 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 Classification and 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 to Data 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 improve the 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 organizational change and development.

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

CONTENTS

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

Text Books	
1	S.P. Robbins, "Fundamentals Management: Essentials Concepts Applications", Pearson Education, 2014.
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 functioning of an organization.
CO3: Learn some of the tools and techniques of marketing with focus on Indian experiences, approaches and cases.

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

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 Perspective with 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 economic environment. The purpose of the course is to offer the students relevant, systematic, efficient and actual knowledge of financial management that can be applied in practice while making financial decisions and resolving financial problems.

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

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

Pre-requisite: 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 rejected by determining an appropriate investment criteria and projecting cash flows associated with corporate project evaluation.
CO3: Differentiate between the various sources of finance and their pros and cons.
CO4: Outline capital requirements for starting a business and management of working capital.
CO5: Analyse the complexities associated with management of cost of funds in the capital structure.
CO6: Apply the concepts of financial management to contemporary financial events.

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

CONTENTS

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

Text Books	
1	M.Y. Khan and P.K. Jain, "Financial Management", McGraw Hill Education, 8 th Edition, 2018.
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 develop skill to design rational decisions in the discipline of human resource management.

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

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

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

Text Books	
1	G. Dessler. "A Framework for Human Resource Management", Pearson Education, 2017, 15th Edition.
2	D. A. Decenzo, S. P. Robbins, S. L. Verhulst, "Human Resource Management", Wiley India 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-410 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 occurred gradual 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:

- To understand the fundamentals of AI including its architecture and algorithms.
- To understand AI enabling technologies and role of AI in Information Technology.
- To gain insights of Artificial Intelligence in Computer Vision.
- To understand 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. with respect 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 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
Artificial Intelligence (AI): Futuristic Issues and Applications, Artificial Intelligence Architecture, Tools, Techniques and Technologies in AI, Algorithms in AI	
UNIT-II	**10 Hours**
AI Enabling Technologies, ABC: Artificial Intelligence, Big Data and Cloud Computing, Artificial Intelligence vs. Machine Learning vs. Deep Learning AI for Data Mining and Knowledge Discovery, Role of AI in Information Technology.	
UNIT-III	**12 Hours**
AI in Computer Vision, Generative Adversarial Network (GAN) and it's Applications, Smart Transportation & Smart Vehicles using AI. Smart Grid Computing & Technologies with AI	
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 - based Security and Intrusion Detection, Smart AI and it's Applications, 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," IntechOpen, 2018/ Latest Edition
Reference Books	
1	Stuart Russell, Peter Norvig ," Artificial Intelligence: A Modern Approach", Pearson, 4th Edition, 2020 Marco Fernandez, "Artificial Intelligence-Emerging Trends and applications
2	Dr. Jagreet Kaur, Navdeep Singh Gill, "Artificial Intelligence and Deep Learning for Decision Makers", BPB Publications, 2020 Marco Fernandez, "Artificial Intelligence-Emerging Trends and applications
3	Coursera Course: Artificial Intelligence Part II https://www.coursera.org/lecture/bcg-uva-darden-digital-transformation/artificial-intelligence-part-ii-5oaJQ

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, predictive and prescriptive, based on their data assets. Collection, storage and retrieval of data assets and processing them in reasonable response time is crucial today. This course deals with volume, variety and velocity aspects of Big Data. It exposes students to basic techniques for managing and processing such data.

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

Prerequisite: Essential: Distributed Systems, Data warehouse
Desirable: 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, taking practicality, and usefulness metrics into consideration.
CO3: Understand the role of statistics in the analysis of large of datasets.
CO4: Apply suitable statistical measures and analyses techniques for data of various structure and content and present summary statistics.

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

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 stream Data; Issues with streams of data, Data Stream Management Systems, Concept of Windows: Time based windows, Tuple count based windows, Movement of windows- fixed, sliding, Tumbling, Hoping; Event streaming: architecture, events, producers, consumers. Use in website activity tracking, stream processing, stream query processing.	
UNIT-II	**8 Hours**
Data Warehouse for Big Data: Review of dimensional modeling, bus, hub and spoke architecture, ETL for real time DW, Big Data clusters; Cloud Warehousing: Cloud versus on-perm storage, setting up 'Infrastructure as code'.	
UNIT-III	**11 Hours**
Data Lakes: Data Lakes versus Data Warehouse, Lambda and Kappa Architectures, Meta data management, Curating, designing and deriving value from data lakes, Data pipelines: ETL versus ELT, streaming data pipelines, scheduling batch data pipelines, automated data pipelines. Data governance; Data Virtualization: Need for data virtualization, architecture, abstraction, views and services, design principles, defining specifications for transformations.	
UNIT-IV	**11 Hours**
Map Reduce Framework: Distributed Processing with Hadoop Framework; Architecture; Basic Programs on Read and Write, architecture of a MR job, Mapper, Reducer, Combiner, Partitioner Interfaces; Use of distributed relational Store: HIVE architecture and features; different types of tables and implications; data types; basic queries Societal Issues with Big Data: Data rights, policy and regulation; data and ethics, data and communication. Data as a strategic resource	

Text Books

1.	Gorelik A., The Enterprise Big Data Lake, O'Reilly/Latest Edition
2.	Marz N. and Warren J., Big Data: Principles and best practices of scalable realtime data systems, Manning Publications/Latest Edition
3.	Erl T. Khattak W., Buhler P., Big Data Fundamentals: Concepts, Drivers & Techniques, The Pearson Service Technology Series from Thomas ERL/Latest Edition

Reference Books

1.	DT Editorial Services, Big Data, Black Book, Dreamtech Press/Latest Edition

MULTIMODAL DATA PROCESSING	
Course Code: BAI-401 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 which addresses 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 language models.
- Understand the concepts in Speech processing.
- Understand different techniques of Digital image and video processing.
- Understand 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 text processing.
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 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: Introduction to Multimodal data and applications, Multimodal Representation: two broad approaches, Joint and Coordinated. Challenges of multimodal data, Data collection & cleaning. Text Processing: Text normalization, Lemmatization, Morphology, Subword 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, Image transforms, Spatial and temporal data handling.	
UNIT-IV	**10 Hours**
Other Modalities: Biomedical signals, and Conventional multi-modal learning, co-learning.	

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	H. Wang, A. Meghawat, L.-P. Morency and E. Xing. Select-Additive Learning: Improving Generalization in Multimodal Sentiment Analysis. In Proceedings of the IEEE International Conference on Multimedia & Expo (ICME), 2017/Latest Edition
3	Linkhttps://books.google.co.in/books/about/Intelligent_Multi_Modal_Data_Processing.html?id=pAsjEAAAQBAJ&redir_esc=y

COMPUTER VISION	
Course Code: BIT-316 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, Fully Connected. 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 using Siamese 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 University Press, 2012.
2	L. G. Shapiro, and G.C.Stockman, "Computer Vision", 1st Edition/ Latest Edition, Pearson Prentice Hall, 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.

`	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 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 pattern recognition and its applications: Applications of pattern recognition in image analysis, speech processing, video analysis, text mining, unstructured data analysis. Prominent algorithms and methods of pattern recognition. Traditional and state-of-the-art techniques of pattern recognition. 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, Principal Component 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, Latest Edition, 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 the system is ready for use. Software Quality Assurance includes standards and procedures that developers may use to review and audit software products and activities to verify that the software meets quality criteria which link to standards.

Course Objectives:

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

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

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

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. Faculty members strive to make the classes interactive so that students can correlate the theories with practical examples for better understanding. Use of ICT, web-based resources as well as flipped 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 of Modern Tools, Static Testing Tools, Dynamic Testing Tools, Process Management Tools.	
UNIT-II	**10 Hours**
Functional Testing: Boundary Value Analysis, Robustness Testing, Worst case testing, Special Value Testing, Equivalence Class Testing-Weak normal, Strong normal, weak robust and Strong Robust, Decision Table Based Testing, Cause Effect Graphing Technique. **Structural Testing:** Control flow Testing-Statement, Branch, Condition and Path coverage, Data Flow Testing, testing strategies, Generation of test cases, Slice-based Testing, Mutation Testing, Integration Testing, Decomposition based Integration, Call Graph based Integration, System Testing: Thread Testing.	
UNIT-III	**12 Hours**
Introduction to Object Oriented Testing, State Based Testing, Class Testing, Web Testing, Issues in Object Oriented Testing, Regression testing, Selection of test cases, reducing the number of test cases, Prioritization guidelines.	
UNIT-IV	**10 Hours**
Software Verification Methods, SRS Verification, SDD Verification, Source Code Reviews, Software Project Audit, Debugging Process and Approaches, Software Testing Metrics, Metric used in Testing, Software Quality and Quality Models.	

Text Books

1.	Yogesh Singh, "Software Testing", Cambridge University Press, 2011/Latest Edition
2	Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications; 3rd Edition,2013/Latest Edition

Reference Books

1	Ilene Burnstein, "Practical Software Testing: A Process-Oriented Approach", Springer, 2003/Latest Edition.
2	Aditya P. Mathur, "Foundations of Software Testing", Pearsons, 2nd Edition 2008/ Latest Edition

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 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
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 and entities, 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 process and 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 testing methodologies.	
UNIT-IV	**10 Hours**
Maintenance: Deployment and Management, Wild west approach, types of environments to run to code: 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/Latest Edition
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 and Distributed AI.

CO2: Illustrate and elaborate the working of Parallel, Distributed and connectionist models of AI.

CO3: Interpret and analyze the frameworks for solving problems in the domains of Parallel and 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 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
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, Distributed Reasoning 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 for Distributed 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/distributed computing", Springer Nature Switzerland AG, 2021/Latest Edition

Reference Books

1	Stuart Russell and Peter Norvig" Artificial Intelligence A Modern Approach", PEARSON Education, 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 distributed processing (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 project management 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 and sequencing 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 IT project successful or unsuccessful.
CO3: Understand project management principles and methods in an IT project.
CO4: Understand the project's business context and extent, choose the best project management strategy.

Pedagogy: The teaching-learning of the course would be organized through lectures, tutorials, assignments, projects/ presentations and quizzes. 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 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 to Organize Personnel, Project schedule, Scheduling Objectives, Building the project schedule, Scheduling terminology and techniques, Network Diagrams: PERT, Monte Carlo Approach, CPM, Bar Charts: Milestone Charts, Gantt Charts.	
UNIT-III	**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; Sixth edition, 2017/Latest Edition
2.	Software Project Management in Practice, Pankaj Jalote, Addison-Wesley; 1st edition , 2002/Latest Edition
3.	Software Project Management, Walker Royce, Pearson Education, 1998/Latest Edition.

Reference Books	
1	Software Engineering Project Management, Richard H. Thayer & Edward Yourdon, second edition, Wiley India, 2004/Latest Edition.
2	Agile Project Management, Jim Highsmith, Pearson education, 2004/Latest Edition.
3	The art of Project management, Scott Berkun, O'Reilly, 2005/Latest Edition.