INDIRA GANDHI DELHI TECHNICAL UNIVERSITY FOR WOMEN
(Established by Govt. of Delhi vide Act 9 of 2012)

Department of Information Technology

BTECH- AI & ML

Third Semester (III)

Code	Subject	L-T-P	Credits	Category
BAI-201	Artificial Intelligence	3-0-2	4	DCC
BAM-201	Database Management Systems	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	3-1-0	4
BAS-203	EngineeringNumerical Methods	3-1-0	4
BEC-209	Analog and Digital Electronics	3-0-2	4
BMA-209	Engineering Measurement and	3-0-2	4
BAI-203	MetrologyIT Workshop using R (for other Dept.)	2-0-4	4
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Fourth Semester (IV)

S. No.	Course Code	Course	L-T-P	Credits	Course Category
1	BAI-202	Computer Networks	3-0-2	4	DCC
2	BIT-202	Operating Systems	3-0-2	4	DCC
3	BAM-202	Machine Learning	3-0-2	4	DCC
4	BCS-204	Design and Analysis of Algorithms	3-0-2	4	DCC
5	Bxx-2xx	Open Elective courses	3-0-2	4	OEC
6	HMC-202	Disaster Management	2-0-0	2	HMC
			Total	22	

List of Open Elective Courses

S.No.	Code	Subject	L-T-P	Credits
1	BAS-202	Nano Structures & Materials in Engineering	3-1-0	4
2	BAS-204	Optical Engineering	3-0-2	4
3	BAS-206	Optimization Techniques	3-1-0	4
4	BEC-210	Elements of Information Theory	3-1-0	4
5	BMA-210	Operations Management	3-1-0	4
6	BAJ-206	Introduction to Data Science	3-0-2	4

ARTIFICIAL INTELLIGENCE	
Course Code: BAI-201 Contact Hours: L-3 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.

DATABASE MANAGEMENT SYSTEMS	
Course Code: BAM-201 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 3

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

Course Objectives:

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

Pre-requisites: Basic concepts of set theory

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

CO	Statement
CO1	To understand the basic concepts, applications and architecture of database systems.
CO2	To model the application's data requirements using conceptual modelling tools like E-R diagrams, design database schemas based on the conceptual model, write relational algebra expressions & SQL commands for query.
CO3	To apply the logical design guidelines for databases, normalization approach, primary key, super key, foreign key concepts.
CO4	To analyze the issues of transaction processing, concurrency control, serializability and their various protocols.

Pedagogy:
Lecture delivery via discussions, whiteboard, slideshows, online learning material. Lab-workwith exercises on SQL

Contents

UNIT-I	10 Hours
Overview of Concepts and Conceptual Database Design: Database Administrator and Database Users, Characteristics of the Database, Database Systems, Concepts and Architecture, Data Models, Schemes & Instances, DBMS Architecture & Data Independence, Database Languages & Interfaces, Overview of Hierarchical, Network & Relational Data Base Management Systems, Data Modeling using Entity-Relationship Model, Strong and Weak Entity Sets, Generalization, Specialization, and Aggregation.	
UNIT-II	11 Hours
Relational Model, Languages & Systems: Relational Model Concepts, Relational Model Constraints, Translating your ER Model into Relational Model, Relational Algebra, Relational Calculus (Tuple Calculus) SQL: A Relational Database Language, Data Definition in SQL, View and Queries in SQL, Specifying Constraints and Indexes in SQL, Practicing SQL commands	
UNIT-III	11 Hours
Relational Data Base Design: Functional Dependencies & Normalization for Relational Databases, Functional Dependencies, Normal Forms (1NF, 2NF, 3NF, BCNF, 4NF, 5NF), Lossless Join and Dependency Preserving Decomposition, Multivalued Dependency, Join dependency. Transaction Management: Transaction Concept and State, Implementation of Atomicity and Durability, Serializability, Recoverability, Implementation of Isolation	
UNIT-IV	10 Hours
Concurrency Control: Lock-Based Protocols, Timestamp-based Protocols, Deadlock Handling, Recovery System, Failure Classification, Storage Structure, Recovery and Atomicity, Log-based Recovery. Query Processing: Query Processing Overview, Measures of Query Cost. Framework of Distributed Data Base Management Systems, Introduction to Enhanced Databases: Multimedia Databases, Object Oriented Databases, Mobile Databases.	

Text Books	
1	Elmasri Ramez and Navathe Shamkant, Fundamentals of Database System, Pearson, 6th Ed. (June 2017)/Latest Edition.
2	Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw Hill, 6th Ed/Latest Edition.
3	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill, 3rd Ed., 2003/Latest Edition.

Reference Books	
1	Ceri and Pelagatti, Distributed Databases : Principles & Systems, McGraw-Hill, 2017/Latest Edition.
2	Conolly & Begg, Database Management Systems, Pearson Education Asia., 5th Edition, 2010/Latest Edition.

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 various phases of the software development life cycle.
CO2: Analyze the requirements systematically and develop the model using standard tools and methodologies.
CO3: Apply key aspects of software engineering processes and their security principles for developing a complex software system.
CO4: Develop a quality software project through effective team-building, planning, scheduling, and risk assessment.

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

CONTENTS

UNIT-I	4 Hours
Introduction to materials: Importance of Material science and Engineering, Classification of Materials: Metallic, Ceramic, Polymeric, Electronic and Composite Materials.	
UNIT-II	**16 Hours**
PROPERTIES OF MATERIALS **Electronic Materials:** Fermi energy and Fermi–Dirac distribution function – Variation of Fermi level with temperature in intrinsic and extrinsic semiconductors – Hall effect. **Superconducting Materials:** Normal and High temperature superconductivity. Applications. **Dielectric Materials:** Polarization mechanisms in dielectrics, Frequency and temperature dependence of polarization mechanism, Piezoelectric properties. **Magnetic Materials:** Types of Magnetism: Diamagnetism, Paramagnetism, Ferromagnetism, Anti-ferromagnetism, Ferrimagnetism, Classification of magnetic materials based on spin, Hard and soft magnetic materials, Spintronics (GMR).	
UNIT-III	**10 Hours**
MODERN ENGINEERING AND BIOMATERIALS **Photonic Materials:** LED – LCD – Photo conducting materials, Photo detectors, Photonic crystals and applications. **Smart materials:** – Shape memory alloys, Chromic materials (Thermo, Photo and Electro),– Composite Materials. **Bio-materials:** Metallic implant materials (stainless steel, cobalt-based and titanium-based alloys) – Polymeric implant materials.	
UNIT-IV	**10 Hours**
MATERIALS CHARACTERIZATION **Structural Analysis:** X-ray diffraction, SEM, TEM, AFM- Principals, Instrumentations and applications. **Optical Characterizations:** UV-Vis, FTIR-Principals, Instrumentations and applications. **Thermal Analytical Techniques:** TGA, DTA, DSC-Principals, Instrumentations and applications.	

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

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

Introduction: Numerical Methods give insight into problems we cannot otherwise solve. 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

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

Text Books	
1	Jain M.K., Iyengar, S.R.K., and Jain, R.K. 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**	**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 of K-maps. Combinational circuits: Multiplexers, Demultiplexers, Decoders & Encoders, Adders & Subtractor, Code converters, Comparators, Decoder/drivers for display devices, A/D and D/A converters.	
UNIT-IV	**10 Hours**
Flip Flops: S-R, J-K, D & T Flip-flops, Excitation table of a flip-flop, Race around Condition Sequential circuits: Shift registers, Ripple counter, Design of synchronous counters and Sequence detectors, Sequence generators	

Text Books	
1	Morris Mano, "Digital Design", PHI, 5th edition, 2013.
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: IV

Introduction: The course introduces main concepts of computer networks, 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 computer networks.
- Familiarize the students with the standard network models for the layered approach to communication between machines in a network and the protocols of the various layers.

Pre-requisite: NIL

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

- **COl:** 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.
- **C03:** Discuss the algorithms of the network layer to perform subnetting and routing mechanisms.
- **C04:** Identify 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 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.

Course details

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,	

Operating Systems	
Course Code: BIT-202 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: IV

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

Course Objective:

- To learn the fundamentals of Operating Systems.
- To learn the mechanisms of OS to handle processes and threads and their communication.

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
- To learn the mechanisms involved in memory management in contemporary OS.
- To gain knowledge on OS architecture, mutual exclusion algorithms, deadlock detection algorithms etc.
- To know the components and management aspects of concurrency management.

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

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

- Analyze the structure of OS and basic architectural components involved in OS design.
- Analyze and design the applications to run in parallel either using process or thread models of different OS.
- Analyze the various device and resource management techniques for timesharing and distributed systems.
- Understand the mutual exclusion, deadlock detection concepts in OS.
- Interpret the mechanisms adopted for file sharing in distributed applications.

Pedagogy: The class will be taught using theory and tutorial based methods which include board teaching and presentations/slides, discussions, brainstorming, case based studies etc. Along with classroom teaching, students will also be given assignments regarding the topics covered. The 31 course instructor will demonstrate and explain about the applications of Operating Systems techniques with real-time examples

Course details

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	**10 Hours**
UNIT III	
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.	**10 Hours**
UNIT IV	
Information Management: Introduction, Simple File System, General Model of a File System, Symbolic File System, Basic File System, Access Control Verification, Logical File System, Physical File System File-System Interface: File Concept, Access Methods, Directory Structure, Protection, and Consistency Semantics. File-System Implementation: File-System Structure, Allocation Methods, Free-Space Management, Directory Implementation, Efficiency and Performance, Recovery.	

Text Books	
1	Silberschatz and Galvin, "Operating System Concepts", John Wiley, 9th Ed., 2016
2	R. C. Joshi, "Operating Systems", Wiley Dreamtech, 2008.
3	Deitel, Deitel and Choffnes, "Operating Systems", Pearson, 3rd Edition, 2003
Reference Books/Materials	
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

Machine Learning	
Course Code: BAM-202 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: IV

Introduction:
Machine learning (ML) is the science of getting computers to act without being explicitly programmed. Many researchers also think it is the best way to make progress towards human-level AI. This course provides a broad introduction to machine learning, data mining, and statistical pattern recognition.

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 be adopted.

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.

Design & 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 Outcome: After studying this course, students will be able to:

- Assess and analyze the performance of algorithmic efficiency.
- Choose the most relevant and apt algorithm design approaches for problems solving.
- Understand the working of dynamic programming and determining computational complexity of the algorithms that influence the performance of programs.
- Learn designing of algorithms for different purposes.

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

Course Details:

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

UNIT IV		10 Hours
String matching: Naïve String-Matching algorithm, Rabin-Karp Algorithm, String Matching with finite automata, The Knuth-Morris Pratt algorithm. NP-Complete Problem: Polynomialtime verification, NP-Completeness and Reducibility, NP-Completeness Proof, NP-Complete problems.		
Text Books		
1	T .H .Cormen, C .E .Leiserson, R .L .Rivest, "Introduction to Algorithms", 3rd Ed., PHI.	
2	E. Horowitz, S. Sahni, and S. Rajsekaran, "Fundamentals of Computer Algorithms," 2nd Ed., Universities Press.	
3	P. H. Dave, H. B. Dave, "Design and Analysis of Algorithms", 2nd Ed., Pearson Education	
Reference Books/Materials		
1	Design and Analysis of Algorithms, S. Sridhar, Oxford Univ. Press.	
2	Design and Analysis of algorithms, Aho, Ullman and Hopcroft, Pearson Education, 2008.	
3	Foundations of Algorithms, R. Neapolitan and K. Naimipour, 4th edition, Jones and Bartlett Student edition	

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: The objective of the course is to acquaint the students about the concept of information system in business organizations, and also the management control systems.

- Explain types, trends, causes consequences and control of disaster
- Recall disaster management cycle and frame work
- Summarize disaster management agencies and their roles in the country.
- Relate applications of sciences and technology for disaster management and mitigation

Prerequisite: Knowledge of Risk identification, Risk analysis, monitoring search and rescue activities.

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

- To gain and integrate knowledge, to analyze, evaluate and manage the different public health aspects of disaster events at local and global levels
- To describe, analyze and evaluate the environmental, social, cultural, economic, legal and organizational aspects, minimize risk, prepared community and develop capacities to mitigate disasters.
- To understand theoretically and practically different step of disaster management and relate their interconnections, with psychosocial, livelihood, logistics and Public Health aspects of the disasters
- To build capacity to work at the time of need, support community.

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.

Course Details:

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, heatwaves, cold waves, avalanches, Man-made disasters – fire, urban fire, forest fire, Chemical, biological, radiological and nuclear disasters, armed conflict and civil strife, oil and Gas leakage, 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.	

Text Books	
1	Alexander David, Introduction in Confronting Catastrophe, Oxford University Press, 2000/ Latest Edition.
2	Kapur, Anu and others, Disasters in India Studies of grim reality, Rawat Publishers, Jaipur, 2005/ Latest Edition.
3	Mukta Girdhar, Natural Disasters, Amy publication, Dariyaganj, New Delhi, 2019/ Latest Edition.
Reference Books/Materials	
1	Andharia J., Vulnerability in Disaster Discourse, JTCDM, Tata Institute of Social Sciences Working Paper No. 8, 2008/ Latest Edition.
2	Govt. of India: Disaster Management Act 2005, Government of India, New Delhi.
3	https://ndma.gov.in/en/

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 màke 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:

- **COl:** Understand basics of Nanotechnology and various size dependent phenomena at nanoscale.
- **CO2:** Learn various synthesis and fabrication techniques of nanomaterials.
- **C03:** Enhance knowledge of nanomaterials and their potential applications.
- **C04:** 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-3 T-0 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-I and Applied Physics -2.

Course Outcomes: Having successfully completed this course, the student will be able to
COl: 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, OTP-effects of aberration and apodization. Techniques for measurement ofOTF, 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.	W. Goodman, Introduction to Fourier Optics, 2nd Edition, Mc Graw Hill, 1996.
2.	IP. Hariharan, Optical Holography Principles, techniques and applications, 2nd Edition, Cambridge University Press, 1996.
3	ID. Malacara, Optical Shop Testing, 3rd Edition, Wiley,2007
4	IE. Hecht, Optics, 4th Edition, Pierson, 2002.
Reference Books	
1	K. Ghatak, Optics, 5th Edition, Mc Graw Hill, 2014.
2	K. Johnson, Optics and Optical instruments, Dover Publications, 1967.
3	A. Jenkins and H. E. White, Fundamentals of Optics, 4th Edition, McGraw Hill, 2001.
4	K.Johnson, Optics and Optical instruments, Dovers Publications Inc., 1960.

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 a logical 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 economic applications 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
- **C03:** Analyze Project Management problems and their solutions using PERT and CPM
- **C04:** 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.

Course details

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 ShiraliHanifD., 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.

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

- **COl:** Analyze 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.

Course Details

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-pano 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

INTRODUCTION TO DATA SCIENCE

Course Code: BAJ-206 Contact Hours: L-3 T-0 P-2 Course Category: OEC	Credits: 4 Semester: 4

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:

COI: Understand the basic principles and ethics of data science to process the data.
CO2: Explore different data preprocessing and manipulating techniques.
C03: Use the visualization techniques to translate analytical data into visual results.
C04: 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 ofICT, 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 !Python, 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, Ist/Latest Edition (2013)

OPERATIONS MANAGEMENT

Course Code: BMA-210 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 –

- **COl:** 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.

Course Details

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.