DAYANANDA SAGAR UNIVERSITY

SCHOOL OF ENGINEERING

SCHEME & SYLLABUS
FOR
BACHELOR OF TECHNOLOGY (B.Tech)

COMPUTER SCIENCE & ENGINEERING

(Data Science)

(CSE)

(With effect from 2021-22)

SCHEME - B.TECH – 2021-22 ONWARDS

I SEM - CHEMISTRY CYCLE

SL	PROGRAM CODE	COURSECODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	101-105 & 121-123	21EN1101	LINEAR ALGEBRA AND CALCULUS	CR	3	1	-	-	4	*	***
2	101-105 & 121-123	21EN1102	ENGINEERING CHEMISTRY	CR	3	-	2	-	4	*	***
3	101-105 & 121-123	21EN1103	BASIC ELECTRICAL ENGINEERING	CR	3	-	-	-	3	*	***
4	101-105 & 121-123	21EN1104	ELEMENTS OF MECHANICAL ENGINEERING	CR	2	-	2	-	3	*	***
5	101-105 & 121-123	21EN1105	FUNDAMENTALS OF PROGRAMMING	CR	3	-	4	-	5	*	***
6	101-105 & 121-123	21EN1106	ENVIRONMENTAL SCIENCES	CR	2	-	-	-	2	*	***
7	101-105 & 121-123	21EN1107	KANNADA KALI/MANASU	CR	1	-	-	-	1	*	***
					17	01	08	--	22		

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SCHEME - B.TECH – 2021-22 ONWARDS

I SEM - PHYSICS CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSECODE
1	101-105 & 121-123	21EN1101	LINEAR ALGEBRA AND CALCULUS	CR	3	1	-	-	4	*	***
2	101-105 & 121-123	21EN1108	ENGINEERING PHYSICS	CR	3	-	2	-	4	*	***
3	101-105 & 121-123	21EN1109	BASIC ELECTRONICS	CR	3	-	2	-	4	*	***
4	101-105 & 121-123	21EN1110	ENGINEERING GRAPHICS AND DESIGN	CR	1	-	4	-	3	*	***
5	101-105 & 121-123	21EN1111	ENGINEERING MECHANICS	CR	2	-	-	-	2	*	***
6	101-105 & 121-123	21EN1112	BIOLOGICAL SCIENCES	CR	2	-	-	-	2	*	***
7	101-105 & 121-123	21EN1113	TECHNICAL COMMUNICATION	CR	2	-	-	-	2	*	***
8	101-105 & 121-123	21EN1114	DESIGN THINKING	CR	-	-	2	-	1	*	**
					16	01	10	--	22		
9	101-105 & 121-123	21AU0004	CONSTITUTION OF INDIA AND ETHICS	AU	02	--	--	--	--	*	**

SCHEME - B.TECH – 2021-22 ONWARDS

II SEM - CHEMISTRY CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	101-105 & 121-123	21EN1201	TRANSFORMS AND DIFFERENTIALEQUATIONS	CR	3	1	-	-	4	*	***
2	101-105 & 121-123	21EN1102	ENGINEERING CHEMISTRY	CR	3	-	2	-	4	*	***
3	101-105 & 121-123	21EN1103	BASIC ELECTRICAL ENGINEERING	CR	3	-	-	-	3	*	***
4	101-105 & 121-123	21EN1104	ELEMENTS OF MECHANICAL ENGINEERING	CR	2	-	2	-	3	*	***
5	101-105 & 121-123	21EN1105	FUNDAMENTALS OF PROGRAMMING	CR	3	-	4	-	5	*	***
6	101-105 & 121-123	21EN1106	ENVIRONMENTAL SCIENCES	CR	2	-	-	-	2	*	***
7	101-105 & 121-123	21EN1107	KANNADA KALI/MANASU	CR	1	-	-	-	1	*	***
					17	01	08	--	22		

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SCHEME - B.TECH – 2021-22 ONWARDS

II SEM - PHYSICS CYCLE

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	101-105 & 121-123	21EN1201	TRANSFORMS AND DIFFERENTIALEQUATIONS	CR	3	1	-	-	4	*	***
2	101-105 & 121-123	21EN1108	ENGINEERING PHYSICS	CR	3	-	2	-	4	*	***
3	101-105 & 121-123	21EN1109	BASIC ELECTRONICS	CR	3	-	2	-	4	*	***
4	101-105 & 121-123	21EN1110	ENGINEERING GRAPHICS AND DESIGN	CR	1	-	4	-	3	*	***
5	101-105 & 121-123	21EN1111	ENGINEERING MECHANICS	CR	2	-	-	-	2	*	***
6	101-105 & 121-123	21EN1112	BIOLOGICAL SCIENCES	CR	2	-	-	-	2	*	***
7	101-105 & 121-123	21EN1113	TECHNICAL COMMUNICATION	CR	2	-	-	-	2	*	***
8	101-105 & 121-123	21EN1114	DESIGN THINKING	CR	-	-	2	-	1	*	***
					16	01	10	--	22		

9	101-105 & 121-123	21AU0004	CONSTITUTION OF INDIA AND ETHICS	AU	02	--	--	--	--	*	** *

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SCHEME - B.TECH – 2021-22 ONWARDS

III SEM – CSE (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR /AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	122	21CS2301	DISCRETE MATHEMATICAL STRUCTURES	CR	3	-	-	-	3	*	***
2	122	21CS2302	DATA STRUCTURES	CR	3	-	-	-	3	*	***
3	122	21CS2303	DIGITAL ELECTRONICS & LOGIC DESIGN	CR	3	-	-	-	3	*	***
4	122	21CS2304	FULL STACK DEVELOPMENT	CR	2	-	2	-	3	*	***
5	122	21DS2301	DATA WAREHOUSE AND KNOWLEDGE MINING	CR	3	-	-	-	3	*	***
6	122	21DS2302	DATA ANALYTICS AND EXPLORATION	CR	3	-	-	-	3	*	***
7	122	21CS2307	DATA STRUCTURES LAB	CR	-	-	2	-	1	*	***
	122	21CS2308	DIGITAL ELECTRONICS & LOGIC DESIGN LAB	CR			2		1		

9	122	21CS2309	MANAGEMENT AND ENTREPRENEURSHIP	CR	2	-	-	-	2	*	* * *
10	122	21CS2310	LIBERAL STUDIES – I	CR	1	-	-	-	1	*	* * *
					20	-	06	-	23		

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SCHEME - B.TECH – 2021-22 ONWARDS

IV SEM – CSE (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S / P	C	SEM	COURSE CODE
1	122	21CS2401	PROBABILITY AND STATISTICS	CR	3	-	-	-	3	*	***
2	122	21CS2402	DESIGN AND ANALYSIS OF ALGORITHMS	CR	3	-	-	-	3	*	***
3	122	21CS2403	PRINCIPLES OF MICROPROCESSORS AND COMPUTER ORGANIZATION	CR	4	-	-	-	4	*	***
4	122	21CS2404	FINITE AUTOMATA & FORMAL LANGUAGES	CR	3	-	2	-	4	*	***
5	122	21CS2405	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	CR	3	-	-	-	3	*	***
6	122	21DS2401	FUNDAMENTALS OF DATA SCIENCE	CR	3	-	-	-	3	*	***
7	122	21CS2407	DESIGN AND ANALYSIS OF ALGORITHMS LAB	CR	-	-	2	-	1	*	***
8	122	21DS2402	DATA SCIENCE LAB	CR	-	-	2	-	1	*	***

9	122	21CS2409	SPECIAL TOPICS – I	CR	-	-	-	4	2	*	***
10	122	21CS2410	LIBERAL STUDIES – II	CR	1	-	-	-	1	*	***
					19	-	08	4	25		

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SCHEME - B.TECH – 2021-22 ONWARDS

V SEM – CSE (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	122	21DS3501	DATABASE MANAGEMENT SYSTEMS	CR	3	-	-		3	*	***
2	122	21DS3502	OBJECT ORIENTED PROGRAMMING WITH JAVA	CR	3	-	2	-	4	*	***
3	122	21DS3503	OPERATING SYSTEMS	CR	3	1	-	-	4	*	***
4	122	21DS3504	MACHINE LEARNING TOOLS & TECHNIQUES	CR	3	-	2		4	*	***
5	122	21DS35XX	PROFESSIONAL ELECTIVE-1	CR	3	-	-	-	3	*	AS INDICATED IN ELECTIVE LIST
6	122	21OEXXXX	OPEN ELECTIVE-1	CR	3	-	-	-	3	*	***
7	122	21DS3505	DATABASE MANAGEMENT SYSTEMS LABORATORY	CR	-	-	2	-	1	*	***
8	122	21DS3506	OPERATING SYSTEMS LABORATORY	CR	-	-	2	-	1	*	***
9	122	21DS3507	SPECIAL TOPICS -II	CR		-	-	4	2	*	***
					18	**1**	**8**	**4**	**25**		

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SCHEME - B.TECH – 2021-22 ONWARDS
V SEM-PROFESSIONAL ELECTIVE – I

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	21DS3508	PATTERN RECOGNITION	03	–	–	–	03	–	**
2	21DS3509	ARTIFICIAL INTELLIGENCE	03	–	–	–	03	–	**

SCHEME - B.TECH – 2021-22 ONWARDS

VI SEM – CSE (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	122	21DS3601	COMPILER DESIGN AND SYSTEM SOFTWARE	CR	3	1	-	-	4	*	***
2	122	21DS3602	COMPUTER NETWORKS	CR	3	-	2	-	4	*	***
3	122	21DS3603	ADVANCED DATA SCIENCE	CR	3	-	-	-	3	*	***
4	122	21DS36XX	PROFESSIONAL ELECTIVE-2	CR	3	-	-	-	3	*	AS INDICATED IN ELECTIVE LIST
5	122	21DS36XX	PROFESSIONAL ELECTIVE-3	CR	3	-	-	-	3	*	
6	122	21OEXXXX	OPEN ELECTIVE-2	CR	3	-	-	-	3	*	***
7	122	21DS3604	COMPILER DESIGN AND SYSTEM SOFTWARE LAB	CR	-	-	2	-	1	*	***
8	122	21DS3605	ADVANCED DATA SCIENCE LAB	CR	-	-	2	-	1	*	***
					18	**01**	**06**		**22**		

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VI SEM-PROFESSIONAL ELECTIVE – II

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	21DS3606	NATURAL LANGUAGE PROCESSING	3	-	-	-	03	*	***
2	21DS3607	EMBEDDED IOT	3	-	-	-	03	*	***

VI SEM-PROFESSIONAL ELECTIVE – III

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	21DS3608	MOOC	3	-	-	-	03	*	***
2	21DS3609	SOCIAL NETWORK ANALYSIS	3	-	-	-	03	*	***

SCHEME - B.TECH – 2021-22 ONWARDS

VII SEM – CSE (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	122	21DS47XX	PROFESSIONAL ELECTIVE – 4	CR	3	-	-	-	3	*	AS INDICATED IN ELECTIVE LIST
2	122	21DS47XX	PROFESSIONAL ELECTIVE – 5	CR	3	-	-	-	3	*	
3	122	21OEXXXX	OPEN ELECTIVE-3	CR	3	-	-	-	3	*	***
4	122	21DS4701	PROJECT PHASE – I	CR	-	-	-	6	3	*	***
					9			06	12		

VII SEM-PROFESSIONAL ELECTIVE – IV

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	21DS4702	IMAGE PROCESSING AND COMPUTER VISION	3	-	-	-	03	*	***
2	21DS4703	CLOUD DATA ANALYTICS	3	-	-	-	03	*	***

VII SEM-PROFESSIONAL ELECTIVE – V

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	21DS4704	DEEP LEARNING	3	-	-	-	03	*	***
2	21DS4705	BUSINESS INTELLIGENCE	3	-	-	-	03	*	***

SCHEME - B. TECH – 2021-22 ONWARDS
VIII SEM – CSE (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	122	21DS48XX	PROFESSIONAL ELECTIVE – 6	CR	3	-	-	-	3	*	AS INDICATED IN ELECTIVE LIST
2	122	21DS4801	PROJECT PHASE – II	CR	-	-	-	12	6	*	***
3	122	21DS4802	INTERNSHIP		-	-	-	6	3		
					03	-	-	12	12		

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VIII SEM-PROFESSIONAL ELECTIVE – VI

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	21DS4803	DATA PRIVACY AND CYBER SECURITY	3	-	-	-	3	*	***
2	21DS4804	BLOCK CHAIN AND CRYPTOCURRENCY	3	-	-	-	3	*	***
3	21DS4805	HIGH PERFORMANCE COMPUTING	3	-	-	-	3	*	***

OPEN ELECTIVE (offered from Data Science)

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	21OE0030	STATISTICAL TOOLS AND TECHNIQUES OF DATA SCIENCE	3	-	-	-	3	*	***

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1101	LINEAR ALGEBRA AND CALCULUS	3	1	-	-	4

COURSE LEARNING OBJECTIVES:

1. To understandthe basic concepts of linear algebra to illustrate its power and utility through applications to science and Engineering.
2. To study the basic concepts of vector spaces, linear transformations, matrices andinner product spaces in engineering.
3. To discuss the algebraic as well as geometric perspectives pretained to the course.
4. To learn the basic functions represented in a variety of ways: graphical, numerical, analytical, or verbal.
5. To develop an appreciation of calculus as a coherent body of knowledge and as a human accomplishment.
6. To understand the meaning of the definite integral both as a limit of Riemann sumsand as the net accumulation of a rate of change.
7. To understand the relationship between the derivative and the definite integral as expressed in both parts of the Fundamental Theorem of Calculus.

COURSE OUTCOME:

At the end of this course the students are expected to

1. Determine the reasonableness of solutions, including sign, size, relative accuracy, and units of measurement.
2. Apply thhe abstract concepts of matrices and system of linear equations using decomposition methods
3. Explain the basic notion of vector spaces and subspaces
4. Apply the concept of vector spaces using linear transforms which is used in computer graphics and inner product spaces.
5. Analyze functions using limits, derivatives, and integrals.
6. Recognize the appropriate tools of calculus to solve applied problems.

COURSE CONTENT: Total: 52 Hours

Module-1

LINEAR EQUATIONS AND VECTOR SPACES

Introduction - Row reduction and echelon forms- Gaussian-Elimination - Solution sets of linear equations – LU decomposition - Inverse of a matrix by Gauss Jordan method, Linearspaces – Subspaces - Linear independence – Span - Bases and Dimensions. Self Learning

Component: Algebra of Matrices.ule-2

LINEAR TRANSFORMATIONS AND ORTHOGONALITY

Linear transformations – Basic properties - Invertible linear transformation - Matrices of linear transformations - Vector space of linear transformations– Orthogonal Vectors - Projections onto Lines - Projections and - The Gram- Schmidt Orthogonalization process.

Self Learning Component: Examples of vector spaces and subspaces, Rank of a matrix.

Module-3

EIGEN VALUES AND EIGEN VECTORS

Introduction to Eigen values and Eigen vectors - Characteristic equation - Diagonalization of a Matrix- Diagonalization of symmetric matrices - Quadratic forms - Singular Value Decomposition - QR factorization.

Self Learning Component: Determinant and Properties of Eigen values and Eigen vectors

Module-4

DIFFERENTIAL CALCULUS

Taylor's Theorem- Taylor's series – Maclaurin Series- Indeterminate forms and L- Hospital'sRule- Partial Differentiation – Total derivative-Chain Rule of Partial Differentiation- Differntiation of Implicit function, Euler's Theorem on homogeneous function- Jacobian- Maxima and Minima of functions of two variables-Taylor's Theorem.

Self Learning Component: Functions and graphs, Limits and Continuity, Differentiation

Module-5

INTEGRAL CALCULUS

Reduction formula-Improper integrals- Beta and Gamma integrals-Double integration-Change of order of integration-triple integration.

TEXT BOOK(S)

1. D C Lay, S R Lay and JJ McDonald, Linear Algebra and its Applications, Pearson India,Fifth edition.
2. Linear Algebra and its Applications by Gilbert Strang, 4 th Edition, ThomsonBrooks/Cole, Second Indian Reprint 2007.
3. G.B. Thomas, Maurice T Weir and Joel Hass Thomas's Calculus ,12th Edition, Pearson India.

REFERENCE BOOKS

1. Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Cengage Learning (2015).
2. Higher Engineering Mathematics by B S Grewal, 42 nd Edition, Khanna Publishers.
3. Elementary Linear Algebra, Stephen Andrilli and David Hecker, 5th Edition, Academic Press (2016)
4. Contemporary linear algebra, Howard Anton, Robert C Busby, Wiley 2003
5. B.S. Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2014.
6. Introductory Linear Algebra- An applied first course, Bernard Kolman and David, R. Hill,9th Edition, Pearson Education, 2011.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1102	ENGINEERING CHEMISTRY	3	-	2	-	4

COURSE LEARNING OBJECTIVES:

- The Theory Course intends to provide chemical concepts most relevant to engineering students and demonstrate them in an applied context.
- The student is exposed to the principles required to understand important contemporary topics like alternate energy sources, corrosion control, polymer technology, phase equilibria nanomaterials and green chemistry and catalysis.
- The underlying theme is to emphasize on applications of these concepts to real world problems

COURSE OUTCOME:

• Appreciate the basic principles of electrochemistry, use of different types of electrodes in analysis and evaluate cell potential for different cell reactions.

• Know construction, working and applications of various energy storage devices such as batteries, fuel cells and supercapacitors.

• Understand basic principles of corrosion and apply suitable techniques for corrosion control. Also know the technological importance and processes involved in metal finishing.

• Know the synthesis, structure –property relationship and applications of commercially important polymers and polymer composites. Understand properties and applications of nanomaterials. Also learn the principles of green chemistry for a sustainable and eco-friendly world.

COURSE CONTENT: Total: 40 Hours

Theory –Syllabus

Module-

1Chemical

Energy Source:

Introduction to energy; Fuels - definition, classification, importance of hydrocarbons as fuels; Calorific value-definition, Gross and Net calorific values (SI units). Determination of calorific value of a solid / liquid fuel using Bomb calorimeter. Numerical problems on GCV & NCV. Petroleum cracking-fluidized catalytic cracking. Reformation of petrol. octane number, cetane number, anti-knocking agents, power alcohol, Biodiesel & Biogas.

Solar Energy:

Thermal energy: Photovoltaic cells- Introduction, definition, importance, working of PV cell.Solar grade silicon physical and chemical properties relevant to photo-voltaics, doping of silicon by diffusion technique.

Module-2

Energy Science and Technology

Single electrode potential - Definition, origin, sign conventions. Standard electrode potential- Definition-Nernst equation expression and its Applications. EMF of a cell-

Definition, notation and conventions. Reference electrodes– Calomel electrode, Ag/AgCl electrode. Measurement of standard electrode potential. Numerical problems on EMF. Ion-selective electrode- glass electrode

Battery technology: Basic concepts including characteristics of anode, cathode, electrolyte and separator. Battery characteristics. Classification of batteries–primary, secondary and reserve batteries. State of the art Batteries-Construction working and applications of Zn-air, Lead acid battery, Nickel-Metal hydride and Lithium ion batteries.

Introduction to fuel cells, types of fuel cells. Construction, working and application of Methanol-Oxygen fuel cell.

Module-3

Corrosion Science:

Definition, Chemical corrosion and Electro-chemical theory of corrosion, Types of corrosion, Differential metal corrosion, Differential aeration corrosion (pitting and water line corrosion), Stress corrosion. Corrosion control, Metal coatings- Galvanization, Tinning and its disadvantages. Cathodic protection of Corrosion: Sacrificial anode method and current impression method.

Surface Modification Techniques:

Definition, Technological importance of metal finishing. Significance of polarization, decomposition potential and over-voltage in electroplating processes, Electroless Plating. Distinction between electroplating and Electroless plating, advantages of electroless plating. Electroless plating of copper.

Module-4

High Polymers: Introduction to polymers, Glass transition temperature, structure and property relationship. Synthesis, properties and applications of Teflon. PMMA. Elastomers -Deficiencies of natural rubber and advantages of synthetic rubber. Synthesis and applicationof silicone rubber, Conducting polymers-Definition, mechanism of conduction in polyacetylene. Structure and applications of conducting Polyaniline.

Nanotechnology: Introduction, properties, synthesis by sol-gel. Fullerenes, Carbon nanotubes, dendrimers and nano-composites

Module-5

Water Technology:

Impurities in water. Hardness of Water: Types of Hardness and determination of total hardness of water by using disodium salt of ethylenediaminetetraacetic acid method, Potablewater treatment by Electro dialysis and Reverse Osmosis. Water analysis- Biochemical oxygen demand and Chemical oxygen demand. Determination of COD. Numerical problems on COD. Sewage treatment.

Instrumental Methods of Analysis: Instrumental methods of analysis, Principles ofspectroscopy-Beer's Lamberts law, Difference between spectrometer and spectrophotometer, Potentiometry, Conductometry (Strong acid against strong base, weak acid against strong base, mixture of strong acid and a weak acid against strong base)

TEXT BOOK(S)

1. Dr. S. Vairam, Engineering Chemistry, Wiley-India Publishers, 2017,
2. S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, 2015

REFERENCE BOOK(S)

1. Prasanta Rath, "Engineering Chemistry", Cengage Learning India PVT, LTD, Delhi, 2015.
2. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.

List of Laboratory/Practical Experiments activities to be conducted: 28

Hrs Volumetric Analysis and Preparations

1. Evaluation of quality of water in terms of total hardness by Complexometic titration.
2. Determination of Chemical Oxygen Demand (COD) of the given industrial waste water sample.
3. Determination of Alkalinity of the given water sample
4. Preparation of MgO nanoparticles by solution combustion method (Demonstration experiment) and spectrometric analysis.
5. Electroless plating of copper (Demo experiment)
6. Preparation of Polyaniline (Demo experiment)

Instrumental methods of Analysis

1. Potentiometric titration–Estimation of FAS using standard K2Cr2O7 solution.
2. Conductometric estimation of hydrochloric acid using standard sodium hydroxide solution
3. Determination of viscosity coefficient, surface tension, density of a given liquid
4. Colorimetric estimation of copper in a given solution
5. Determination of Pka of given weak acid.
6. Determination of calorific value of coal/oil using Bomb calorimeter (Group

REFERENCE BOOKS:

1. Dayanada Sagar University laboratory manual.
2. J. Bassett, R.C. Denny, G.H. Jeffery, Vogels, Text book of quantitative inorganic analysis, 4th Edition.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1103	BASIC ELECTRICAL ENGINEERING	3	-	-	-	3

COURSE LEARNING OBJECTIVES:

This course enables students:

- To impart basic knowledge of electrical quantities such as current, voltage, power and energy
- To distinguish between passive and active electrical components
- To explain the general structure of electrical power system
- To define basic laws of electric circuit and to solve related problems
- To understand basics of earthing, protective devices and wiring
- To introduce concepts, analogies and laws of magnetic circuits
- To learn the working principle, construction and characteristics of various DC machines
- To study the construction, principle of operation and types of transformers
- To understand the working principles of measuring equipment.

COURSE OUTCOME:

- Explain the basic knowledge about the Electric and Magnetic circuits.
- Applying basic laws and determine various circuit parameters in AC and DC Circuits.
- Analyze the working of various Electrical Machines.
- Explain the construction, basic principle of operation, applications and determine performance parameters of various measuring instruments
- Outline the knowledge of Green Energy, Electrical Safety Rules & standards COURSE

CONTENT: Total: 45 Hours

Module -1

ELECTRICAL CIRCUIT CONCEPTS

Voltage and current sources: independent, dependent, ideal and practical; V-I relationships of resistor, ohm's law, inductor, and capacitor; types of electrical circuits, voltage and currentdivider rule, Kirchhoff's laws, Peak, average and rms values of ac quantities; apparent, active and reactive powers; phasor analysis, Power factor, impedance and admittance, power and energy in electrical elements, introduction to 3 phase systems

Module -2

MAGNETIC CIRCUIT CONCEPTS

Basics of magnetic circuits, laws of magnetism, magnetic field, magnetic lines of force, permeability, Electromagnetic Fields: Relation between field theory and circuit theory;numerical on capacitance calculations, Biot-Savart's law, Ampere's law, Curl, Faraday's law,Lorentz force, Inductance, Self and Mutual inductance of simple configurations.Module-3 DC Machines and Transformers

Dc Machines: Basic principles of electromagnetic energy conversion, Construction,operation, characteristics, performance, of dc generators and motors, testing of dc machines, applications, Transformers: Construction, working principle, equivalent circuit, voltage regulation, efficiency, Auto-transformers

Module-4

SI units, systematic and random errors in measurement, expression of uncertainty - accuracyand precision index, propagation of errors. General working principles and construction of indicating instruments. Electro-magnetic Instruments for the measurement of current, voltage, power and energy. Instruments for the measurement of power factor, frequency, Potentiometers. CRO, Calibration of instruments; importance, procedures and standards

Module-5

POWER STATION PRACTICES, ECONOMICS, AND GREEN ENERGY CONCEPTS

Energy generation-Conventional generation of electrical energy using thermal, hydro, nuclear and, non-conventional sources of energy; overview on green energy technology, load forecasting, electricity tariffs, power factor improvement, power plant economics, Overviewon electrical safety standards in industries

Text Books

1. D.P.Kothari and I.J. Nagrath, "Basic Electrical Engineering", 4th Edition, Tata McGraw Hill, 2010

2. B.L Thereja and A.K Thereja, "A text book of Electrical Technology (Vol III) (Transmission, distribution, and Utilization)", 23rd Edition, S Chand and Company.

Reference Books

1. Clayton Paul, Syed A Nasar and Louis Unnewehr, 'Introduction to Electrical Engineering', 2nd Edition, McGraw-Hill, 1992

2. P.S. Dhogal, 'Basic Electrical Engineering – Vol. I& II', 42nd Reprint, McGraw-Hill, 2012.

3. A. K Sawhney, A course in Electrical and Electronic Measurements and Instrumentation Dhanpat Rai & Co. (P) Limited January 2015

4. NPTEL - https://nptel.ac.in/courses/108/108/108108076/

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1104	ELEMENTS OF MECHANICAL ENGINEERING	2	-	2	-	3

COURSE LEARNING OBJECTIVES:

The objectives of the Course are to:

- Introduce different ways power generation using renewable and non- renewable energy resources
- Understand thermodynamic cycles for power generation
- Explain materials used for engineering applications
- Learn transmission of power using Gear & Belt Drives
- Understand manufacturing process like metal cutting, welding and Foundry
- Introduce mechatronics, PLC, instrumentation & control systems
- Explain rapid prototyping, 3D printing and electric mobility
- Develop skills to use tools, machines, and measuring instruments

COURSE OUTCOMES:

- Identify various renewable and non-renewable energy resources
- State laws of thermodynamics used for energy conversion
- Compare power transmission using gear and belt drives
- Select different manufacturing methods like metal cutting, joining and foundry
- Construct different types of fitting, welding, sheet metal, turning models
- Demonstrate working of engines, turbines, pumps, 3D printing; wood working, foundry & smithy operations

COURSE CONTENT: Total: 28 Hours

Module-1

Energy Conversion

Renewable & Nonrenewable energy resources: Introduction to Steam, Hydro & Nuclear power plants, solar, wind and biomass energy based power plants, Effect of power generation on environment

Thermodynamics: First and second laws of thermodynamics, Efficiency, COP, Carnot theorem, Numericals

Module-2

Prime Movers & Pumps

Gas and Vapour cycles: Carnot, Otto, Diesel, Brayton, Rankine & Refrigeration cycles Prime movers: 4 stroke- petrol and Diesel engines, Gas turbines-open and closed Cycle, steam turbines-Impulse and reaction, Numericals.

Introduction to pumps: Working of centrifugal and reciprocatingModule-3

Materials & Mechanical Design

Materials: Introduction to ferrous, non-ferrous & composites, Stress-strain diagrams, Mechanical Properties for materials
Mechanical Design: Introduction, Simple Stresses and strains, Elastic constants, PowerTransmission: Gear & Belt Drives, Numerical problems

Module-4

Manufacturing Processes
Metal cutting: Introduction, classification of machine tools, basic operations on lathe, drilling,shaper, milling, grinding, introduction to CNC machining
Joining Processes: Welding- classification, gas, arc, laser & friction welding, brazing and soldering
Foundry: Basic terminology, Types of patterns, sand moulding

Module-5

Advanced Technologies in Mechanical Engineering
Mechatronics: Introduction, Mechatronics, PLC, Instrumentation & control systemsRobotics: Introduction, Robot anatomy, configurations, Sensors, applications
Rapid prototyping & 3D Printing: Introduction & applications, powder-based additive manufacturing processes
Electric Mobility: Introduction, electric, hybrid and autonomous vehicles

List of Laboratory/Practical Experiments activities to be conducted: 28 Hrs

1. Fitting Shop- Simple exercises involving fitting work-Dove tail.
2. Welding Shop- Simple butt and Lap welded joints using arc welding
3. Sheet-metal Shop- Fabrication of tray, Making Funnel complete with soldering
4. Lathe machining on plain and step turning

Demonstration of:
1. Pelton wheel and Francis turbine
2. 4 stroke petrol and diesel engines
3. Lathe, milling, drilling, grinding & CNC milling machines and wood turning lathe
4. Foundry and smithy operations
5. 3D printing parts

Industrial Visit- Report makingText books:

1. Nag P K (2017). “Basics and applied thermodynamics”, Second edition, Tata McGraw Hill, New Delhi.
2. P.N. Rao (2018). “Manufacturing Technology-Foundry, Forming and Welding”, Volume 1, 4th Edition, Tata McGraw Hill Publishing Co Ltd.
3. P.N. Rao (2018). “Manufacturing Technology- Metal Cutting and Machine Tools”, Volume 2, 4th Edition, Tata McGraw Hill Publishing Co Ltd.

REFERENCES:

1. El –Wakil M. M (2017). “Power plant technology”, Tata McGraw Hill edition, New Delhi.
2. Larminie J, Lowry J (2017). “Electric vehicle technology explained”, John Wiley and & Sons Ltd. USA.
3. William D. Callister and David G. Rethwisch (2011). “Fundamentals of Materials Science and Engineering: An Integrated Approach”, John Wiley & Sons; 4th Edition.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1105	FUNDAMENTALS OF PROGRAMMING	3	-	4	-	5

COURSE LEARNING OBJECTIVES:

- To develop student competence in writing clear, correct, and maintainable programs that implement known algorithms.

COURSE OUTCOMES:

- Express algorithms learned implicitly in school explicitly in algorithmic form and calculate the number of basic operations (exact or upper bound).
- Trace the execution of short programs/code fragments involving fundamental programming constructs.
- Write a short program/code fragment for a given task using fundamental programming constructs.
- Debug a short program/code fragment with fundamental programming constructs manually, and debug more complex code using a modern IDE and associated tools.
- Design a large program, conduct a personal code review, and contribute to a small- team code review focused on common coding errors and maintainability using a provided checklist.

COURSE CONTENT: Total: 56 Hours

Module-1

BASICS AND OVERVIEW OF C

Introduction to Problem Solving using Algorithms and Flowchart: Key features of Algorithms: Sequence, Decision, Repetition with examples. Background, structure of C program, keywords, Identifiers, Data Types, Variables, Constants, Input / Output statements, Operators (Arithmetic, relational, logical, bitwise etc.), Expressions, Precedence and Associativity, Expression Evaluation, Type conversions. Conditional Branching Statements- if and switch statements, iterative statements (loops)-while, for, do-while statements, Loop examples, Nested loops, break, continue, go to statement.

Module-2

ARRAYS AND STRINGS

Arrays: Introduction, declaration & initialization of array, reading and writing array elements, Operations on array: Traversal, searching, sorting. Declaration and Initialization of two-dimensional arrays. Matrix Operations (addition, subtraction, multiplication, transpose) using two-dimensional array.

Strings: Definition, declaration, initialization, and representation. String handling functions and character handling functions.Module-3

POINTER AND FUNCTIONS

Pointers: Definition and declaration and initialization of pointers. Accessing values using pointers. Accessing array elements using pointers.
Functions: Definition and declaration. Built-in functions and User-defined functions. Categories of functions with example. Pointers as function arguments, array as function argument, Call-by-value and call-by-reference. Recursion.

Module-4

STRUCTURES AND UNIONS

Structures: Purpose and usage of structures. Declaration of structures. Assignment with structures. Structure variables and arrays. Nested structures. Student and employee database implementation using structures.
Unions: Declaration and initialization of a union. Difference between structures and unions. Example programs.

Module-5

DYNAMIC MEMORY ALLOCATION AND FILES

Memory allocation in C programs: Dynamic memory allocation, memory allocation process, allocating a block of memory, releasing the used space, altering the size of allocated memory.Files: Defining, opening and closing of files. Input and output operations.

List of Laboratory/Practical Experiments activities to be conducted :
1. Design a C program to Swapping of two numbers. (Simple Expressions).
2. Design a C program to Convert Celsius to Fahrenheit.
3. Design a C program to find the simple interest as per the below conditions (Simple expressions, Integer division issues (data loss), Explicit typecasting, when p, t, r are integers and si is float.
4. Design a C program to find the largest of 3 numbers. a) Using if and no else. (Conditionals) b) Using nested if. (conditionals and Boolean expressions) c) Using Ladder if else if d) Using Ternary operator.
5. Design a program that takes three coefficients (a, b, and c) of a Quadratic equation (ax2+bx+c=0) as input and compute all possible roots.

6. Design a C program to read the vehicle type (Use c or C for car, b or B for bus, t or T for Tempo for vehicle type) and Duration of customer vehicle parked in parking slot. Parking fare is calculated as per the rates given below: print the total parking charges.

Vehicle	First Rate	Second Rate
Car	Rs 20/hr for first 2hr	Rs 30/hr for next
Bus	Rs 40/hr for first 2hr	Rs 50/hr for next
Tempo	Rs 30 /hr for first 2hr	Rs 40/hr for next

7. a Write a program to calculate the factorial of a given number.
   b Write a program using four functions to check if the given number is a palindrome.

8. a Sum of natural numbers (sum(n) = n + sum(n-1);).
   b. Write a program to calculate Power of a number ($b^n = b * b^{n-1}$).

9. Write a program to calculate nth fibonacci number given first two numbers in the series.

Inputs	n	Output
0,1	3	2
1,5	4	11
2,4	7	42
8,1	5	19
3,5	6	34

10. a Write a program using four functions to check if the given number is apalindrome.
    b. Write a program to calculate GCD of two numbers.

11. Write a program to emulate a calculator with the following operations: Addition, Subtraction, Multiplication, Division – using functions, switch and break.)

12. Write a program using four functions to compute the sine of a value using Taylor's series approximation - pass by value.

13. Write a program to find the sum of n different using four functions and arrays.
    Use the following function prototype: void
    input(int n, int a[n]);
    int add(int n, int a[n]);
    void output(int n, int a[n],int sum) and main().

14. Write a program to add two matrices using separate function for input, add matrices, display_matrix and main function.
15. String handling: a) Write a function to reverse the string in reverse and display it. (Strings))

b) Write a function to concatenate the two strings without using strcat.(Strings) c) Write a function to find the length of the string.
16. Write a program using Bubble sort technique to sort an array of integer elements .(Sorting technique, Const array arguments.)
17. Write a program to search an array of elements of data type requested by the user for a given item using binary search algorithm. (Searching technique, Const array arguments).
18. Write a program with functions to add and multiply two complex numbers. Define a structure Complex to represent a complex number. The main function should call other functions for the purposes of input, computations and display. (Structs as arguments).
19. Write a program to add n fractions using function.
20. Define a structure, student, to store the following data about a student: rollno (integer), name (string) and marks(integer) . Your program must contain the following functions: (Array of Structures). (5 marks) · A function to read the students data. · A function to display records of each student. · A function to sort the records of student RankWise · A function print all students details · A function to search student details by Rollno · A function to print the names of the students having the highest test score

TEXT BOOKS:

1. Brian W. Kernigham and Dennis M. Ritchie, (2012) “The C Programming Language”, 2nd Edition, PHI.
2. Reema Thareja, "Programming in C". Oxford University Press, Second Edition, 2016

REFERENCES:

1. R. S Bichkar, “Programming with C and Data Structure”, University Press, 2014
2. Behrouz A. Forouzan, Richard F. Gilberg, “Computer Science - A Structured Approach Using C”,Cengage Learning, 2007
3. Brian W. Kernigham and Dennis M. Ritchie, “The C Programming Language”, 2nd Edition, PHI, 2012
4. Vikas Gupta, “Computer Concepts and C Programming”, Dreamtech Press 2013.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1106	ENVIRONMENTAL SCIENCES	2	-	-	-	2

COURSE LEARNING OBJECTIVES:

- To understand the concepts of ecosystem, energy and non-renewable energy resources
- To learn water quality aspects requirement and water safety plans
- To explain solid waste and sewage management
- To create awareness of noise, air & land pollution and knowledge of the current issues and pollution endangering life on earth
- To learn environmental laws and regulations
- To understand environmental protection protocols and regulations

COURSE OUTCOMES

- Analyse basic concepts that govern environmental quality, atmospheric principlesand environmental standards
- Compare different Energy resource and their environmental implications
- Identify different types of pollution, waste streams
- Identify different natural and manmade disasters and prevention
- Apply the process of environmental impact assessment and implications of Indian Environment Laws

COURSE CONTENT: Total: 28 Hours

Module-1

Basic Concepts of Environment

Scope and importance of environmental studies, Definition of environment- comprehensive understanding of environment, Basic concepts: Xenobiotic, natural & anthropogenic; why are we concerned? Types of xenobiotics: Chemical, Physical, Biological pollutants; Hazard &Risk, Eco-kinetic & Bio-kinetic Properties of a xenobiotic, Dose-Response Relationships- chronic and acute effects, Environmental Standards: AAQS, TLV's, Appraisal, Assessment & Abatement (Recognition, Evaluation & Control) of pollutants- Structure of Atmosphere; Atmospheric inversions, Environmental System.
Air Pollution: Criteria pollutants – Ozone, Particulate Matter, Carbon Monoxide, Nitrogen, Oxides, Sulphur Dioxide, Lead; SMOG & Air-pollution episodes
Aerosols: Primary & Secondary pollutants, Acid Rain Cycle.

Module-2

Water Treatment
Hydrosphere, Lentic and Lotic Water Systems, Fresh Water as a resource; Rain WaterHarvesting, Treatment of potable water, Waste water- Characteristics, Municipal Sewage

Water and Treatment.
Waste ManagemenTypes of Wastes: Municipal Solid Waste, Hazardous Waste, Nuclear Waste, Electronic Waste, Biomedical Waste, Solid Waste Management: Landfills, composting
Water Standards

Module-3

Energy

Types of energy: Conventional sources of energy, fossil fuel, Coal, Nuclear based, Solar, wind,sea-Tidal Wave energy, Geo-Thermal, Non-conventional sources of Energy, Biofuels - biomass, biogas, Natural Gas; Hydrogen as an alternative future source of energy.

Module-4

Disasters & Management
Definition, origin and classification. Natural (Earthquakes, landslides, floods, Cyclones), Man-made disasters (biological, chemical, nuclear, radiological explosions) – definition, causes and management and/or mitigation strategies; Bhopal & Chernobyl Disasters, Environment& Health - Occupational Health Hazards, Occupational Diseases, Epidemics, Pandemics,Endemics (Fluoride, Arsenic)
Principles and Significance of Sanitation

Module-5

Environmental Impact Assessment (EIA) and Indian acts and regulations

Principles of EIA, Indian Acts and Rules, Wildlife (Protection) Act 1972. Water Act – 1974 (Rules 1975), Forest Conservation Act 1980 (Rules 2003), Air Act -1981 (Rules 1982, 1983),Environment Protection Act, 1986

TEXT BOOKS:

1. Benny Joseph (2005). “Environmental Studies”, Tata McGraw – Hill Publishing Company Limited, New Delhi.
2. R.J.Ranjit Daniels and Jagadish Krishnaswamy (2009). “Environmental Studies”. Wiley India Private Ltd., New Delhi.
REFERENCES:
1.P.Aarne Vesilind, Susan M.Morgan, Thomson (2008). “Introduction to Environmental Engineering” (2008), Thomson learning, Second Edition, Boston.
2. R. Rajagopalan (2005). “Environmental Studies – From Crisis to Cure” Oxford University Press, New Delhi.
3. R. J. Ranjit Daniels and Jagadish Krishnaswamy (2014). “Environmental Studies” (2014), Wiley India Pvt Limited, New Delhi.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1107`	KANNADA KALI	1	-	-	-	1

COURSE OBJECTIVES:

- To introduce Kannada language & culture to Non – Kannada speakers.
- To train them to communicate in colloquial Kannada with connivance

COURSE OUTCOMES:

- The learners can communicate in Kannada & acquaint themselves with Kannada culture

COURSE CONTENT

- Introduction to Karnataka & Kannada Culture.
- Evolution of Kannada.
- Introduction to Kannada Alphabets.
- Introduction to Kannada Numbers.
- Kannada words, sentences & phrase making for colloquial communication.

REFERENCE BOOKS:

1. Kannada Kali –Dr. Lingadevaru Halemane
2. Kannada Paatagalu– Editor: Dr. Chandrashekara Kambara.
3. SLN Sharma & K Shankaranarayana “Basic Grammar”, Navakarnataka Publications.
4. Spoken Kannada. Publication: Kannada Sahitya Parishat Bengaluru.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1201	TRANSFORMS AND DIFFERENTIAL EQUATIONS	3	1	-	-	4

COURSE LEARNING OBJECTIVES:

1. To provide the basic concepts and necessary fundamentals to formulate, solveand analyze engineering problems.
2. To discuss the theoratic as well as geometric perspectives.
3. To understand the Fourier Series and Laplace Transform to solve real world problems.
4. To make strong foundation of the integral transforms and their inverses.
5. To understand the basic concepts of ODE and PDE to illustrate its power and utility through applications to science and Engineering.

COURSE OUTCOME:

At the end of this course the students are expected to

1. Apply Laplace transform and its inverse to solve differential and integral equations.
2. Represent the periodic functions using Fourier series.
3. Use Fourier transforms and its inverse in practical applications of engineering problems.
4. Apply transform techniques to analyze continuous-time and discrete-time
5. Solve engineering problems using the principles of solution of differential equations.
6. Solve ordinary differential equations using Laplace transform.
7. Apply the partial differential equation for solving engineering problems.

COURSE CONTENT: Total: 52 hours

Module-1

LAPLACE TRANSFORM AND INVERSE LAPLACE TRANSFORM

Basic concepts, Laplace transform of basic functions-Linearity and First shifting theorem, Laplace transforms of derivatives and integrals, Second shifting theorem, Initial and Final value theorems, Some basic transforms, Inverse Laplace transform, Convolution theorem, Applications to differential equations.

Self Learning Component: Differentiation of functions

Module-2

FOURIE

RSERIES

Fourier Series, Dirichlet's conditions , Euler's Formulae, Fourier series of discontinuous functions, Even and odd functions, Change of interval, Parseval's theorem, Complex form of Fourier series
Self-Learning Component: Basic definitions of series, examples

Module-3

FORIER TRANSFORM AND INVERSE FOURIER TRANSFORM

Fourier transform and Fourier's integral theorem, Fourier cosine integral, Fourier sine integral, Basic properties of Fourier transform.

Self Learning Component : Basic definitions and properties of integration

Module-4

ORDINARY DIFFERENTIAL EQUATION

Basic definitions-First oder first degree differential equations-Non homogeneous equations reducible to Homogeneous form-Exact differential equations-Bernaulli equation-Linear differential equations of second order with variable coiffiecients- Second order D.E with constant coiffiecients.

Self Learning Component: Basic definitions of differential equation and examples

Module-5

PARTIAL DIFFERENTIAL EQUATION s

Formation of partial differential equation –Solutions of partial differential equation – Linear equations of the first order- Charpit's Method-Rules for finding the complementary function-Finding the particular integral-Method of separation of variables-Heat equation- Wave equation – Laplace equation

Self Learning Component: Geometrical interpretation of Partial Differential equation

TEXT BOOKS

1. B.V Ramana, Higher Engineering Mathematics, Mc Graw Hill education India Pvt ltd,31st edition
2. B.S. Grewal , Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2014.
3. G.B.Thomas, Maurice T Weir and Joel Hass Thomas's Calculus ,12th Edition, Pearson India.

REFERENCE BOOKS

1. P. P. G. Dyke, An introduction to Laplace transform and Fourier Series, 4th Edition, Springer (2004).
2. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad S. Chand publication.
3. Erwin Kreyzsig, Advanced Engineering Mathematics, Wiley, 10th edition.
4. Stanley J. Farlow, Partial Differential Equations for Scientists and Engineers.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1108	ENGINEERING PHYSICS	3	-	2	-	4

COURSE LEARNING OBJECTIVES:

- To introduce the basic concepts of Quantum mechanics which are essential in understanding and solving problems in engineering,
- To review different types of Engineering materials –Electronic, electrical, mechanical and Magnetic materials Properties and their applications in Science and Engineering.
- To understand Band structure of solids, Semiconductors and electrical conductivity of SC’s, and their applications.
- To explain semiconductor devices like LED, Photodiode and Solar cell and Semiconductor BJT.
- To explain Thin-film Phenomena, Thin-film fabrication Process and their applications in engineering.
- To learn how to fabricate Nano materials by using Top-down and Bottom –up approach& To review Nano science and technology and its practical applications in biology, engineering and medicine.

COURSE OUTCOME:

- Describe the concepts of Quantum mechanics and applications of Schrodinger time independent wave equation in one dimensions.
- Discuss the different engineering materials such as Electronic, electrical and mechanical materials properties and their applications in engineering
- Illustrate Semiconductors , Semiconductor devices like Photo diode, LED, Solar cell and BJT and its applications
- Classify Lattice parameters of different crystalline solids by using X-ray diffraction methods and Summarize theoretical background of laser, construction and working of different types of lasers and its applications in science and engineering
- Interpret Basic concepts of Thin films and Thin film deposition processes and their applications leads to Sensors and engineering devices
- Discuss Nano materials, Properties and fabrication of Nano materials by using Top-down and Bottom –up approach’s-Applications for Science and technology

COURSE CONTENT: Total: 42 Hours

Module-1

Quantum Mechanics: Foundations of quantum theory, Wave function and its properties, de-

Broglie hypothesis, Heisenberg Uncertainty principle. One dimensional time independent Schrodinger wave equation, Eigen values and Eigen functions. Applications: one dimensional motion of an electron in a potential-well.
LASER PHYSICS: Introduction to lasers. Conditions for laser action. Requisites of a Laser system Principle, Construction and working of Nd-YAG and , Semiconductor Laser. Application of Lasers in Defense (Laser range finder), Engineering (Data storage) and Applications of Lasers in medicine

Module-2

Semiconductor Physics: Band structure, Fermi level in intrinsic and extrinsic semiconductors, Density of energy states in conduction and valence bands of a semiconductor (Mention the expression), Expression for concentration of electrons in conduction band (Derivation), Hole concentration in valance band (Mention the expression),Intrinsic carrier concentration Conductivity of semiconductors.
Semiconducting devices for optoelectronics applications: Principle and working of LED, photodiode, Solar cell,BJT and Numericals

Module-3

Introduction to Engineering materials: Classification of Engineering Materials such as Conductors, Semiconductors, Insulators. Electrical conductivity of metals and Semiconductors. Effect of temperature, composition on resistivity of materials.
Dielectrics: Introduction –Dielectric polarization– Dielectric Polarizability, Susceptibility and Dielectric constant-types of polarizations: Electronic and Ionic (Quantitative), Orientation polarizations (qualitative) – Lorentz Internal field – Claussius- Mossoti equation – Applications of Dielectrics. Numericals.

Module-4

Crystallography: Lattice, unit cell, lattice parameters, crystal systems, Bravais lattices, Packing fraction for SCC,BCC and FCC crystal systems. Introduction to Miller Indices. Determination of Crystal structure by Miller Indices. Expression for Inter-planar distance. X-ray diffraction, Bragg's law and Determination of Crystal structure by Powder method. Numericals
Mechanical Engineering Materials – mechanical properties: stress- strain curve for different materials. Introduction to Tensile strength, Compressive strength, Ductility, Toughness, Brittleness, Impact strength, Fatigue, Creep. Testing of engineering materials: Hardness Tests: Brinell and Vickers hardness test- (4 hours)

Module-5

Thin films technology: Introduction to thin-films-Advantages of thin-films over bulk materials. Thin film deposition processes- Physical vapour deposition (Thermal evaporationtechnique, and sputtering technique) process, Applications of Thin films.

Nano Science &technology: Introduction to Nano materials, Classification of nano materials, Size dependent properties of materials, Top-down and Bottom-up approach- Ball-milling and Photolithography, Process. Fundamental Principles of Bio- Physics &Applications of Nano technology in Biology and Engineering.

LABORATORY EXPERIMENTS

List of Experiments:

1. I-V characteristics of a Zener Diode
   I–V Characteristics of a Zener diode in forward and reverse bias condition(Module2)
2. Planck's constant
   Measurement of Planck's constant using LED(Module 2)
3. Transistor characteristics
   Input and output characteristics of a NPN transistor in C-E configuration(Module2)
4. Dielectric constant
   Determination of dielectric constant of a dielectric material (Module 2)
5. Torsional Pendulum
   Determination of moment of inertia of a circular disc using torsional pendulum
6. Diffraction grating
   Determination of wavelength of a laser light using diffraction grating (Module 4)
7. LCR series and parallel resonance
   Study the frequency response of a series and parallel LCR circuit (Module 3)
8. Band gap energy
   Determination of energy gap of an intrinsic semiconductor (Module 2)

TEXT BOOKS

1. S. M. Sze, Semiconductor devices, Physics and Technology, Wiley.Publishing
2. Engineering Physics (2019), DSU Pearson, New Delhi

REFERENCE BOOKS

1. M. Young (1977), Optics & Lasers An Engineering Physics approach, Springer2 K.L. Chopra, Thin film Phenomena, McGraw Hill, New York.
3. S. O. Pillai (2018), Solid State Physics, revised edition, New Age International Publishers, New Delhi
4. M N Avadhanulu, P G Kshirsagar, TVS Arun Murthy (2018), A textbook of Engineering Physics, S Chand, New Delhi.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1109	BASIC ELECTRONICS	3	-	2	-	4

COURSE OBJECTIVES

This course enables students:

•To introduce the concepts of fundamentals of semiconductor devices with the basicknowledge of the flow of current in semiconductor devices such as diodes and transistors

•To Explain the characteristics of various semiconductor devices and the concept ofIntegrated circuits

• To understand the principles of electronic circuits for operations of energy conversionsfrom AC to DC, noise removal and building the required power supply

•To understand how a particular electronic device can increase the power of a signal andalso to be acquainted with gain calculations

•To implement the Boolean functions and to realize basic logic gate operations and logic functions

•To understand the basics of communication system, to modify the characteristics of carrier signals according to the information signals

•To study the fundamentals of electromagnetic waves

•To identify and understand the different blocks present in transmitter and receiver.

•To describe various parameters of Op-Amp, its characteristics and specifications.

•To understand the various applications of Op-Amp.

COURSE OUTCOMES

- Explain the fundamentals of semiconductor devices, analog and digital circuits
- Design and analyze the behavior of analog and digital circuits.
- Outline the overview of communication systems and oscillators.
- Solve various kinds of numerical problems
- Develop the analog and digital circuits using simulation tool COURSE

CONTENT: Total: 45 Hours

Module-1

Semiconductor Diodes Semiconductor materials- intrinsic and extrinsic types, Ideal Diode. Terminal characteristics of diodes: p-n junction under open circuit condition, p-n junction under forward bias and reverse bias conditions, p-n junction in breakdown region, Zener diode, Series voltage regulator, Rectifier Circuits: Half wave and full wave, Reservoir and smoothing circuits.

Module-2

Transistors - Introduction, Transistor construction, operation and characteristics; Configuration types: Common base and common emitter configuration, Active region operation of transistor, Transistor amplifying action, Biasing the BJT: fixed bias, emitter feedback bias, collector feedback bias and voltage divider bias, Transistor as aswitch: cut-off and saturation modes. Field Effect Transistors: Construction and characteristics of n-channelJFET, Types of power amplifiers: Class A operation, Class B operation, Class AB operation.

Module-3 Operation Amplifier

Ideal Op-amp, Differential amplifier: differential and common mode operation common mode rejection ratio (CMRR), Practical op-amp circuits: inverting amplifier, non-inverting amplifier, comparator, summing amplifier, integrator, differentiator. The concept of positive feedback, Oscillator circuits using op amps: RC phase shift oscillator, wein bridge oscillator.

Module-4

Communication system - The radio frequency spectrum, electromagnetic waves, A simple CW transmitter and receiver, modulation, demodulation, AM transmitter, FM transmitter, Tuned radio frequency receiver, Superheterodyne receiver. RF amplifiers, AM demodulators.

Module-5

Digital circuits - Logic functions, Switch and lamp logic, logic gates, combinational logic, bistables/flipflops, application of Flipflops, Integrated circuit logic devices: introduction to Microprocessor and microcontrollers (Architecture), Related Problems.

TEXT BOOKS

1. Electronic Devices and Circuit Theory: Robert L Boylestad and Louis Nashelsky, Pearson Education, Eleventh Edition, 2013.
2. Electronic Circuits: Fundamentals and applications, Michael Tooley, Elsevier, Third edition, 2006

REFERENCE BOOKS

1. David A Bell, Electronic Devices and Circuits, PHI, 5th edition, 2007.
2. Millman & Halkias, Electronics Devices and Circuits, McGraw Hill, second edition, 2010
3. Modern Digital and Analog Communication Systems by B.P.Lathi. Oxford University Press, Fourth edition, 2010
4. NPTEL- https://nptel.ac.in/courses/122/106/122106025/
5. Virtual Labs- http://vlabs.iitkgp.ac.in/be/

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1110	ENGINEERING GRAPHICS & DESIGN	1	-	4	-	3

COURSE OBJECTIVES:

- To create awareness and emphasize the need for Engineering Graphics
- To understand the principles of geometrical curves and construct manually
- To learn using professional CAD software for construction of geometry
- To construct orthographic projection of points, lines, planes and solids
- To develop the lateral surfaces of solids
- To construct isometric projections of planes and solids
- To create simple engineering 3D components and assembly

COURSE OUTCOMES

- Identify usage of instruments, dimensioning & tolerances, conventions and standards related to working drawings
- Construct points, lines, planes and solids using orthographic projections principles
- Construct geometries of planes and solids using isometric projection principles
- Develop section of solids for different planes of inclination
- Construct lateral surfaces of solids using geometry development principles
- Create associative models at the component and assembly levels for product design

COURSE CONTENT: Total 70 hours

Module-1

Introduction: Fundamentals, Drawing standard - BIS, dimensioning, Lines, lettering, scalingof figures, symbols and drawing instruments, Introduction to orthographic & perspective projection. Types of projections, Principles of Orthographic projection Plain & Miscellaneous Curves: Construction of ellipse, parabola, hyperbola, Construction of Tangent and Normal at any point on these curves. Construction of Cycloid, Epicycloid and Hypocycloid, Involute of a circle. Construction of Tangent and Normal at any point on these curves.

Module-2

Projection of Points and Lines: Projections of points located in same quadrant and different quadrants. Projection of straight lines inclined to both the principal planes – Determinationof true lengths and true inclinations by rotating line method.

Projection of planes: Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by change of position method.

Module-3

Projection of Solids: Projection of solids such as prisms, pyramids, cone, cylinder, tetrahedron, Projections of solids with axis perpendicular and parallel to HP and VP, solids with axis inclined to one or both the planes, suspension of solids.

Module-4

Sections of Solids: Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other, obtaining true shape of section.

Development of Surfaces: Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

Module-5

Isometric Projection: Principles of isometric projection, isometric scale, Isometric projections of simple solids and truncated solids – Prisms, pyramids, cylinders, cones,combination of two solid objects in simple vertical positions, Conversion of orthographic views into isometric projection and vice versa

Module-6

Computer Aided Design: Introduction to computer aided drafting and tools to make drawings. Layout of the software, standard tool bar/menus and description, drawing area, dialog boxes and windows, Shortcut menus, setting up and use of Layers, layers to create drawings, customized layers, create, zoom, edit, erase and use changing line lengths through modifying existing lines (extend/lengthen) and other commands Demonstration ofa simple team design project: Product Design- Introduction, stages, Design Geometry and topology of engineered components creation of engineering models and their presentation in standard 3D view. Use of solid-modeling software for creating associative models at the component and assembly levels; include: simple mechanical components-bolts, nuts, couplings; simple civil fixtures -windows, doors, bath, sink, shower, etc. Applying colour coding to the components.

TEXT BOOKS:

1. Gopalakrishna, K. R. and Sudheer Gopala Krishna (2015). “Computer Aided Engineering Drawing”, Subash Publishers, Bangalore, India.
2. Bhatt N.D. (2019). “Engineering Drawing”, 53rd Edition, Charotar Publishing House, Gujarat, India.

REFERENCES:

1. Dhananjay .A .J, (2018). “Engineering Drawing with Introduction to AutoCAD”, Tata McGraw-Hill Publishing Company Ltd.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1111	ENGINEERING MECHANICS	2	-	2	-	3

COURSE OBJECTIVES:

- Explain different types of forces and couples, resolution of forces and couples, equilibrium conditions and related theorems
- Explain concepts of friction and their relevance in Engineering problems
- Describe centroid, center of gravity and differences between them, area moment of inertia, examples of planar objects and computations for them
- Describe Trusses and its classification, assumptions in analysis of trusses, forces in members in a truss
- Calculate various dynamic quantities of translational motion and projectile motion
- Explain principles of dynamics in plane motion analysis

Course Outcomes

- Analyze structure using free body diagrams and principle of statics
- Analyze structures using concept of equilibrium conditions considering effect of frictional forces
- Calculate the centroid and moment of inertia of composite geometrical sections
- Compute axial forces in members of determinate truss
- Analyze plane kinematics and kinetics of particles/rigid bodies COURSE

CONTENT: Total 28 hours

Module-1

Introduction to Engineering Mechanics

Introduction to Engineering Mechanics, Force Systems Basic concepts, Particle Equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Resultant-Moment of Forces and its Application; Couples and Resultant of force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium.

Module-2

Friction

Introduction, Types of friction, Limiting friction, Cone of Friction, Laws of Friction, Static andDynamic Friction; Motion of Bodies, wedge friction, Ladder friction, related problems.

Module-3

Centroid, Centre and gravity and Moment of inertia

Introduction, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone.

Module-4

Analysis of Trusses

Introduction, Classification of trusses, Equilibrium in two and three dimension; Method of Sections; Method of Joints; To determine if a member is in tension or compression; Simple Trusses; Zero force members.

Module-5

Dynamics

Introduction, Rectilinear motion; Plane curvilinear motion (rectangular path, and polar coordinates); Projectile motion, Relative and constrained motion; Basic terms, general principles in dynamics; Types of motion, Instantaneous Centre of rotation in plane motion and simple problems; D Alembert's principle and its applications in plane motion andconnected bodies.5

TEXT BOOKS:

1. Irving H. Shames (2006), "Engineering Mechanics", 4th Edition, Prentice Hall publications.
2. A. Nelson (2009), "Engineering Mechanics: Statics and dynamics", Tata McGraw Hill publications.

REFERENCES:

1. R.C. Hibbler (2006), "Engineering Mechanics: Principles of Statics and Dynamics", Pearson Press.
2. Bansal R.K (2010), "A Text Book of Engineering Mechanics", Laxmi Publications.
3. H.J. Sawant, S.P Nitsure (2018), "Elements of Civil Engineering and Engineering Mechanics", Technical Publications.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1112	BIOLOGICAL SCIENCES	2	-	-	-	2

COURSE OBJECTIVES

1. To familiarize the student with the structure and function of important components of biological systems and cellular processes.
2. Biological systems and processes will be analyzed from an engineering perspective, with an emphasis on how these can be re-designed for industrial processes and commercial products.

COURSE OUTCOMES

1. Student understands biological systems
2. Student gets the engineering aspects from biological systems

COURSE CONTENT: Total 28 hours

Biology in the 21st Century: The new world in the post genome era. Past, present and futureof our society, industry and life style: impact of discoveries and technological innovations inbiology. Challenges and excitement of research in biology and bioengineering. Bioengineering as an emerging science at the intersection of biology, engineering, physics and chemistry.

Career opportunities in biotechnology, biomedical engineering, pharmaceutical industry, agro-biotechnology and in the diverse areas of basic science and medical research. Emergingtrends of collaboration between industry and academia for development of entrepreneurship in biotechnology.

Quantitative views of modern biology. Importance of illustrations and building quantitative/ qualitative models. Role of estimates. Cell size and shape. Temporal scales. Relative time in Biology. Key model systems - a glimpse.

Management and transformation of energy in cells. Mathematical view - binding, geneexpression and osmotic pressure as examples. Metabolism. Cell communication. Genetics. Eukaryotic genomes. Genetic basis of development. Evolution and diversity. Systems biologyand illustrative examples of applications of Engineering in Biology.

TEXT BOOKS:

1. R. Phillips, J. Kondev and J. Theriot, Physical Biology of the Cell, Garland Science Publishers. 2008. 1st edition.
2. J. B. Reece, L. A. Urry, M. L. Cain, S. A. Wasserman, P.V.Minorsky, and R.B.Jackson.Campbell Biology, Benjamin Cummings publishers. 2010. 9th edition.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1113	TECHNICAL COMMUNICATION	2	-	-	-	2

COURSE LEARNING OBJECTIVES:

The objectives of the Course are:

- To improve students lexical, grammatical competence
- To enhance their communicative skills
- To equip students with oral and appropriate written communicationskills
- To inculcate students with employability and job search skills
- To achieve proficiency in English
- To develop professional communication skills
- To create interest among the students about a topic by exploring thoughts and ideas
- To enable students with good use of tenses
- To learn the use of body language and improve verbal message
- To equip with Types of Teams and Leadership styles to develop managing skills in corporate world.
- To acquire skills for placement

COURSE OUTCOMES

- Explain communication and types of Communication: Managerial, Corporate, Technical & Organizational Communication.
- Distinguish Listening and hearing. Demonstrate various aspects of speaking. Discuss Word formation and types.
- Write a report, essay. Minutes of Meeting. Evaluate current issues and debate
- Use Leadership skills and Team building. Solve Tense exercise.
- Write a job application and CV.
- Discuss topic and speak on the spot. Interpret data

COURSE CONTENT:

Module-1

Language Skills & Communication and Types of Communication.

Definitions. Communication process diagram. Types of Communication: Managerial, Corporate, Technical & Organizational Communication.

Barriers to effective Communication.

Listening: Types & its Importance. Difference between hearing & listening. Speaking: Different aspects of Effective Speaking.

Reading: Extensive and intensive.

Word Formation and Types of Word Formation.

Word Family.

Module-2

Group Discussion and Writing Skills

Report Writing: Importance. Steps for Report Writing.

Group Discussion: Definition, How GD helps in Student Life & Corporate Life. Minutes of Meeting: Importance; Steps for writing MOM in Organizations.

Module-3

Team &Team Building; Leadership Styles & Tenses.

Teams: Definition, Importance, Types of Team; TEAM BUILDING:

Approaches to team building, Characteristics of Effective Teams,

Creating Effective Teams Key Team Roles, Team Processes, Interpersonal Processes in Teams, Task and maintenance leadership, Team Dynamics, Team cohesiveness, Decision Making in Teams, Diversity, Characteristics of "High Performance Teams," Principles of Effective Teamwork, Turning Individuals into Team Players, Teams and Quality Management, Relationship between team working and innovation in organization.

Leadership: Styles of Leadership; Characteristics of a good leader, Influence of differentforces on leadership

LAB BASED: Tenses: Types of tenses, structure & usage. (Exercises based on tenses)

Module-4

JOB APPLICATION, RESUME, COVER LETTER & Data Interpretation.

JOB Application, Covering Letter; Resume/CV Writing; Difference between JobApplication & Resume.

Writing Covering letter and Resume.

Module-5

DATA Interpretation-Tables, Bar-graph, Pie chart & Flowchart.(Theoretical as well as Numerical).

Activities:

1. Activities on Fundamentals of Inter-personal Communication and Building Vocabulary –Starting a conversation – responding appropriately and relevantly – using the right body language – Role Play in different situations and Discourse Skills- using visuals – Synonyms and antonyms, word roots, one-word substitutes,prefixes and suffixes, study of word origin, business vocabulary, analogy, idioms and phrases, collocations and usage of vocabulary.
2. Activities on Group Discussion , Interview Skills and Debate– Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and organization of ideas and rubrics for evaluation- Concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele-conference and video-conference and Mock Interviews- Critical thinking skills in debate, analytical research , organize thoughts, note- taking skills, effective speech composition and delivery and team work

REFERENCE BOOKS

1. Chauhan, Gajendra S., L. Thimmesha and Smita, Kashiramka (2019). TechnicalCommunication, Cengage Learning, New Delhi.
2. Bailey, Stephen. Academic Writing: A Handbook for International Students. Routledge, 5th Edition.
3. Kumar, Shiv K., Nagarajan,Hemalatha. (2007).Learn Correct English – A Book of Grammar, Usage and Composition.
4. Raman, Meenakshi, Sharma, Sangeeta. (2009). Technical Communication. Oxford University Press.
5. English Vocabulary in Use. (2008) Cambridge University Press.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21EN1114	DESIGN THINKING	-	-	2	-	1

COURSE OBJECTIVES:

- Introduce students to a discipline of design thinking that enhances innovation activities in terms of value creation, speed, and sustainability
- Learn application of design methods and tools on real world problem
- To impart knowledge and skills to use various workbenches in Autodesk Fusion360.
- To provide hands-on training in virtual modeling and table-top modeling.
- Application of design thinking, design methods and tools on real world problem.

Course Outcomes

- Apply the design thinking principles and recognize the significance of innovation
- Develop creative ideas through design criteria & brainstorming sessions
- Sketch various part models related to engineering field using Autodesk Fusion 360
- Evaluate project on ideation & generate solution
- Construct table top models using card board and clay

COURSE CONTENT: Total 28 hours

Module-1
Design Thinking
Introduction, Phases of design thinking, Design thinking: an iterative and non-linear process.

Module-2
Scope and Morphology of Design Process
Creativity and Idea Generation, Concept Development, Testing and Prototyping, Brainstorming & decision making.

Module-3
Design Communication and Presentation
Types of design communications, Barriers and Difficulties in Communication

Module-4
Project on Ideation
Generation of Solution from Students for Problem Brief Generated. Brainstorming session withstudents on example problem.

Module-5
Project on Creativity
Table-top modelling: Using paper and cardboard based modelling, clay modelling.

TEXT BOOKS:

1. C. L. Dym and Patrick Little (2015). “Engineering Design- A Project Based Introduction”, John Wiley.

2. N. Cross (2021). “Engineering Design Methods: Strategies for Product Design”, John Wiley.

REFERENCES:

1. Tim Brown (2019). “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”, Harper Business.

2. Bruce Hannington and Bella Martin (2015). “Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions”, Rockport Publishers.

COURSE CODE	COURSE TITLE	L	T	P	S/P	C
21AU0004	CONSTITUTION OF INDIA & ETHICS	2	-	-	-	-

Course objectives

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.

Course outcomes

At the end of the course student will be able

- Understand state and central policies, fundamental duties
- Understand Electoral Process, special provisions
- Understand powers and functions of Municipalities, Panchayats and Cooperative Societies,
- Understand Engineering ethics and responsibilities of Engineers

Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights &its limitations.
Directive Principles of State Policy & Relevance of Directive Principles State Policy fundamental Duties.
Union Executives – President, Prime Minister Parliament Supreme Court of India. StateExecutives – Governor Chief Minister, State Legislature High Court of State.
Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86^{th}&91stAmendments.

Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions.

Powers and functions of Municipalities, Panchyats and Co – Operative Societies.

Text Books:

1. Brij Kishore Sharma,"Introduction to the Constitution of India", PHI Learning Pvt. Ltd., New Delhi, 2011.
2. Durga Das Basu: "Introduction to the Constitution on India", (Students Edn.) PrenticeHall, 19th / 20th Edn., 2001

Reference Books:

1. M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	21CS2301					
TITLE OF THE COURSE	**DISCRETE MATHEMATICAL STRUCTURES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Solve problems using relations and generating functions.
- Understand and Construct mathematical arguments.
- Use propositional and predicate logic in knowledge representation and program verification.
- Develop recursive algorithms based on mathematical induction.
- Know essential concepts in graph theory and related algorithms.
- Apply knowledge of discrete mathematics in Elementary Number Theory and problem solving.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Classify functions, basic set theory relations.	L4
CO2	Demonstrate the correctness of an argument using propositional and predicate logic, laws and truth tables.	L2
CO3	Compare and differentiate graphs in different geometries related to edges.	L4
CO4	Apply mathematical induction, counting principles, recursion, elementary number theory.	L3
CO5	Apply and solve Euclidean Division Algorithm and Chinese Remainder Theorem.	L3

COURSE CONTENT:

MODULE 1	**8Hrs**
RELATIONS AND FUNCTIONS: Relation and Types of relations, Closure Properties, Equivalence Relations, Partial Ordering Relations, n-ary relations, Functions: one-to-one, onto and invertible functions, sequences, indexed classes of sets, recursively defined functions, cardinality Counting Principles: Permutation, combination, the pigeonhole principle, inclusion-exclusion principle Self – Learning Component: Set theory definition and Properties	
MODULE 2	**8Hrs**
LOGIC: Propositions and truth tables, tautologies and contradictions, logical equivalence, algebra of propositions, logical implications, predicate logic, theory of inference for propositional logic and predicate logic. Introduction to Predicate Calculus.	
MODULE 3	**8Hrs**
NUMBER THEORY: Properties of Integers: Introduction, order and inequalities, absolute value, mathematical induction, division algorithm, divisibility, primes, greatest common divisor, Euclidean algorithm, fundamental theorem of arithmetic, congruence relation, congruence equations and Chinese Reminder Theorem (CRT).	
MODULE 4	**7Hrs**
GRAPH THEORY: Graphs and multi-graphs, sub-graphs, isomorphic and homomorphic graphs, paths, connectivity, Euler and Hamilton paths, labelled and weighted graphs, complete, regular and bipartite graphs, planar graphs.	
MODULE 5	**8Hrs**
TREES AND GRAPH COLORING: Trees: Definitions-properties - fundamental theorems of trees-rooted trees-binary trees-spanning trees. Coloring of planar graphs, Chromatic Number- Chromatic partitioning- The four Color Problem-Five- color.	

TEXT BOOKS:

1. K. H. Rosen, Discrete Mathematics & its Applications, 7th Ed., Tata McGraw-Hill, 2007.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall India (PHI).

REFERENCES:

1. M.Huth and M. Ryan, Logic in Computer Science, Cambridge University N.Press, 2004.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	21CS2302					
TITLE OF THE COURSE	**DATA STRUCTURES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	***	***

COURSE OBJECTIVES:

- To introduce the concept of data structure and its applications
- To introduce C language concepts required for data structures
- To design data structure operations to solve problems
- To introduce applications of data structures
- To introduce non-primitive data structures
- To analyze the complexity of a data structure
- To introduce static and dynamic memory allocation using C language
- To explain linear data structures – stack, queue, linked list
- To explain non-linear data structures – trees and graphs

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Outline basic C program design for data structures	L2
CO2	Implement stack & queue data structure and their applications	L3
CO3	Apply concepts of dynamic memory allocation to real-time Problems	L3
CO4	Implement tree data structure and its applications	L3
CO5	Implement graph data structure and its applications	L3
CO6	Outline the concepts of file structures	L2

COURSE CONTENT:	
MODULE 1	**7Hrs**
INTRODUCTION TO DATA STRUCTURES: Definition, Types, C Pointers, C Structure, Arrays, Representation of Linear Array in Memory, Array Operations (Insertion, Deletion, Search and Traversal), Single Dimensional Arrays, Two Dimensional Arrays, Function Associated with Arrays, Arrays as Parameters, Recursive Functions.	
MODULE 2	**9Hrs**
INTRODUCTION TO STACK AND QUEUE: **Stack:** Definition, Array Representation of Stack, Operations Associated with Stacks-Push & Pop, Applications of Stack: Recursion, Polish expressions, Conversion of Infix to Postfix, Infix to Prefix,Postfix Expression Evaluation, Tower of Hanoi. **Queue:** Definition, Representation of Queues, Operations of Queues, Priority Queues, Circular Queue.	
MODULE 3	**9Hrs**
DYNAMIC DATA STRUCTURE: **Linked List:** Types, Introduction to Singly Linked lists: Representation of Linked Lists in Memory,Traversing, Searching, Insertion & Deletion from Linked List. Doubly Linked List, Operations on Doubly Linked List (Insertion, Deletion, Traversal). Applications: Polynomial Representation & Basic Operations, Stack & Queue Implementation using Linked Lists.	
MODULE 4	**8 Hrs**
TREES & GRAPHS: **Trees:** Basic Terminology, Binary Trees and their Representation, Complete Binary Trees, Binary Search Trees, Operations on Binary Trees (Insertion, Deletion, Search & Traversal), Application: Expression Evaluation. **Graphs:** Terminology and Representations, Graphs & Multigraphs, Directed Graphs, Sequential Representation of Graphs, Adjacency Matrices, Graph Transversal	
MODULE 5	**6 Hrs**
FILE STRUCTURES: Physical storage media, File Organization, Linked Organization of File, Inverted File, Organization Records into Blocks, Sequential Blocks, Indexing & Hashing	

TEXT BOOKS:

1. A M Tannenbaum, Y Langsam, M J Augentien “Data Structures using C”, Pearson, 2013
2. R.L. Kruse, B.P. Leary, C.L. Tondo, “Data Structure and Program Design in C” PHI

REFERENCES:

1. Horowitz Anderson-Freed, and Sahni, “Fundamentals of Data structures in C”, 2nd Edition, Orient Longman, 2008

2. Data Structures and Algorithm analysis in C by Mark Allen Weiss, Published by Addison Wesley (3rd Indian Reprint 2000).
3. D E Knuth, The Art of Computer Programming, Volume 1, Addison-Wesley Publishing, 20

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	21CS2303					
TITLE OF THE COURSE	**DIGITAL ELECTRONICS & LOGIC DESIGN**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To understand various number systems and conversion from one to other number systems
- To introduce basic postulates of Boolean algebra
- To manipulate expressions into POS or SOP form.
- To introduce the methods for simplifying Boolean expressions like K-Map and Quine Mclusky
- To understand the concept of don't care conditions and how they can be used to further optimize the logical functions
- To design simple combinational circuits such as multiplexers, decoders, encoders
- To understand the differences between combinational and sequential Logic circuits
- To familiar with basic sequential logic component-SR Latch
- To understand the basics of various types of memories.
- To present the working of various Flip- Flops (T flip-flop, D flip-flop, R-S flip-flop, JK flip-flop)
- To get familiarized with State Diagram, State Table, State Assignment
- To design combinational circuits using programmable logic devices.
- To design sequential circuits such as different types of Counters, Shift Registers

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**

CO1	Demonstrate the knowledge of binary number systems, Logic families, Boolean algebra and logic gates	L 2
CO2	Analyze different methods used for simplification of Boolean expressions	L 4
CO3	Design combinational logic circuits using combinational logic elements	L 3
CO4	Design combinational circuits using Programmable Logic Devices	L 3
CO5	Analyze sequential logic elements in the design of synchronous and asynchronous systems	L 4
CO6	Design sequential systems composed of standard sequential modules, such as counters and registers	L 3

COURSE CONTENT:	
MODULE 1	**9Hrs**
NUMBER SYSTEMS: BCD number representation, Unsigned and signed number representation, Binary arithmetic. **BOOLEAN ALGEBRA AND SIMPLIFICATION:** Laws of Boolean algebra, Theorems of Boolean algebra, Boolean/Switching functions and their implementation. **SIMPLIFICATION OF BOOLEAN EXPRESSIONS AND FUNCTIONS:** Canonical forms, Sum-of-Products Method, Truth Table to Karnaugh Map, Karnaugh Simplifications, Don’t-care Conditions. Product-of-sums Method, Product-of-sums simplifications, Simplification by Quine-McClusky Method.	
MODULE 2	**8Hrs**
DESIGN OF COMBINATIONAL LOGIC CIRCUITS: Modular combinational logic elements- Multiplexers and Demultiplexers, Decoders, Magnitude comparator, BCD converter, Encoders, Priority encoders.	
MODULE3	**9Hrs**
INTRODUCTION TO SEQUENTIAL CIRCUITS: Introduction to Sequential Circuits. Combinational Vs sequential circuits, Clock, Clock Triggering, Memory elements and their excitation functions – Latches, T flip-flop, D flip-flop, R-S flip-flop. JK flip-flop and their excitation requirements, State diagram, state table and state equation	
MODULE 4	**6 Hrs**
REGISTERS Registers-Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In - Serial Out, Parallel In –Parallel Out, Universal Shift Register. Applications of Shift Registers	
MODULE 5	**7 Hrs**

COUNTERS, PROGRAMMABLE LOGIC: Ring, Johnson counters, Design of synchronous and asynchronous Counters Programmable Logic Arrays, Design of Combinational Circuits using Programmable Logic Devices (PLDs):

TEXT BOOKS :

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 6th Edition,N.Pearson Education, 2018

2. Donald.P. Leach, Albert Paul Malvino & Goutam Saha: Digital Principles and Applications, 8thEdition, Tata McGraw Hill, 2015

REFERENCES:

1. D Sudhaker Samuel: Illustrative Approach to Logic Design, Sanguine-Pearson, 2010.
2. Charles H. Roth: Fundamentals of Logic Design, Jr., 7th Edition, Cengage Learning, 2014
3. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	21CS2304					
TITLE OF THE COURSE	**FULL STACK DEVELOPMENT**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**2**	**-**	**26+26**	**3**

Prerequisite Courses			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

1. Understand the major areas of web programming
2. To gain the skill into web applications and development.

3. To create website using HTML5, CSS3, JavaScript.
4. Server Side Scripting using Node.JS, Express JS and Mongo dB

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Know the fundamentals of front end web technologies using HTML 5 and CSS3	L1
CO2	Apply Cascading Style Sheets and XHTML to the idea of a web application.	L3
CO3	Comprehend the principles of client-side programming and understand how to use JavaScript to implement them in order to create dynamic web sites.	L3
CO4	Implementing the principles of server side programming using Node.js, Mongo dB	L3
CO5	Applying the Node.js framework -Express.JS to create web applications faster and smarter	L3

COURSE CONTENT:	
MODULE 1: Markup Language (HTML5)	**4 Hrs**
Introduction to HTML and HTML5 - Formatting and Fonts -Commenting Code – Anchors – Backgrounds – Images – Hyperlinks – Lists – Tables – HTML Forms, Audio Video, Tag.	
MODULE 2: CSS3	
CSS3: Levels of style sheets; Style specification formats; Selector forms; Property value forms; Font properties; List properties; Color; Alignment of text; Background images, Conflict Resolution, CSS Box Model .CSS3 features: Box Shadow, Opacity, Rounded corners, Attribute selector.	**4 Hrs**
MODULE 3 : JavaScript	**6 Hrs**
Overview of JavaScript; Object orientation and JavaScript; General syntactic, characteristics; Primitives, operations, and expressions; Screen output and keyboard input. Control statements; Arrays; Functions, Constructors; A brief introduction on pattern matching using regular expressions, DOM Events	
MODULE 4: Node JS	**6 Hrs**
Introduction to NodeJS, Set up Dev Environment, Node JS Modules, Node Package Manager, File System, Events, Database connectivity using Mongo DB.	
MODULE 5: Express.JS	**6 Hrs**
Introducing Express: Basics of Express, Express JS Middleware: Serving Static Pages ,Listing Directory Contents, Accepting JSON Requests and HTML Form Inputs, Handling Cookies.	

List of Laboratory/Practical Experiments activities to be conducted

HTML5

1. Design a web page depicting: -

    - How markup works, including the working of various basic HTML elements and attributes..
    - The basic structure of an HTML document.
    - The usage of table tag to format a web page
    - Use <span> and <div> tags to provide a layout to the page instead of a table Layout.
    - The usage of lists to bring order to web pages
    - The usage of other various HTML tags like Image, anchor, links etc.

2. Design a web page and embed various multimedia features in the page.

3. Building of HTML Forms

CSS3:

4. Change the Look of a web page with a Style Sheet

JAVASCRIPT

5. Design of dynamic and Interactive web pages using Java script

    - Depicting the usage of declaring variables, running loops, if/then statements, and writing functions/Constructors using JavaScript
    - Depicting Event handling using Java script.
    - Depicting the Pattern matching using regular expressions.

NODE.JS

6. Demonstrate how to use Node.js http module to create a web server.

7. Create a Node.js file that that depicts the usage of various File System Modules

EXPRESS.JS

8. Create an app that starts a server using Express.js.

9. Demonstrate the usage of various Express JS Middleware.

TEXT BOOKS:

1. Robert W. Sebesta , "Programming the World Wide Web", 7th Edition, Pearson Education, 2008.
2. Basarat Ali Syed," Beginning Node.js ",Apress ,2014

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**21DS2301**					
TITLE OF THE COURSE	**DATA WAREHOUSE AND KNOWLEDGE MINING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**-**	**-**	-	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will emphasize the study of data warehousing.	L2
CO2	Understanding the data mining applications	L2
CO3	Apply mining techniques and algorithms to real life problems	L2
CO4	Describing Classification and Clustering algorithms for various applications	L2
CO5	Special emphasis will be given on the recent trends in mining text data, mining graphs, mining,spatio-temporal data, using Weka and R	L2

COURSE CONTENT	
MODULE 1	**8 Hrs**
Data Warehousing, Business Analysis And On-Line Analytical Processing (OLAP)-Basic Concepts - Data Warehousing Components – Building a Data Warehouse – Database Architectures for Parallel Processing – Parallel DBMS Vendors - Multidimensional Data Model – Data Warehouse Schemas for Decision Support, Concept Hierarchies -Characteristics of OLAP Systems – Typical OLAP Operations, OLAP and OLTP, Data Cube.	
MODULE 2	**8 Hrs**

Introduction to Data Mining Systems – Knowledge Discovery Process – Data Mining Techniques – Issues – applications- Data Objects and attribute types, Statistical description of data, Data Preprocessing – Cleaning, Integration, Reduction, Transformation and discretization, Data Visualization, Data similarity and dissimilarity measures.

MODULE 3	**7 Hrs**
Data Mining - Frequent Pattern Analysis-Mining Frequent Patterns, Associations and Correlations – Mining Methods- Pattern Evaluation Method – Pattern Mining in Multilevel, Multi-Dimensional Space – Constraint Based Frequent Pattern Mining, Classification using Frequent Patterns	

MODULE 4	**9 Hrs**
Classification and Clustering- Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by BackPropagation – Support Vector Machines — Lazy Learners – Model Evaluation and Selection-Techniques to improve Classification Accuracy. Clustering Techniques – Cluster analysis- Partitioning Methods - Hierarchical Methods – Density Based Methods - Grid Based Methods – Evaluation of clustering – Clustering high dimensional data-Clustering with constraints, Outlier analysis-outlier detection methods	
MODULE 5	**7 Hrs**
Introduction to WEKA and R programming for the data mining applications: Special data mining, multimedia data mining, text mining and mining the www.	

TEXT BOOKS:

1. Jiawei Han, Micheline Kamber and Jian Pei “Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2011.
2. Amitesh Sinha, “Data Warehousing”, Thomson Learning, 2007.

REFERENCES:

1. Introduction to Data Mining – Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Pearson education
2. Data Mining: Practical Machine Learning Tools and Techniques by Ian H. Witten and Eibe Frank, Morgan Kaufmann
3. Margaret H Dunham, “Data Mining Introductory and Advanced Topics”, 2e, Pearson Education, 2006.
4. https://www.tutorialspoint.com/weka/index.htm

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**21DS2302**					
TITLE OF THE COURSE	**DATA ANALYTICS AND EXPLORATION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- This course covers the fundamentals of statistics and probability required in the analysis of data.
- This course also gives the details of R and it's usage in Data Analytics.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To understand the statistical tools and techniques	L2
CO2	To be able apply these tools and techniques in data analytics using R.	L2
CO3	Understanding the concepts of Statistics	L3
CO4	Analyzing the data with metrics and test	L3
CO5	Applying the techniques of regression and correlation from the data	L4

COURSE CONTENT	
MODULE 1	**9 Hrs**

Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers and Bad Data, Finding Duplicates-Fuzzy Matching-RegEx Matching-Normalizing and Standardizing the Data, Saving the Data-Determining suitable Data Clean-up-String Manipulation: Vectorized String Functions in pandas.	
MODULE 2	**8 Hrs**
Fundamentals of Python programming: Getting started with Python, Type Variables and Operators, Strings, Lists, Dictionary, Control Statements and Loops, Functions and Scope of Variable, Python numpy, Python pandas, Python matplotlib. User defined Modules and Packages in Python- Files: File manipulations, File and Directory related methods - Python Exception Handling. OOPs Concepts -Class and Objects, Constructors – Data hiding- Data Abstraction- Inheritance.	
MODULE 3	**8 Hrs**
Statistical Programming: R Fundamentals, Getting started with R, Data Types, Control Structures, Functions, Data files, inputting data, Removing data sets, Data Structures, Types of Data, Variables within data, Defining Matrix and its operations, Logical operations on the string-concatenation, matching, ordering, Naming columns. Lists and Data frames. Plots with coordinate vector, Reading and writing files	
MODULE 4	**7 Hrs**
Data Visualization idioms: Bar Chart, Vertical & Horizontal, Pie Chart and Coxcomb Plot, Line Chart, Area Chart, Reusable scatter plots. Making Colour Maps, Visualizing Trees and Networks. Encoding Data using Colour. Encoding Data using Size, Stacked & Grouped Bar Chart, Stacked Area Chart & Streamgraph, Line Chart with Multiple Lines.	
MODULE 5	**7 Hrs**
Statistical tests and Distance Metrics: Basic Tests: Mean, Variance, Quantile, Length, T-test: Variance equal/unequal, Paired t-test, T-test Step by Step. Chi Squared: Chi-Squared Step by Step, Goodness of Fit test, Distance Metrics.	

TEXT BOOKS:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer 2009

2. Richard Cotton, Learning R,O'reilly Publication
3. Tilman M.Davies,"THE BOOK OF R - A FIRST PROGRAMMING AND STATISTICS" Library of Congress Cataloging-in-Publication

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	21CS2307					
TITLE OF THE COURSE	**DATA STRUCTURES LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**26**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES:

- To introduce C language concepts required for data structures
- To design data structure operations to solve problems
- To introduce applications of data structures
- To implement linear data structures – stack, queue, linked list
- To implement non-linear data structures – trees and graphs

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Design and develop the programs in C to understand the different concepts of data structures.	L3
CO2	Implement stack & queue data structure and their applications, Analyse the output based on the given input data.	L3
CO3	Implement Conversions of Polish and reverse polish expressions and Record Experimental process and results	L4
CO4	Apply and implement concepts of dynamic memory allocation	L3
CO5	Use the concepts of file structures and communicate results effectively	L3

Sl. No.	List of Laboratory/Practical Experiments activities to be conduct
1.	Write a program to add, subtract, multiply and divide two integers using user defined function with return type.
2.	Write a program to find the sum of digits of the number and print the reverse of that number using Recursive Function.
3.	Write a program to add and multiply two matrices using pointers
4.	Design, Develop and Implement a menu driven Program in C for the Searching Techniques on arrays i.e, 1. Linear search 2. Binary search. If an unsorted array is given as input, your program must perform sorting (bubble sort) to use it as input for the binary search algorithm.
5.	Write a C program to convert infix expressions to prefix expressions.
6.	Write a C program to convert infix expressions to postfix expressions.
7.	Write a C program to implement stack, queue and their variations using arrays.
8.	Write a C program to evaluate postfix expressions
9.	Write a C program to solve tower of hanoi using recursion
10.	Write a C program to implement stack, queue and their variations using linked lists.
11.	Write a C program to implement Binary search tree insertion, deletion and traversal.
12.	Write a C program to implement Graph insertion, and traversal.
13.	Write a C program to implement File operations a. Open a file b. Write c. Read d. close d. close

Open-Ended Experiments

1. A man in an automobile searches for another man who is located at some point on a certain road. He starts at a given point and knows in advance the probability that the second man is at any given point of the road. Since the man being sought might be in either direction from the starting point, the searcher will, in general, must turn around many times before finding his target. How does he search to minimize the expected distance traveled? When can this minimum expectation be achieved?

2. The computing resources of a cloud are pooled and allocated according to customer demand. This has led to increased use of energy on the part of the service providers

due to the need to maintain the computing infrastructure. What data structure will you use for allocating resources which addresses the issue of energy saving? Why? Design the solution.

3. Mini-Project on applying suitable data structure to a given real-world problem

TEXTBOOKS:

1. A M Tannenbaum, Y Langsam, M J Augentien “Data Structures using C”, Pearson, 2013
2. R.L. Kruse, B.P. Leary, C.L. Tondo, “Data Structure and Program Design in C” PHI

REFERENCE BOOKS

1. Horowitz Anderson-Freed, and Sahni, “Fundamentals of Data structures in C”, 2nd Edition, OrientLongman, 2008
2. Data Structures and Algorithm Analysis in C by Mark Allen Weiss, Published by Addison Wesley (3rd Indian Reprint 2000).
3. D E Knuth, The Art of Computer Programming, Volume 1, Addison-Wesley Publishing, 2013

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	21CS2308					
TITLE OF THE COURSE	**DIGITAL ELECTRONICS & LOGIC DESIGN LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**26**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES:

- To design digital circuit for given Boolean expressions using logic gates.
- To verify the design of arithmetic circuits using logic gates and ICs.
- To test different code-conversion circuits.
- Applications of Multiplexer and De-multiplexers for implementation of different logic circuits.
- To test comparator circuits.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Build a logic circuit using basic gates after simplifying the given Boolean expression using Karnaugh map method	L3
CO2	Design and implementation of comparators	L3
CO3	Build logic circuits and realize the given Boolean expression using Multiplexers.	L3
CO4	Design of Combinational circuits like Encoder and Decoder using basic gates	L3
CO5	Design of Synchronous and Asynchronous Sequential circuits like registers and counters.	L3

List of Laboratory/Practical Experiments activities to be conducted

1. Study and verification of Basic gates with Truth Tables
2. Simplification of expressions using Karnaugh Maps and realizing circuitsusing Basic Gates
3. Realize binary to gray code converter and vice versa
4. Simplify the given expression using tabular method and to realize circuits using Multiplexers.
5. Design and implementation parallel adder and subtractor
6. Design and implementation of comparators
7. Design various combinational logic circuits like encoders, decoders
8. Design and implementation of shift register20
9. Design and implementation synchronous counters
10. Design and implementation ring counter and Johnson counter
11. Study of 7490 BCD counter
12. Design and implementation of asynchronous counters

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, “Digital Design”, 6th Edition, Pearson Education, 2018
2. Donald.P. Leach, Albert Paul Malvino & Goutam Saha: Digital Principles and Applications, 8th Edition, Tata McGraw Hill, 2015

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	21CS2309					
TITLE OF THE COURSE	**MANAGEMENT & ENTREPRENEURSHIP**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Identify and analyze the factors that contribute to the process of successfully launching an entrepreneurial venture and managing a new business.
- Learn the entrepreneurial process from idea generation to implementation.
- Acquainted with special problems of starting new ventures, finding products and services, which can support new enterprises, and raising capital.
- Discuss how to start your own business and also to work in or with small businesses or are involved with entrepreneurship.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate knowledge of the key elements of the entrepreneurial process	L2
CO2	Employ strategies to generate new ideas for startups	L2
CO3	Outline how to protect IP legally	L2
CO4	Examine different ways of generating funding	L2
CO5	Explain organizing managing people, finance and customers	L2

COURSE CONTENT:

MODULE 1	5Hrs
OVERVIEW OF ENTREPRENEURSHIP: THE ENTREPRENEURIAL PERSPECTIVE: Nature and Development of Entrepreneurship. Defining Manager, Entrepreneur, Entrepreneurship and Entrepreneurship. Key Elements of Entrepreneurship. Personality Characteristics of Successful Entrepreneurs. Common Myths about Entrepreneurs. Ethics and Social Responsibility of Entrepreneurs. Types of Start-Up Firms. Process of New Venture Creation. Role of Entrepreneurship in Economic Development. Emerging Trends and Issues in Entrepreneurship. **Case Study: Successful Entrepreneurs Narayana Murthy Infosys**	
MODULE 2	6Hrs

THE ENTREPRENEURIAL AND ENTREPRENEURIAL MIND: The Entrepreneurial Process: Identify and Evaluate the Opportunity, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise. Managerial Versus Entrepreneurial Decision Making: Strategic Orientation, Commitment to Opportunity, Commitment of Resources, Control of Resources, Management Structure, Entrepreneurial Venturing inside a Corporation, Causes for Interest in Entrepreneurship, Climate for Entrepreneurship, Entrepreneurial Leadership Characteristics. **Case study: How to develop effective Business Plan**	
MODULE 3	**5Hrs**
CREATIVITY AND BUSINESS IDEA: Identify and Recognizing Opportunities: Observing Trends and Solving Problems. Creativity: Concept,Components and Types of Creativity, Stages of Creative Process. Sources of New Venture Ideas.Techniques for Generating Ideas. Stages of Analyzing and Selecting the Best Ideas. Protecting the Idea:Intellectual Property Rights and its Components. Linking Creativity, Innovation and Entrepreneurship. **Case study: Application of Design Thinking in New business ideas generation in particular sector (Health care, Water Saving, Energy saving)**	
MODULE 4	**5Hrs**
PREPARING THE PROPER ETHICAL AND LEGAL FOUNDATION: Initial Ethical and Legal Issues Facing a New Firm, Establishing a Strong Ethical Culture, Choosing an attorney (Lawyer), Drafting a founder's agreement, Avoiding legal disputes, Choosing a form of business organization, Obtaining business licenses and permits, Choosing a Form of Business Ownership (Sole, Proprietorship, Partnership, Corporation & Limited Liability Company) **Case study: Startup Law A to Z IP** https://techcrunch.com/2019/02/25/startup-law-a-to-z-intellectual-property/	
MODULE 5	**5Hrs**

MANAGING EARLY GROWTH AND CHALLENGES

Recruiting and Selecting Key Employees. Lenders and Investors. Funding Requirements: Sources of Personal Financing. Venture Capital. Commercial Banks. Sources of Debt Financing. Key Marketing Issues for New Ventures. Why marketing is critical for Entrepreneurs. Entrepreneurs face unique Marketing Challenges. Guerrilla Marketing. Business Growth: Nature of Business Growth, Planning for Growth, Reasons for Growth. Managing Growth: Knowing and Managing the Stages of Growth, Challenges of Growing a Firm. Strategies for Firms Growth: Internal and External Growth Strategies. Implications of Growth for the Firm and Entrepreneur. Entrepreneurial Skills and Strategies to Overcome Pressures On: Financial Resources (Financial Control, Managing Inventory and Maintaining Good Records). Human Resources, Management of Employees, Time Management.

Case study: 9 ways to get startups funded

https://www.quicksprout.com/how-to-get-your-startup-funded/

TEXT BOOKS:

1. Barringer, Ireland, “Entrepreneurship: Successfully Learning New Ventures”, Pearson,Latest Edition.
2. Hisrich, Peters, Shepherd, “Entrepreneurship”, McGraw Hill, Sixth Edition.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	21CS2401					
TITLE OF THE COURSE	**PROBABILITY AND STATISTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Understand probability, random variable and random process concepts and their importance in Computer Engineering course.
- Calculate statistics related to Random variables and processes such as mean, variance, etc.
- Evaluate standard distribution functions such as Poisson's, Normal distributions
- Apply functions of random variables such as characteristic function, moment generating function to calculate statistics.
- Understand probability, random variable and random process concepts and their importance in Computer Engineering course.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Compute and interpret descriptive statistics using numerical and graphical techniques.	L4
CO2	Understand the basic concepts of random variables and find an appropriate distribution for analyzing data specific to an experiment.	L2
CO3	Extend the concepts to multiple random variables and apply them to analyze practical problems.	L2
CO4	Make appropriate decisions using statistical inference that is the central to experimental research.	L4

COURSE CONTENT:	
MODULE 1: INTRODUCTION TO PROBABILITY THEORY:	**6 Hrs**
Basic Notions of Probability, Axiomatic definition, properties, Conditional Probability and Independence – Bayes Theorem.	
MODULE 2: DISCRETE PROBABILITY DISTRIBUTIONS:	**7 Hrs**
Discrete random variables and its properties - Bernoulli trials – Binomial Distribution and its properties – Poisson Distribution and its properties.	
MODULE 3	**8 Hrs**
CONTINUOUS PROBABILITY DISTRIBUTIONS Continuous random variables and its properties – Exponential Distribution and its properties - Normal Distribution and its properties. **BIVARIATE DISTRIBUTIONS:** Bivariate random variables – Joint – Marginal - Conditional distribution**.**	
MODULE 4: RANDOM PROCESS AND QUEUING THEORY	**9 Hrs**
Classification – Stationary process – Markov process – Markov chain – Poisson process Auto correlation functions – Cross correlation functions – Properties – Power spectral density Queuing Models, Methods for generating random variables and Validation of random numbers	
MODULE 5: TESTING OF HYPOTHESIS	**9 Hrs**
Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis- Large sample tests- Z test for Single Proportion - Difference of Proportion, mean and difference of mean - Small sample tests- Student’s t-test.	

TEXT BOOKS:

1. A First Course in Probability, S. Ross, Pearson International Edition, 9th Edition.
2. Fundamentals of Mathematical Statistics, S. C. Gupta and V. K. Kapoor, Sultan Chand & Sons, 11thEdition.

REFERENCES:

1. K. S. Trivedi, Probability and Statistics with Reliability, Queuing, and L.Computer Science Applications, 2nd Ed., Wiley, 2001.
2. Robert V. Hogg, J.W. McKean, and Allen T. Craig: Introduction to Mathematical Statistics,Seventh Edition, Pearson Education, Asia.
3. Rohatgi, V K. and Saleh , A. K. Md. Ehsanes, "An Introduction to Probability and Statistics", (John Wiley and Sons) , (2nd edition) (2000)
4. Higher Engineering Mathematics by B S Grewal, 42 nd Edition, Khanna Publishers.
5. Probability and Statistics for engineers and scientists, R.,E.Walpole, R.H.Myers, S.L.Mayers

andK.Ye, 9th Edition, Pearson Education (2012).

6. An Introduction to Probability Theory and its Applications, W. Feller , Vol. 1, 3rd Ed., Wiley, 1968

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	21CS2402					
TITLE OF THE COURSE	**DESIGN AND ANALYSIS OF ALGORITHMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	-	-	39	3

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**	**	***

COURSE OBJECTIVES:

- To introduce and implement various techniques for designing algorithms and advanced data structures
- To learn space and time complexity analysis of algorithms.
- To understand the Divide and conquer design strategy and the Greedy Technique
- To understand the concepts of Dynamic Programming Applications
- Synthesize efficient algorithms in common engineering design situations

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Outline the overview of Data structures and Algorithms	L1
CO2	Understand the different Algorithmic Design strategies	L2
CO3	Apply the Design principles and concepts to Algorithmic design	L3
CO4	Describe the DAA paradigms and when an Algorithmic Design situation calls for it.	L6
CO5	Analyse the efficiency of Algorithms using Time and Space complexity theory	L4
CO6	Implement an existing algorithm to improve the run time efficiency	L3

COURSE CONTENT:

MODULE 1: INTRODUCTION	6 Hrs
The role of Algorithms in Computing, Running time analysis -- recall of asymptotic notation, big-oh, theta, big-omega, and introduce little-oh and little-omega. Worst case and average case complexity	
MODULE 2: DIVIDE AND CONQUER	**9 Hrs**
Recursive algorithms, Divide-and-Conquer recurrences, Methods for solving recurrences: substitution method, recursion tree method and the Master method. Examples-Binary search, Quick sort, Merge sort, Strassen's Matrix Multiplication. **GREEDY METHOD** Optimal substructure property- Minimum cost spanning tree, Knapsack problem, Single Source Shortest Path Algorithm. Fractional knapsack	
MODULE 3 : DYNAMIC PROGRAMMING	**9 Hrs**

Integral knapsack (contrasted with the fractional variant: 0/1 knapsack), longest increasing subsequence, All pair shortest path in graph, Matrix chain multiplication, Travelling salesman Problem

MODULE 4: APPLICATION OF GRAPH TRAVERSAL TECHNIQUES	**9 Hrs**
Recall representation of graphs, BFS, DFS, connected components, Strongly-connected components of DAGs, Kosaraju's algorithm 1 and 2, Applications. Graph matching, String Matching: Boyer Moore algorithm.	
MODULE 5: REASONING ABOUT ALGORITHMS	**6 Hrs**
Complexity Analysis (Polynomial vs Non-Polynomial time complexity), P, NP-hard and NP-Completeness, Reductions.	

TEXT BOOK:

1. T. H. Cormen, Leiserson, Rivest and Stein, "Introduction of Computer algorithm," , 3rd Edition, The MIT Press, 2015

REFERENCES:

1. E. Horowitz, S. Sahni, and S. Rajasekaran, " Fundamentals of Computer Algorithms," Galgotia Publication, 2015.
2. Anany Levitin, —Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012
3. Sara Basse, A. V. Gelder, "Computer Algorithms : Introduction Design & Analysis", 3rd Edition, Addison Wesley.
4. J.E Hopcroft, J.D Ullman, "Design and analysis of Computer algorithms", PearsonEducation, 2009.
5. Steven S. Skiena, "The Algorithm Design Manual", Second Edition, Springer, 2008

SEMESTER	IV
YEAR	II

COURSE CODE	21CS24**03**					
TITLE OF THE COURSE	**PRINCIPLES OF MICROPROCESSORS & COMPUTER ORGANIZATION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/ Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES:

- To introduce the architecture of 8086
- To understand the importance and function of each pin of 8086 Microprocessor
- To familiarize with the architecture of 8086 microprocessor and its operation
- To understand the various addressing modes required for assembly language
- Programming and to calculate the physical address.
- To learn the 8086 instruction set and write 8086 Assembly level programs
- To understand the importance of different peripheral devices and their interfacing to 8086
- Understand the concepts of Hardwired control and micro programmed control.
- To explain the current state of art in memory system design
- Discuss the concept of memory organization.
- Summarize the types of memory.
- Learn about various I/O devices and the I/O interface.
- Learn the different types of serial communication techniques.
- To understand DMA technique
- To provide the knowledge on Instruction Level Parallelism
- To understand the concepts of pipelining techniques.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy** Level
CO1	Identify the basic building blocks of 8086 microprocessor and use the addressing modes for executing programs efficiently	L2
CO2	Develop assembly language programs using modern 8086 assembler tools	L3

CO3	Discuss the computer arithmetic and design algorithms for various Arithmetic operations.	L2
CO4	Design data part and control part of a processor	L3
CO5	Analyze the performance of various classes of Memories	L4
CO6	Understand pipeline & parallel processing	L2

COURSE CONTENT:	
MODULE 1: Introduction to Microprocessor & its Architecture:	**8 Hrs**
Introduction-Evolution of Microprocessor, The Microprocessor-Based Personal Computer Systems, Internal Microprocessor Architecture, Real mode memory addressing, 8086 pin diagram, Internal Architecture of 8086, Registers, Addressing Modes-Immediate addressing, Register addressing, direct addressing, indirect addressing, relative addressing, Instruction formats	
MODULE 2: Programming 8086	**12 Hrs**
Assembler directives, Data Movement Instructions, String Data Transfers, Miscellaneous Data Transfer Instructions, Arithmetic and Logic Instructions, BCD and ASCII Arithmetic, Basic Logic Instructions, Shift and Rotate, String Comparisons. Program Control Instructions: The Jump Group,Assembly language programming with 8086, macros, procedures	
MODULE 3: Processor Organization:	**10 Hrs**
Basic organization of computers, Block level description of the functional units as related to the execution of a program; Fetch, decode and execute cycle. Execution cycle in terms of machine instructions. Information representation, Floating point representation (IEEE754), computer arithmetic and their implementation; **Data Part Design:** Fixed-Point Arithmetic-Addition, Subtraction, Multiplication and Division, Arithmetic Logic Units control and data path, data path components, design of ALU and data-path, **Control Part Design:** Control unit design; Hardwired and Micro programmed Control unit. Discussions about RISC versus CISC architectures.	
MODULE 4: Memory Technology, Input/Output Organization:	**12 Hrs**
Memory hierarchy, static and dynamic memory, RAM and ROM chips, Memory address map, Auxiliary Memory, Associative Memory, Cache Memory and organization. Peripheral devices, Input-Output Interface; I/O Bus and Interface Modules, Isolated versus Memory- Mapped I/O, Modes of Transfer; Programmed I/O, Interrupt-initiated I/O, Direct memory access (DMA)	
MODULE 5: Pipelining	**10 Hrs**

Basic Concepts, Arithmetic Pipeline, Instruction Pipeline; Four-Segment Instruction Pipeline, Pipeline hazards and their resolution, **Parallel Processing;** Flynn's classification, Multicore architectures, Introduction to Graphics Processing Units, Example: NVIDIA GPU Architecture

TEXT BOOK:

1. Barry B Brey: The Intel Microprocessors, 8th Edition, Pearson Education, 2009
2. Mano, Morris M. Computer system architecture. Dorling Kindesley Pearson, 2005

REFERENCES:

1. Douglas V Hall, "MICROPROCESSORS AND INTERFACING, PROGRAMMING AND HARDWARE" TMH, 2006.
2. Kenneth J. Ayala, "The 8086 Microprocessor: Programming & Interfacing The PC",Delmar Publishers, 2007
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Danny Causey, The x86 PC Assembly LanguageDesign and Interfacing, 5th Edition, Pearson, 2013.
4. V. Carl Hamacher, Safwat G. Zaky and Zvonko G. Vranesic , Computer Organization ,McGraw- Hill Series 2002
5. Hayes, J.P , Computer Architecture and Organization, McGraw-Hill, 1998
6. David Patterson and John Hennessey, Computer Organization and Design, Elsevier. 2008
7. Comer, Douglas. Essentials of computer architecture. Chapman and Hall/CRC, 2017.
8. Hord, R. Michael. Parallel supercomputing in MIMD architectures. CRC press, 2018.
9. Tanenbaum, Andrew S. Structured computer organization. Pearson Education India, 2016.
10. William Stallings-Computer Organization and Architecture, Seventh Edition, Pearson Education

SEMESTER	IV					
YEAR	II					
COURSE CODE	21CS2404					
TITLE OF THE COURSE	FINITE AUTOMATA AND FORMAL LANGUAGES					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	2	-	39+26	4

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES:

- To learn general theory of automata, properties of regular sets and regular expressions.
- To understand the basics of formal languages.
- To know push-down automata, context- free languages, Turing machines.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the basic concepts of formal languages of finite automata techniques such as DFA, NFA and E-NFA	L2
CO2	Design Finite Automata for different Regular Expressions and Languages Demonstrate the properties of regular grammar, regular language, regular expression & their relationship with finite automata	L3
CO3	Construct context free grammar for various languages. Interpret and design different PDA for a given language	L3
CO4	Construct context free, regular, Chomsky normal form grammars to design computer languages	L3
CO5	Design Turing machine to solve problems	L3

COURSE CONTENT:

MODULE 1	8Hrs
Introduction to Finite Automata: Study and Central concepts of automata theory, An informal picture of finite automata, deterministic and non-deterministic finite automata, applications of finite automata,finite automata with epsilon – transitions.	
MODULE 2	**8Hrs**
Regular expression and languages: Regular expressions, finite automata and regular expressions, algebraic laws of regular expressions. P3r1operties of Regular Languages: closure properties of regular languages, Pumping Lemma, equivalence and minimization of automata .	

MODULE 3	9Hrs
Context – free Grammars and Languages: Context free grammars, Context-free languages,Parse trees, Ambiguity in grammars and languages, Pushdown Automata: Pushdown automaton (PDA), the language of PDA, equivalence of PDA and CFG's, DeterministicPushdown Automata	
MODULE 4	**8Hrs**
Properties of Context – Free Languages: Normal forms of context free grammars, pumping lemma for context free languages, closure properties of context free languages. Applications of CFG - such as spec of programming languages, parsing techniques, and Yacc	
MODULE 5	**6Hrs**
Introduction to Turing Machine- The Turing machine, programming techniques for Turing machine, extensions to the basic Turing machine, Chomsky hierarchy	

List of Laboratory/Practical Experiments activities to be conducted

1. Design a Program for creating machines that accept three consecutive ones.

2. Design a Program for creating a machine that accepts the string always ending with 101.

3. Design a Program for Mode 3 Machine

4. Design a program for accepting decimal number divisible by 2.

5. Design a program for creating a machine which accepts string having equal no. of 1's and 0's.

6. Design a program for creating a machine which count number of 1's and 0's in a given string.

7. Design a Program to find 2's complement of a given binary number.

8. Design a Program which will increment the given binary number by 1.
9. Design a Program to convert NDFA to DFA.

10. Design a Program to create PDA machine that accept the well-formed parenthesis.

11. Design a PDA to accept WCWR where w is any string and WR is reverse of that string and C is a Special symbol.

12. Design a Turing machine that's accepts the following language an b n c n where n>0.

TEXT BOOKS:

1. Daniel I. A. Cohen, Introduction to Computer Theory, 2nd Edition, Wiley India Student Edition, 2008.
2. J.E. Hopcroft , R. Motwani, and J. D. Ullman, Introduction to Automata Theory,Languages and Computation, 3rd Edn. Pearson Education , New Delhi 2008

REFERENCES:

1. K.L.P. Misra and N. Chandrashekaran. Theory of Computer Science- Automata,Languages and Computation, 3rd Edn. PHI, New Delhi, 2007

2. C. Martin - Introduction to Languages and the Theory of Computation 2ndEdn,TMH, New Delhi, 2000.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	21CS2405					
TITLE OF THE COURSE	**SOFTWARE ENGINEERING AND PROJECT MANAGEMENT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- This course is introduced to give the students necessary knowledge.
- Understanding and Design aspects in Software Engineering
- To understand the Software Project Planning and Evaluation techniques

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand software development life cycle models, process models, and various design engineering techniques	L2
CO2	Apply new software models, techniques and technologies to bring out innovative and novelistic solutions for the growth of the society in all aspects and evolving into their continuous professional development	L3
CO3	Analyze a problem, and identify and define the computing requirements appropriate to its solution	L4
CO4	Apply a wide variety of testing techniques in an effective and an efficient manner.	L3
CO5	Understand Project Management principles while developing software.	L2

COURSE CONTENT:	
MODULE 1	**8Hrs**
Introduction to Software Engineering: FAQs about software engineering, Professional and ethical responsibility. Socio-Technical systems: Emergent system properties, Organizations, people and computer systems; Legacy systems, the evolving role of software, Changing Nature of Software, Software myths. **A Generic view of process:** Software engineering- A layered technology, a process framework, The Capability Maturity Model Integration (CMMI), Process patterns, process assessment, personal and team process models. Software Cost Estimation: Productivity; Estimation techniques	
MODULE 2	**8Hrs**
Process models: A simple safety- critical system; System dependability; Availability and reliability, the waterfall model, Incremental process models, Evolutionary process models, The Unified process. Agile Development: Agile Tech, Extreme Programming, and other Agile Process Models: Scrum Methodology	
MODULE 3	**8Hrs**
Software Requirements: Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management.	
MODULE 4	**8Hrs**
Testing Strategies: Verification and Validation: Planning; Software inspections; Automated static analysis; Verification and formal methods. A strategic approach to software testing, System testing, the art of Debugging; Component testing; Test case design; Test automation - Selenium, Test strategies for conventional software: Black-Box and White-Box testing, Validation tests, System testing.	
MODULE 5	**7Hrs**
Software Project Management Introduction to Software Project Management – all life cycle activities – Methodologies – Categorization of Software Projects – Setting objectives – Management Principles – Management Control – Project portfolio Management – Cost-benefit evaluation technology – Risk evaluation – Strategic program Management – Stepwise Project Planning.	

TEXT BOOKS:

1. Software Engineering, by Ian Sommerville Eighth edition, International Computer Science Series.
2. Software Engineering, A practitioner’s Approach- Roger S. Pressman, 6th edition. McGraw Hill International Edition.

REFERENCES:

1. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – FifthEdition, Tata McGraw Hill, New Delhi, 2012.
2. SoftwareEngineering-K.K.Agarwal&YogeshSingh,NewAgeInternationalPublishers
3. Software Engineering, an Engineering approach-JamesF. Peters, Witold Percy, John Wiley.
4. Systems Analysis and Design –Shelly Cashman Rosenblatt, Thomson Publications.
5. Software Engineering principles and practice-Waman Jawadekar,The McGraw-

SEMESTER	IV					
YEAR	II					
COURSE CODE	21DS2401					
TITLE OF THE COURSE	**FUNDAMENTALS OF DATA SCIENCE**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Project s Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To use the statistical and computational techniques to Discover, Analyze, Visualize and Present the Data.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To Summarize the data using visual & summary analytics and common probability distributions	L2
CO2	To make inference about a sample & population using hypothesis test.	L2
CO3	To fit, interpret, and assess regression models and classification with one or more predictors.	L4
CO4	To assess the data integrity and data relevancy to a specific application	L3
CO5	To understand the unsupervised learning and clustering models	L2

COURSE CONTENT:	
MODULE 1: Introduction	**8 Hrs**

Overview of the Data Science process. Different types of data, Data Pre-processing: Data Cleaning-Missing values, Noisy data, Data cleaning as process, Data Reduction: Principal Components Analysis, Data Transformation: Strategies Overview, Data Transformation by normalization, Discretization by binning. Introducing Python Libraries (Pycharm)	
MODULE 2: EXPLORATORY DATA ANALYSIS AND HYPOTHESIS TESTING	**9 Hrs**
Exploratory Data Analysis: Central Tendency, Dispersions, Five number Distributions, Cross Tabulations. Data Visualization: Histogram, Box Plot, Correlation Plot, Scatter Plot, Line Chart, Bar Chart, Pie Chart, Bubble Chart, Decision Tree, Cluster Charts. Hypothesis Testing: Confidence Intervals, Constructing a hypothesis, Null Hypothesis & Alternative Hypothesis, Type I and Type II errors, Power Value	
MODULE 3: PARAMETRIC AND NON-PARAMETRIC TESTS	**8 Hrs**
Parametric test: Z test, One Sample T-TEST, Paired T-TEST,Independent Sample T-TEST, ANOVA, MANOVA, Level of significance, Power of a test. Non parametric test: Chi Square Test, Fisher's Test, Mann-Whitney U test, Kruskal-Wallis Rank Test, Wilcoxon sign rank.	
MODULE 4: CLASSIFICATION MODELS	**7 Hrs**
Classification Models: Logistic Regression, Discriminate Regression Analysis, Test of Associations, Chi-square strength of association, Maximum likelihood estimation, Confusion matrix, Support Vector Machines (SVM), Naive Bayes, Random Forests: Bagging & Boosting, CHAID Analysis, Decision trees, k-Nearest Neighbors, Neural Network.	
MODULE 5: UNSUPERVISED LEARNING	**7 Hrs**
Unsupervised Learning: Principal component analysis, Reliability Test, KMO tests, EigenValue Interpretation, Rotation and Extraction steps. Clustering Methods: K Means clustering, Agglomerative Clustering	

TEXTBOOKS:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services,Wiley
2. Jiawei Han, Micheline Kember and Jian Pei, Data Mining Concepts and Techniques, 3rd edition, Elsevier, 2012
3. Statistics for Managers Using Microsoft Excel , 8th Edition, by David M. Levine , David F. Stephan , and Kathryn A. Szabat , Publisher: Pearson

REFERENCE BOOKS:

1. Data Mining in excel: Lecture Notes and cases by Galit Shmueli, Publisher: Wiley
2. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd ed)., Springer, 2008.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	21CS2407					
TITLE OF THE COURSE	**DESIGN AND ANALYSIS OF ALGORITHMS LABORATORY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	2	-	26	1

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	****	****	****

COURSE OBJECTIVES:

- To learn mathematical background for analysis of algorithm
- To understand the concept of designing an algorithm.
- To analyze the algorithms using space and time complexity.
- To learn dynamic programming and greedy method.
- To acquire knowledge of various applied algorithms.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO 1	Design and develop the Algorithms to understand the different concepts.	L3
CO 2	Apply the Design principles and concepts to Algorithmic design	L3
CO 3	Describe the DAA paradigms and when an Algorithmic Design situation calls for it.	L6
CO 4	Analyse worst-case and best – case running times of algorithms using asymptotic analysis.	L4

CO 5	Implement an existing algorithm to improve the run time efficiency	L3

List of Laboratory/Practical Experiments activities to be conducted
1. Design a C program to solve the Tower of Hanoi. Compute the time complexity. 2. Apply divide and conquer method and Design a C program to search an element in a given array and Compute the time complexity. Binary search - recursive method 3. Apply Divide and Conquer method Design a C program to sort an array using Merge sort algorithm and compute its time complexity

Apply Divide and Conquer method Design a C program to sort an array using Quick sort algorithm and compute its time complexity.

Apply Greedy method and Design a C program to find the minimum cost spanning tree using Prim's and Kruskal's Algorithm and compute its complexity

Apply Dynamic Programming Technique and Design a C program to find the all pairs shortest path using Dijkstra's Algorithm and computes its complexity

Design a C program to find the optimal solution of 0-1 knapsack problem using dynamic programming and Compute the time complexity

Design a C program to solve the Travelling Salesman Problem using dynamic programming and compute its time complexity.

Design a C program to find the longest common subsequence using dynamic programming and compute its time complexity

Mini project proposal should be submitted and Implementation should be done based on the problem stated in the proposal

TEXT BOOK:

1. Levitin A, "Introduction to the Design And Analysis of Algorithms", Pearson Education, 2008.
2. T. H. Cormen, Leiserson, Rivest and Stein, "Introduction of Computer algorithm," , 3rd Edition, The MIT Press, 2015

REFERENCES:

1. E. Horowitz, S. Sahni, and S. Rajsekaran, "Fundamentals of Computer Algorithms," Galgotia Publication, 2015.
2. Goodrich M.T., R Tomassia, "Algorithm Design foundations Analysis and Internet Examples", John Wiley and Sons, 2006.
3. Sara Basse, A. V. Gelder, "Computer Algorithms : Introduction Design & Analysis", 3rd Edition, Addison Wesley.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	21DS2402					
TITLE OF THE COURSE	**DATA SCIENCE LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**26**	**01**

COURSE OBJECTIVES:

- To use the statistical and computational techniques to Discover, Analyze, Visualize and Present the Data.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To Summarize the data using visual & summary analytics and common probability distributions	L2
CO2	To make inference about a sample & population using hypothesis test.	L2
CO3	To fit, interpret, and assess regression models and classification with one or more predictors.	L6
CO4	To assess the data integrity and data relevancy to a specific application	L3
CO5	To understand the unsupervised learning and clustering models	L2

List of Experiments activities to be conducted

1. R AS CALCULATOR APPLICATION
    - a. Using with and without Python/R objects on console
    - b. Using Python/R mathematical functions on console

2. DESCRIPTIVE STATISTICS IN R a. Write an Python/R script to find basic descriptive statistics using summary, str, quartile function on mtcars & cars datasets. b. Write an Python/R script to find subset of dataset by using subset (), aggregate () functions on iris dataset
3. READING AND WRITING DIFFERENT TYPES OF DATASETS a. Reading types of data sets (.txt, .csv) from web and disk and writing in file in specific disk location. different
b. Reading Excel data sheet in Python/R. c. Reading XML dataset in Python/R.
4. VISUALIZATIONS USING PYTHON/R a. Find the data distributions using box and scatter plot. b. Find the outliers using plot. c. Plot the histogram, bar chart and pie chart on sample data
5. CORRELATION AND COVARIANCE USING Python/R a. Find the correlation matrix. b. Plot the correlation plot on the dataset and visualize giving an overview of relationships among data on iris data. c. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.
6. REGRESSION MODEL using Python/R Import data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in an institute based on his or her GRE score, GPA obtained and rank of the student. Also check if the model is fit or not.
7. MULTIPLE REGRESSION MODEL Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset
8. REGRESSION MODEL FOR PREDICTION Apply regression Model techniques to predict the data on above dataset.

9. CLASSIFICATION MODEL a. Install relevant package for classification. b. Choose classifier for a classification problem. c. Evaluate the performance of classifier.
10. CLUSTERING MODEL a. Clustering algorithms for unsupervised classification. b. d. Plot the cluster data using R visualizations.

TEXT BOOK:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services,Wiley
2. Jiawei Han, Micheline Kember and Jian Pei, Data Mining Concepts and Techniques, 3rd edition, Elsevier, 2012

SEMESTER	**V**
YEAR	**III**
COURSE CODE	**21DS3501**
TITLE OF THE COURSE	**DATABASE MANAGEMENT SYSTEMS**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

COURSE OBJECTIVES:

- To learn data models, conceptualize and depict a database system using ER diagram
- To understand the internal storage structures in a physical DB design
- To know the fundamental concepts of transaction processing techniques

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OUTCOMES

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate the basic elements of a relational database management system	L2
CO2	Identify the data models for relevant problems	L2
CO3	Apply normalization for the development of application software's	L3
CO4	Use Structured Query Language (SQL) for database manipulation.	L3
CO5	Understand transactions and their properties (ACID)	L2
CO6	Design and develop a large database with optimal query processing	L6

COURSE CONTENT:	
MODULE 1	**8Hrs**
Introduction: Purpose of Database System-–Views of data–data models, database management system, three-schema architecture of DBMS, components of DBMS. E/R Model - Conceptual data modeling - motivation, entities, entity types, attributes relationships, relationship types, E/R diagram notation, examples.	
MODULE 2	**8Hrs**
Relational Model: Relational Data Model - Concept of relations, schema-instance distinction, keys, referential integrity and foreign keys, relational algebra operators, SQL -Introduction, data definition in SQL, table, key and foreign key definitions, update behaviors. Querying in SQL, notion of aggregation, aggregation functions group by and having clauses.	
MODULE 3	**8Hrs**
Database Design: Dependencies and Normal forms, dependency theory –functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, 4NF, and 5NF	
MODULE 4	**8 Hrs**
Transactions: Transaction processing and Error recovery - concepts of transaction processing, ACID properties, concurrency control, locking based protocols for CC, error recovery and logging, undo, redo, undo-redo logging and recovery methods.	
MODULE 5	**7Hrs**
Embedded SQL: triggers, procedures and database connectivity. Introduction to NoSQL	

TEXT BOOKS :	
1.	Silberschatz, Henry F. Korth, and S. Sudharshan, “Database System Concepts”, 5thEd, Tata McGraw Hill, 2006.
2.	J. Date, A. Kannan and S. Swamynathan, “An Introduction to Database Systems”, 8thed, Pearson Education, 2006.

REFERENCES :	
1.	Ramez Elmasri and Shamkant B. Navathe, “Fundamentals of Database Systems”, Fourth Edition, Pearson/Addision Wesley, 2007
2.	Raghu Ramakrishnan, “Database Management Systems”, Third Edition, McGraw Hill, 2003
3.	S. K. Singh, “Database Systems Concepts, Design and Applications”, First Edition, Pearson Education, 2006

SEMESTER	**V**
YEAR	**III**
COURSE CODE	**21DS3502**
TITLE OF THE COURSE	**OBJECT ORIENTED PROGRAMMING WITH JAVA**

SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Understand the basic concepts of object-oriented design techniques.
- Understand the fundamentals of object-oriented programming with Java.
- Draw UML diagrams for the software system.
- Impart basics of multithreading and database connectivity.
- Develop GUI using event handling techniques in Java.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Apply the concepts of object-oriented programming in the software design process.	L3
CO2	Develop Java programs using Java libraries and construct them to solve real-time problems.	L3
CO3	Understand, develop and apply various object-oriented features using Java to solve computational problems	L2
CO4	Implement exception handling and JDBC connectivity in Java.	L3
CO5	Build an event-oriented GUI (graphical user interface).	L6

COURSE CONTENT:	
MODULE 1	**08 Hrs**

An Overview of Object-Oriented Systems Development: Introduction; Two Orthogonal Views of the Software; Object-Oriented Systems Development Methodology; Why an Object-Oriented? Overview of the Unified Approach. **Object Basics**: Introduction; An Object-Oriented Philosophy; Objects; Objects are Grouped in Classes; **Attributes**: Object State and Properties; Object behavior and Methods; Object Respond to Messages; Encapsulation and Information Hiding; **Class Hierarchy:** Inheritance; Multiple Inheritance; **Polymorphism**; Object Relationships and Associations: Consumer-Producer Association; Aggregation and Object Containment; **Case Study** - A Payroll Program; **Object-Oriented Systems Development Life Cycle**: Introduction; Software Development Process; Building High-Quality Software; Object-Oriented Systems Development: A Use Case Driven Approach; Reusability.	
MODULE 2	**08 Hrs**
Unified Modelling Language: Introduction; Static and Dynamic models; Why Modeling? Introduction to the UML; UML Diagrams; UML Class Diagram; Use-Case Diagram. **Introduction to Java**: Java's Magic: The Bytecode; JVM; Object-Oriented Programming; Simple Java programs; Two Control Statements; Lexical Issues; **Data Types; Variables, Arrays and String constructors**; **Operators; Control Statements; Introducing Classes:** Class Fundamentals; objects; methods; constructors; this Keyword; Garbage Collection; finalize() method; Parameter Passing; Overloading; Access Control Keywords. Inheritance basics; method overriding; abstract classes; Packages and interfaces. Exception handling fundamentals; multiple catch; nested try statements.	
MODULE 3	**08 Hrs**
Multi-Threaded Programming :Multi-Threaded Programming: Java Thread Model; The main Thread; Creating a thread and multiple threads; Extending threads; Implementing Runnable; Synchronization; Inter Thread Communication; producer consumer problem. **Input/Output**: I/O Basic; Reading console input Writing Console output.	
MODULE 4	**08 Hrs**
Event and GUI Programming: Introducing Swing; The Origins of Swing; Swing Is Built on the AWT; Two Key Swing Features; The MVC Connection; Components and Containers; The Swing Packages; A Simple Swing Application; Event Handling; JLabel; JTextField; JButton, Applets	
MODULE 5	**07 Hrs**
Database Access: The Concept of JDBC; JDBC Driver Types; JDBC Packages; A Brief Overview of the JDBC process; Database Connection; Associating the JDBC/ODBC Bridge with the Database; Statement Objects; ResultSet. **Distributed Computing:** RMI (Remote Method Invocation), Java Messaging Services (JMS), Java RMI-IIOP, Web services and SOAP/REST	

List of Laboratory/Practical Experiments activities to be conducted

1. Develop an in-depth understanding of programming in Java: data types, variables, operators, operator precedence, Decision and control statements, arrays, switch statement, Iteration Statements, Jump Statements, Using break, Using continue, return.
2. Write Object Oriented programs in Java: Objects, Classes constructors, returning and passing objects as parameter, Inheritance, Access Control, Using super, final with inheritance Overloading and overriding methods, Abstract classes, Extended classes.
3. Develop java program on packages & Interfaces: Package, concept of CLASSPATH, access modifiers, importing package, Defining and implementing interfaces.
4. Develop java program on Strings and exception handling: String constructors, special string operations, character extraction, searching and comparing strings, string Buffer class. Exception handling fundamentals, Exception types, uncaught exceptions, try, catch and multiple catch statements. Usage of throw, throws and finally.
5. Develop applications involving file handling: I/O streams, File I/O.
6. Development of programs/projects to demonstrate concepts like inheritance, exception handling, packages, interfaces etc. such as application for electricity department, library management, ticket reservation system, payroll system etc.

TEXTBOOKS

1. Bahrami A.; Object Oriented Systems Development using the Unified Modeling Language; McGraw Hill; 1999.
2. Schildt; Herbert. Java The Complete Reference; 8th Edition. US: McGraw-Hill Osborne Media; 2011.
3. Jim Keogh; J2EE: The Complete Reference; McGraw Hill Education in 2002.

REFERENCE BOOKS

1. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.

2. Y. Daniel Liang, Introduction to Java Programming, 7th edition, Pearson, 2013

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**21DS3503**					
TITLE OF THE COURSE	**OPERATING SYSTEMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**39**	**4**
Perquisite Courses (if any)						
#	**Sem/ Year**	**Course Code**	**Title of the Course**			
*	***	***	****			

COURSE OBJECTIVES:

- To understand the basic concepts and functions of operating systems.
- To understand Processes and Threads
- To analyze Scheduling algorithms.
- To understand the concept of Deadlocks.
- To analyze various Memory and Virtual memory management, File system and storage techniques.
- To discuss the goals and principles of protection in a modern computer system.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO 1	Interpret the different structures, functions, services of operating system and use operating system level virtualization to improve security, manageability and availability of today's complex software environment with small runtime and resource overhead & with minimal changes to the existing computing infrastructure	L2
CO 2	Infer the performance of various CPU scheduling algorithms to make the system more efficient, faster & fairer	L4
CO 3	Use the knowledge of synchronization hardware, semaphores, monitors to resolve process synchronization problems	L3
CO4	Identify the deadlocks using resource allocation graph & resolve the deadlocks using roll back &	L2, L3

	abort algorithm, bankers algorithm to ensure system is free from dead locks	
CO 5	Compare & Contrast various memory management schemes to implement the virtual address & provide the memory protection	L4
CO 6	Examine the various file management techniques, disk scheduling methods for efficient resource utilization & Interpret the system, network, program threats & employ protection principles to safeguard the system resources	L2,L5

COURSE CONTENT:	
MODULE 1: OS Overview and System Structure	**8 Hrs**
Introduction to operating systems, System structures: What operating systems do; Computer System organization; Computer System architecture; Operating System structure; Operating System operations; Process management; Memory management; Storage management; Protection and Security; Distributed system; Computing environments. Operating System Services: User - Operating System interface; System calls; Types of system calls; System programs; Operating system design and implementation; Operating System structure; Virtual machines;	
MODULE 2: Process Management	**8 Hrs**
Process Management: Process concept; Process scheduling; Operations on processes. Multi-threaded Programming: Overview; Multithreading models; Threading issues. Process Scheduling: Basic concepts; Scheduling Criteria; Scheduling Algorithms.	
MODULE 3: Process Coordination	**8 Hrs**
Process Synchronization: The critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors Deadlocks: Deadlocks; System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.	
MODULE 4: Memory Management	**7 Hrs**
Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. Virtual Memory Management: Background; Demand paging; Copy-on-write; Page replacement; Allocation of frames; Thrashing.	
MODULE 5: File System and Secondary Storage Structure	**8 Hrs**

File System, Implementation of File System**:**

File system: File concept; Access methods; Directory structure; File system mounting; File sharing. Protection: Implementing File system: File system structure; File system implementation; Directory implementation; Allocation methods; Free space management.

Mass storage structures; Disk structure; Disk attachment; Disk scheduling; Disk management; Swap space management.

Protection and Security:

Protection: Goals of protection, Principles of protection, System Security: The Security Problem, Program Threats, System and Network Threats.

TEXT BOOKS:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 8th edition, Wiley-India, 2010

REFERENCES:

1. Operating Systems-Internals and Design Principles, William Stallings, 6th Edition, Pearson Education, 2009.
2. Operating Systems: A Modern Perspective, Gary J. Nutt, Addison-Wesley, 1997

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**21DS3504**					
TITLE OF THE COURSE	**MACHINE LEARNING TOOLS & TECHNIQUES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**02**	**-**	**39+26**	**04**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To understand the basic building blocks and general principles that allows one to design Deep learning algorithms
- To become familiar with specific, widely used Deep learning networks
- To introduce building blocks of Convolution neural network architecture
- To learn to use deep learning tools and framework for solving real-life problems

COURSE OUTCOMES

CO NO.	**OUTCOMES**	**BLOOM'S TAXONOMY LEVEL**
CO 1	Apply the concepts of learning to find all hypotheses that match all the given training examples	**L3**
CO 2	Train a classifier and analyze the results on MNIST datasets	**L4**
CO 3	Usage of ensemble methods and ANN for classification	**L3**
CO 4	Implement hierarchical, density-based, grid-based clustering algorithms	**L3**

CO 5	Application of all the concepts to complete a machine learning project on different datasets and algorithms	**L3**

COURSE CONTENTS

MODULE 1: INTRODUCTION	**6 HRS**
The Machine Learning Landscape— What Is Machine Learning?; Why Use Machine Learning?; Types of Machine Learning Systems; Concepts Learning and the General-to-Specific Ordering; Concept Learning Task, Concept Learning as Search, Find-S, Version Spaces and the CANDIDATE ELIMINATION Algorithm and Remarks; Challenges of Machine Learning; Testing and Validating. (T1: Chapter 1)	
MODULE 2: CLASSIFICATION	**8 HRS**
Classification — MNIST Dataset; Training a Binary Classifier; Performance Measures; Error Analysis; Multilabel Classification; Multi Output Classification. (T1: Chapter 3) **Training Models —** Gradient Descent; Polynomial Regression; Learning Curves; Regularized Linear Models; Logistic Regression - Estimating Probabilities, Training and Cost Function, Decision Boundaries, Softmax Regression. (T1: Chapter 4)	
MODULE 3: CLASSIFICATION ALGORITHMS	**8 HRS**
Ensemble Learning— Parallel ensemble models - Voting Classifiers; Bagging, Bagging and Pasting in Scikit-Learn, Out-of-Bag Evaluation, Random Patches and Random Subspaces, Random Forests, Extra-Trees, Feature Importance; Sequential ensemble method; Incremental ensemble method. (T1: Chapter 7) **Artificial Neural Networks**— From Biological to Artificial Neurons; Training an MLP with TensorFlow's High-Level API; Fine-Tuning Neural Network Hyperparameters; Other ANN Architectures (T1: Chapter 10)	
MODULE 4: CLUSTERING	**9 HRS**
Introduction to Clustering; Proximity Measures; Hierarchical clustering algorithms - Single linkage algorithm, Complete linkage or Clique algorithm, Average linkage, Mean-shift clustering algorithm; Partitional clustering algorithm; Density based Methods; Grid based methods; probability based methods; cluster evaluation methods (T2:Chapter 13)	
MODULE 5: END-to-END MACHINE LEARNING PROJECT	**8 HRS**

Working with Real Data; Frame the Problem; Get the Data; Discover and Visualize the Data to Gain Insights; Prepare the Data for Machine Learning Algorithms; Select and Train a Model; Fine-Tune Your Model; Launch, Monitor and Maintain the System. (T1: Chapter 2)

Case Study : Tensorflow (T1: Chapter 9)

LIST OF PRACTICAL EXPERIMENTS TO BE CONDUCTED:

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using different datasets.
4. Implement ensemble algorithms using appropriate datasets
5. Implement Hierarchical clustering algorithms with appropriate dataset
6. Implement DBScan clustering algorithm
7. Mini project

TEXTBOOKS

1. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems”, O'Reilly Media; 1 edition (April 9, 2017)
2. Dr. S Sridhar, Dr. M. Vijayalakshmi, “Machine Learning”, Oxford University Press, 2021.

REFERENCE BOOKS

1. Tom Mitchell, Machine Learning, McGraw-Hill, 1997

E-RESOURCES

1. https://www.drssridhar.com/?page_id=698

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**21DS3505**					
TITLE OF THE COURSE	**DATABASE MANAGEMENT SYSTEMS LAB**					
SCHEME OF Instruction	**Lecture Hours**	**Tutorial Hours**	**Practical Hours**	**Seminar/Projects Hours**	**Total Hours**	**Credits**
	-	-	2	-	30	1

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**	**	****

COURSE OBJECTIVES :

- Understand the fundamental concepts of database management. These concepts include aspects of database design, database languages, and database-system implementation.
- To provide a strong formal foundation in database concepts, recent technologies and best industry practices.
- To give systematic database design approaches covering conceptual design, logical design and an overview of physical design.
- To learn the SQL and NoSQL database system.
- To learn and understand various Database Architectures and its use for application development.
- To programme PL/SQL including stored procedures, stored functions, cursors and packages

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Install and configure database systems.	L3
CO2	Analyze database models & entity relationship models.	L3
CO3	Design and implement a database schema for a given problem-domain	L3
CO4	Understand the relational and document type database systems.	L2
CO5	Populate and query a database using SQL DML/DDL commands.	L3

List of Laboratory/Practical Experiments activities to be conducted
1. Design any database with at least 3 entities and relationships between them. Apply

	DCL and DDL commands. Draw suitable ER/EER diagram for the system.
2.	Design and implement a database and apply at least 10 different DML queries for the following task. For a given input string display only those records which match the given pattern or a phrase in the search string. Make use of wild characters and LIKE operator for the same. Make use of Boolean and arithmetic operators wherever necessary.
3.	Execute the aggregate functions like count, sum, avg etc. on the suitable database. Make use of built in functions according to the need of the database chosen. Retrieve the data from the database based on time and date functions like now (), date (), day (), time () etc. Use group by and having clauses.
4.	Implement nested sub queries. Perform a test for set membership (in, not in), set comparison (<some, >=some, <all etc.) and set cardinality (unique, not unique).
5.	Write and execute suitable database triggers .Consider row level and statement level triggers.
6.	Write and execute PL/SQL stored procedure and function to perform a suitable task on the database. Demonstrate its use.
7.	Write a PL/SQL block to implement all types of cursor.
8.	Execute DDL statements which demonstrate the use of views. Try to update the base table using its corresponding view. Also consider restrictions on updatable views and perform view creation from multiple tables.
9.	Mini project.

TEXT BOOKS :

1. Ramon A. Mata-Toledo, Pauline Cushman, Database management systems, TMGH, ISBN: IS978-0-07-063456-5, 5th Edition.

REFERENCES :

1. Dr. P. S. Deshpande, SQL and PL/SQL for Oracle 10g Black Book, DreamTech.
2. Ivan Bayross, SQL, PL/SQL: The Programming Language of Oracle, BPB Publication.
3. Dalton Patrik, SQL Server – Black Book, DreamTech Press.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**21DS3506**					
TITLE OF THE COURSE	**OPERATING SYSTEMS LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	**2**	**-**	**26**	**1**

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**	***	****

COURSE OBJECTIVES:

- To learn creating process and Threads
- To implement various CPU Scheduling Algorithms
- To implement Process Creation and Inter Process Communication.
- To implement Deadlock Avoidance and Deadlock Detection Algorithms
- To implement Page Replacement Algorithms
- To implement File Organization and File Allocation Strategies

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Implement system calls to expose the operating system's services to user programs.	L3
CO2	Develop multi-threading and CPU Scheduling algorithms to make the system more efficient, faster, and fairer.	L3
CO3	Implement process synchronization problem using semaphores for the coordination of the process interactions in an Operating System.	L3
CO4	Implement bankers algorithm for the purpose of deadlock avoidance to ensure system is in safe state.	L3

CO5	Develop the page replacement algorithms for effective management of virtual memory.	L3
CO6	Implement file organization and file allocation strategies for efficient disk space utilization.	L3

List of Laboratory/Practical Experiments activities to be conducted		
Exp. No	Division of Experiments	List of Experiments
1	System Calls	Write a C program to create a new process that exec a new program using system calls fork(), execlp() & wait()
2		Write a C program to display PID and PPID using system calls getpid () & getppid ()
3		Write a C program using I/O system calls open(), read() & write() to copy contents of one file to another file
4	Process Management	Write a C program to implement multithreaded program using pthreads
5		Write C program to simulate the following CPU scheduling algorithms a) FCFS b) SJF c) Priority d) Round Robin
6	Process synchronization	Write a C program to simulate producer-consumer problem using semaphores
7	Deadlock	Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.
8		Write a C program to simulate deadlock detection.
9	Memory Management	Write a C program to simulate paging technique of memory management
10		Write a C program to simulate page replacement algorithms a) FIFO b) LRU c) LFU
11	I/O System	Write a C program to simulate the following file organization techniques a) Single level directory b) Two level directory
12		Write a C program to simulate the following file allocation strategies. a) Sequential b) Indexed

TEXT BOOKS:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 8th edition, Wiley-India, 2010

REFERENCES:

1. Operating Systems-Internals and Design Principles, William Stallings, 6th Edition, Pearson Education, 2009.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**21DS3507**					
TITLE OF THE COURSE	**Special Topics-II**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	-	**4**	**52**	**2**

Course objectives

1. To develop problem solving abilities

2. To build the necessary skill set and analytical abilities for developing computer based solutions for real life problems.

3. To train students in professional skills related to Software Industry

4. To prepare necessary knowledge base for research and development in Computer Science

Course Content

Following are some of the ways (but not limited to) of delivering the "Special Topics":

(i) Engaging Students in Small Batches (maximum 3/batch) in **Projects:** DSU Faculty will define and supervise a project which has a well defined scope. Students will work from requirements to delivering a prototype.

(ii) **Delivery from an Industry Expert:** An industry Expert can offer a project for around 20-25 students, clearly defining the scope. The project will have 4-5 sub-modules. Each student group will work on one sub-module from requirements gathering and analysis all the way to a working module. The sub-teams will integrate the modules and will together deliver a working prototype. The industry expert will engage all the teams on one afternoon face to face. One or two SOE faculty will also co- supervise the project.

(iii) **A Start-up company** might have a few project ideas to try out and they would engage a team of 20-25 students (in 4-5 batches) to work on these project ideas from concept to a prototype, with a close supervision from the start-up company technologist together with DSU faculty.

(iv) **Testing a new Product:** A Company has come up with a new product and they require a team of 30-40 students to thoroughly test all the features of the product and come up with a validation of the features of the product, a summary of features that fail to work and also a recommendation on a set of features that may have to be added to the product.

(v) A professor from an elite university from within India or abroad, offering a **short course** on a domain which is very current and state of art. The content has a built in project component.

(vi) A student undergoes a **on-line certification course** (such as coursera, Edx founded by Harward and MIT, MOOC, NPTEL, SWAYAM etc). Student obtains a certificate and an 'End of the Semester' exam will be conducted by the respective department.An expert from a company offers a **3 or 4 day workshop** (on-campus or outside the campus) involving mostly hands-on and a project component and a group of students successfully complete the workshop, with well defined learning components and deliverables.

(vii) Students participate and successfully complete **a Hackathon** (of Minimum two days), conducted by a reputed institution/organization. The deliverables include the pre-hackathon components, work done during Hackathon and post-Hackathon work (if applicable).

(viii) **Industry Project:** Students in a small team of 4-5 work on a project defined by an industry (including DERBI and AIC) during a semester and successfully complete the project.

(ix) **Summer Internship:** A group of students take up Summer Internship at DSU or outside, successfully complete the internship. If done within DSU, a project exhibition will also form a part of evaluation.

(x) **Visit to a University Abroad**: A group of students participate in a well structured program in a University abroad and complete all the requirements of the university.

(xi) **Working under a Research professor** within DSU or from premium institutes such as IISc, IIT, IIIT etc on a specific project/task.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**21DS3508**					
TITLE OF THE COURSE	**PATTERN RECOGNITION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- Numerous examples from machine vision, speech recognition and movement recognition have been discussed as applications.
- Unsupervised classification or clustering techniques have also been addressed in this course.
- Analytical aspects have been adequately stressed so that on completion of the course the students can apply the concepts learnt in real life problems

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Know feature extraction techniques and representation of patterns in feature space.	**L1**
CO 2	Measure of similarity between two patterns. Statistical, nonparametric and neural network techniques for pattern recognition.	**L1**
CO 3	Understand Techniques for recognition of time varying patterns.	**L2**

CO 4	Analyzing the unsupervised learning algorithms for pattern recognition	**L4**
CO 5	Understanding the significance of neural network in pattern analysis	**L2**

COURSE CONTENTS

MODULE 1	**8 HRS**
Introduction: Feature extraction and Pattern Representation, Concept of Supervised and Unsupervised Classification, Introduction to Application Areas. Statistical Pattern Recognition: Bayes Decision Theory, Minimum Error and Minimum Risk Classifiers, Discriminant Function and Decision Boundary, Normal Density, Discriminant Function for Discrete Features, Parameter Estimation.	
MODULE 2	**9 HRS**
Dimensionality Problem: Dimension and accuracy, Computational Complexity, Dimensionality Reduction, Fisher Linear Discriminant, Multiple Discriminant Analysis. Nonparametric Pattern Classification: Density Estimation, Nearest Neighbour Rule, Fuzzy Classification.	
MODULE 3	**8 HRS**
Linear Discriminant Functions: Separability, Two Category and Multi Category Classification, Linear Discriminators, Perceptron Criterion, Relaxation Procedure, Minimum Square Error Criterion, Widrow-Hoff Procedure, Ho-Kashyap Procedure Kesler's Construction	
MODULE 4	**7 HRS**
Feature Selection: Preprocessing, Peeking Phenomenon, Feature selection based on hypothesis testing, ROC curve, Class separability measures, Feature subset selection, optimal feature generation, Feature generation and selection, Generalization theory	
MODULE 5	**7 HRS**
Feature Generation: Basic vectors and images, Karhunen-Loeve Transform, Singular value decomposition, Independent component anlayssis, Regional Features, .Feature for shape and size characterization, Feature for Audio and Speech classification	

TEXTBOOKS

1. Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", John Wiley & Sons, 2001
2. Pattern Recognition and Image Analysis by Earl Gose , Richard Johnsonbaugh

REFERENCE BOOKS

1. Robert J.Schalkoff, Pattern Recognition Statistical, Structural and Neural

Approaches, John
Wiley & Sons Inc., New York, 1992.
2. Pattern Recognition: An Introduction eBook : M. Narasimha Murty, V. Susheela Devi

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**21DS35**09					
TITLE OF THE COURSE	**ARTIFICIAL INTELLIGENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To acquire knowledge on intelligent systems and agents, various search strategies
- Formalization of knowledge, reasoning with and without uncertainty
- To understand the concepts of Game playing and learning
- To learn an expert system with applications at a basic level

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Comprehend different types of problem-solving agents and its applications.	**L2**
CO 2	Solve problems using informed and uninformed search strategies.	**L3**
CO 3	Compare various Knowledge Representation Logic using scripts and frames.	**L3**
CO 4	Identify the need of Production system	**L3**
CO 5	Use expert system tools to realize the concepts and components of the expert system.	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
Problem Solving: Introduction to AI - Agents and Environments – Problems, problem spaces, search: Informed search strategies, uninformed search strategies	
MODULE 2	**9 HRS**
Knowledge Representation: Knowledge representation issues - Using predicate Logic - representing simple facts in logic - representing instance and ISA relationships - computable functions and predicates - Resolution -Representing knowledge using Rules	
MODULE 3	**8 HRS**
UNCERTAINTY: Symbolic reasoning under uncertainty, statistical reasoning ,weak slot and filler structures ,strong slot and filler structures	
MODULE 4	**7 HRS**
Game Playing and Learning: Overview - Minimax search procedure - alpha-beta cutoffs - iterative deepening , Learning	
MODULE 5	**7 HRS**
Expert System & Applications: Expert System- Architecture and Roles of Expert System-Typical Expert System-MYCIN-XOON-DART, PXDES, CaDet **Case Study**- Construction of simple reflex agent with sensor and actuator using Arduino.	

TEXTBOOKS

1. Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", 3rd Edition, Pearson Education / Prentice Hall of India, 2010.
2. Elaine Rich, Kevin Knight, Shivashankar B Nair, "Artificial Intelligence", 3rd Edition, TMH, 2010.

REFERENCE BOOKS

1. "Artificial Intelligence: Foundations of Computational Agents" by David L. Poole and Alan K. Mackworth

2. Joseph C. Giarratano , Gary D. Riley ,"Expert Systems : Principles and Programming",4th Edition, 2015

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**21DS3601**					
TITLE OF THE COURSE	**COMPILER DESIGN AND SYSTEM SOFTWARE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**01**	**-**	**-**	**42**	**04**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To explain the basic system software components such as assembler, loader, linkers, compilers.
- Provide an understanding of the fundamental principles in compiler design
- To discuss the techniques of scanning, parsing & semantic elaboration well enough to build or modify front end.
- To illustrate the various optimization techniques for designing various optimizing compilers.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Understand the architecture of a hypothetical machine, structure and design of assembler.	**L2**
CO 2	Analyse how linker and loader create an executable program from an object module created by assembler	**L4**
CO 3	Describe the major phases of compilation and to apply the knowledge of Lex tool & YAAC tool	**L1**
CO 4	Explain the syntax analysis phase and identify the similarities and differences among various parsing techniques and grammar transformation methods	**L1**
CO 5	Use formal attributed grammars for specifying the syntax and semantics of programming languages.	**L3,L4**

CO 6	Summarize various optimization techniques used for dataflow analysis and generate machine code from the source code of a novel language.	**L4**

COURSE CONTENTS

MODULE 1	**10 HRS**
Introduction to System Software, Machine Architecture of SIC and SIC/XE. ASSEMBLERS: Basic assembler functions: A simple assembler, Assembler algorithm and data structures, Machine dependent assembler features: Instruction formats and addressing modes – Program relocation, Machine independent assembler features: Literals, Symbol-defining statements, Expressions, Program blocks	
MODULE 2	**8 HRS**
Loaders and Linkers: Basic loader functions: Design of an Absolute Loader, A Simple Bootstrap Loader, Machine dependent loader features: Relocation, Program Linking, Algorithm and Data Structures for Linking Loader, Machine-independent loader features: Automatic Library Search, Loader Options, Loader design options: Linkage Editors, Dynamic Linking	
MODULE 3	**9 HRS**
Compilers: Introduction: Language Processors, Structure of compiler, The science of building a compiler, Applications of compiler technology. Lexical and Syntax Analysis: Role of lexical Analyzer, Specification of Tokens, Lexical Analyzer generator Lex. Syntax Analysis I: Role of Parser, Syntax error handling, Error recovery strategies, Writing a grammar: Lexical vs Syntactic Analysis, Eliminating ambiguity, Left recursion, Left factoring.	
MODULE 4	**8 HRS**
Syntax Analysis II: Top down parsing: Recursive Descent Parsing, First and follow, LL (1), –Bottom up parsing: Shift Reduce Parsing, Introduction to LR parsing Simple LR: Why LR Parsers, Items and LR0 Automaton, The LR Parsing Algorithm. Syntax-Directed Translation: Syntax-Directed Definitions: Inherited and Synthesized Attributes, Evaluation orders for SDDs: Dependency graphs, Ordering the evaluation of Attributes, S- Attributed Definition, L-Attributed Definition, Application: Construction of Syntax Trees.	
MODULE 5	**7 HRS**
Intermediate Code Generation: Three Address Code: Addresses and Instructions, Quadruples, Triples, indirect triples. Code Generation: Issues in the design of code generator, Basic Blocks, Optimization of Basic Blocks, The Code Generation Algorithm, Peephole optimization. Machine Independent Optimization: The Principal Sources of Optimization	

TEXT BOOKS:

1. Leland L. Beck, “System Software – An Introduction to Systems Programming”, 3rd Edition, Pearson Education Asia, 2006.
2. Alfred V Aho, Monica S. Lam, Ravi Sethi and Jeffrey D Ullman, “Compilers – Principles, Techniques and Tools”, 2nd Edition, Pearson Education, 2007.

REFERENCES:

1. V. Raghavan, Principles of Compiler Designǁ, Tata McGraw Hill Education Publishers, 2010.
2. Keith D Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann Publishers Elsevier Science, 2004.
3. D.M.Dhamdhere, Systems Programming and operating systems, Second Revised edition, Tata McGraw Hill.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**21DS3602**					
TITLE OF THE COURSE	**COMPUTER NETWORKS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	Sem /Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To introduce the fundamental aspects of various types of computer networks.
- To demonstrate the TCP/IP and OSI models with merits and demerits.
- To Understand the working principle of layering structure and basic network components
- To explore the features of each layer by various approach and methods

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Identify and compare among different layers of networking and associated components.	L3
CO2	Implement error control and error detection mechanisms (CRC, Hamming Code) using the concept of the data link layer.	L3
CO3	Differentiate IP addressing modes, implement routing algorithms, and determine the range of congestion in any network.	L3
CO4	Identify the issues of the Transport layer to analyze the congestion control mechanism	L3
CO5	Compare application layer protocols (WEB and HTTP, FTP, E-MAIL (SMTP, POP3), TELNET, DNS, SNMP).	L4

COURSE CONTENT	
MODULE 1: Overview of Networks	**9 Hrs**

Network Components- Network Physical Structure, Classification of networks (LAN-MAN-WAN), Protocols and Standards, Data representation and data flow, Layered Architecture –Comparison of the OSI and TCP/IP reference model.
Physical Layer: Introduction to wired and wireless transmission media. Transmission mode (Serial/Parallel signals, Analog/Digital Signals and Periodic/Aperiodic Signals), Line coding Schemes.

MODULE 2: Data Link Layer	9 **Hrs**

Data Link Layer – MAC (Media Access Control) and LLC (Logical Link Control) sublayer Functionalities– Design Issues: Framing – Flow control (Simplest protocol, Stop and wait, sliding
window) – Error control (CRC, Hamming code) –– Ethernet Basics-Multi Access Protocols:
ALOHA, CSMA/CD, Connecting Devices: Hubs, Bridges, Switches, Routers, and Gateways

MODULE 3: Network Layer	**8 Hrs**

Network Layer Design issues, Routing Protocol Basics, Routing Algorithm (Distance Vector
Routing, Link State Routing and Hierarchical Routing). IP addressing, IP Packet format IPV4,
IPV6 and IP Tunneling. Congestion control algorithms, QoS (Traffic Shaping, Packet Scheduling).

MODULE 4: Transport Layer	7 **Hrs**

Transport Layer functions- Multiplexing and Demultiplexing. Introduction to TCP and UDP, The TCP Service Model, The TCP Segment Header, The TCP Connection Management, TCP Flow Control- Sliding Window, TCP Congestion Control, User Datagram Protocol

MODULE 5: Application Layer	6 **Hrs**

Principles of Network Applications, WEB and HTTP, FTP, E-MAIL (SMTP, POP3), TELNET,
DNS, SNMP

LIST OF LAB PROGRAMS:

1. Write a program for error detecting code using CRC.
2. Write a program to find the shortest path between vertices using bellman-ford algorithm.
3. Using TCP/IP sockets, write a client – server program to make the client send the
4. file name and to make the server send back the contents of the requested file if present. Implement the above program using as message queues or FIFOs as IPC channels.
5. Write a program on datagram socket for client/server to display the messages on client side, typed at the server side.
6. Write a program for simple RSA algorithm to encrypt and decrypt the data.

7. Write a program for congestion control using a leaky bucket algorithm.

TEXT BOOKS:

1. Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition TMH, 2013.
2. Computer Networks - Andrew S Tanenbaum, 5th Edition, Pearson Education.

REFERENCES:

1. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach", Seventh Edition, Pearson Education, 2017.
2. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.
3. William Stallings, "Data and Computer Communications", Tenth Edition, Pearson Education, 2014.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**21DS3603**					
TITLE OF THE COURSE	**ADVANCED DATA SCIENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**02**	**42**	**04**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To introduce the fundamental aspects of various types of computer networks.
- To demonstrate the TCP/IP and OSI models with merits and demerits.
- To Understand the working principle of layering structure and basic network components
- To explore the features of each layer by various approach and methods

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Implement the time series data analysis using Pandas library	**L3**
CO 2	Application of NLP concepts to solve real world problems	**L3**
CO 3	Usage of Python and NetworkX library for social network data analysis	**L3**
CO 4	Understanding the concepts of CoreML in machine learning model deployment	**L2**
CO 5	Experiment with RapidMiner academy tools to solve problems	**L4**

COURSE CONTENTS

MODULE 1	**9 HRS**

Time Series Analysis: Time Series, Some Examples, Pandas Series in Action, Time series data manipulation, Modelling Time series data, Regression, Moving Average exponential smoothing, Stationarity and seasonality, determining stationarity, Autoregression to the rescue, Autoregression models.	
MODULE 2	**9 HRS**
Text And Natural Language Processing: Page, Accessing Data from the web, Regular Expressions, Processing text with unicode, tokenizing text, Word Tagging, Topic Modelling, Latent Dirichlet Allocation, LDA in action	
MODULE 3	**8 HRS**
Graph Theory and Social Network Analysis: Graphs and Networks, Taking the measure: Degree, Certrality, Network Properties, Social Networks with Python, NetworkX, Social Network Analysis in Action	
MODULE 4	**8 HRS**
Machine Learning Deployment: Data Products, Core ML Python, Apps and ML, Environment Creation, Model Selection, Exploring the Data, Model Properties in core ML	
MODULE 5	**8 HRS**
Data Engineering Master and Professional Course on Altair RapidMiner Academy Machine Learning Applications and Use case Professional Course on Altair RapidMiner Academy	

TEXT BOOKS:

1. Foundations of Data Science, Avrim Blum, John Hopcroft, and Ravindran Kannan, January, 2018

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**21DS3604**					
TITLE OF THE COURSE	**COMPILER DESIGN AND SYSTEM SOFTWARE LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	**2**	**-**	**26**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Experiment on the basic techniques of compiler construction and tools that can used to perform syntax-directed translation of a high-level programming language into an executable code.
- Know the implementation of assemblers, loaders and various parsing techniques.
- Learn how to optimize and effectively generate machine codes.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO 1	Identify patterns, tokens & regular expressions for lexical analysis.	L2
CO 2	Develop LEX and YACC programs for lexical and syntax analysis phases of Compiler.	L3
CO 3	Implement the two-pass assembler and absolute loader to translate assembly language into machine code and load the machine code into RAM for execution	L3
CO 4	Implement the bottom-up parsing applied in the syntax analysis phase of the compiler	L3
CO 5	Develop first sets of Context free grammar to generate a predictive parser used to check whether the input source code follows the syntax of the programming language.	L3

List of Laboratory/Practical Experiments activities to be conducted
1a. Program to count the number of characters, words, spaces and lines in a given input file.

1b. Program to recognize and count the number of identifiers in a file.
2a. Program to count the numbers of comment lines in a given C program. Also eliminate them and copy the resulting program into separate file.
2b. Program to recognize whether a given sentence is simple or compound.
3a. Program to count no of: i.+ve and –ve integers ii. +ve and –ve fractions
3b. Program to count the no of „scanf‟ and „printf‟ statements in a C program. Replace them with “readf‟ and “writef‟ statements respectively.
4.Program to evaluate arithmetic expression involving operators +,-,*,/
5. Program to recognize a valid variable which starts with a letter, followed by any number of letters or digits.
6. Program to recognize the strings using the grammar ($a^n b^n$;n>=0)
7. C Program to implement Pass1 of Assembler
8. C Program to implement Absolute Loader
9. C program to find the FIRST in context free grammar.
10.C Program to implement Shift Reduce Parser for the given grammar $E \rightarrow E+E$ $E \rightarrow E*E$ $E \rightarrow (E)$ $E \rightarrow id$
11. C Program to implement intermediate code generation for simple expression

TEXT BOOKS:

1. Leland L. Beck, “System Software – An Introduction to Systems Programming”, 3rd Edition, Pearson Education Asia, 2006.
2. Alfred V Aho, Monica S. Lam, Ravi Sethi and Jeffrey D Ullman, “Compilers – Principles, Techniques and Tools”, 2nd Edition, Pearson Education, 2007.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**21DS3605**					
TITLE OF THE COURSE	**ADVANCED DATA SCIENCE LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	-	**-**	**02**	**-**	**13**	**01**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To introduce the fundamental aspects of various types of computer networks.
- To demonstrate the TCP/IP and OSI models with merits and demerits.
- To Understand the working principle of layering structure and basic network components
- To explore the features of each layer by various approach and methods

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Implement the time series data analysis using Pandas library	**L3**
CO 2	Application of NLP concepts to solve real world problems	**L3**
CO 3	Usage of Python and NetworkX library for social network data analysis	**L3**
CO 4	Usage of Hadoop MapReduce tool to implement Big Data	**L3**
CO 5	Experiment with RapidMiner academy tools to solve problems	**L4**

List of Laboratory/Practical Experiments activities to be conducted

1. Consider, you have a text document as input. Count the number of times a word occurs in the document. Develop a MapReduce framework based on Python threads. The data will be read from a file, stored in-memory and will run on a single computer.
2. Write a Map Reduce program to find the maximum temperature in each year.
   Hint: Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce, since it is semi structured and record-oriented.
3. Model a time series data in order to make predictions using ARIMA. (https://builtin.com/data-science/time-series-python)
4. Time series data analysis using the LSTM model.
5. Write a Python program that performs sentiment analysis on a given text using Natural Language Processing techniques. Your program should take user input for the text and analyze its sentiment using a sentiment analyzer library. The program should provide the sentiment scores for positive, negative, neutral, and compound sentiments.
6. Write a Python program that performs social network analysis on any social network dataset. Your program should utilize the NetworkX library to analyze the network properties and provide insights about the network structure.
7. Altair RapidMiner Certification Exam: Data Engineering Professional
8. Altair RapidMiner Certification Exam: Data Engineering Master
9. Machine Learning Application and Use Cases Certification Exam: Data Engineering Professional
10. MINI PROJECT using ALTAIR Rapid Miner Tool

TEXT BOOKS:

1. Foundations of Data Science, Avrim Blum, John Hopcroft, and Ravindran Kannan, January, 2018.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**21DS3606**					
TITLE OF THE COURSE	**NATURAL LANGUAGE PROCESSING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To understand the basic building blocks and general principles that allows one to design Deep learning algorithms
- To become familiar with specific, widely used Deep learning networks
- To introduce building blocks of Convolution neural network architecture
- To learn to use deep learning tools and framework for solving real-life problems

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Analyzing information from text automatically using concepts and methods from natural language processing (NLP)	**L2**
CO 2	Understanding the stemming and n-grams through data processing in Python programming language to carry out exercises.	**L3**
CO 3	Apply RNNs and learning algorithms for NLP with transformer architectures.	**L3**
CO 4	Understand existing Natural Language Processing (NLP) applications	**L3**
CO 5	Demonstrate the Hidden Markov models in NLP	**L3**

COURSE CONTENTS

MODULE 1	8 HRS
Introduction: Past, present and future of NLP; Classical problems on text processing; Necessary Math concepts for NLP; Regular expressions in NLP; Basic text processing: lemmatization, stop word, tokenization, stemming etc; Spelling errors corrections– Minimum edit distance, Bayesian method;	
MODULE 2	**9 HRS**
Words & Sentences: N-grams: Simple unsmoothed n-grams; smoothing, backoff, spelling correction using N-grams, Metrics to evaluate N-grams; Parts of Speech tagging: Word classes, POST using Brill's Tagger and HMMs; Information Extraction: Introduction to Named Entity Recognition and Relation Extraction WordNet and WordNet based similarity measures, Concept Mining using Latent Semantic Analysis	
MODULE 3	**8 HRS**
Sequence to sequence & Language Modelling: Word embedding: skip-gram model, CBOW, GloVe, BERT; Sequence to sequence theory and applications, Attention theory and teacher forcing; Language Modelling: Basic ideas, smoothing techniques, Language modelling with RNN and LSTM;	
MODULE 4	**7 HRS**
ML for NLP : Classification- binary and multiclass, clustering, regression for text data processing; Machine translation: rule-based techniques, Statistical Machine Translation (SMT); Spam detection, consumer complaint classification.	
MODULE 5	**7 HRS**
Hidden Markov models: Morkov chains, likelihood Computation, Semantic Analyzer, Text summarization. Self-Learn & Hands on practice: Python libraries supporting NLP; Hands on Data collection - from social network platforms, pdfs, wordfiles, json, html, Parsing text using regular expression; scraping data from web; Text processing: convert to lowercase, remove punctuation, remove stop words, standardizing text, tokenizing, stemming, lemmatising.	

TEXTBOOKS

1. Daniel Jurafsky and James H. Martin. 2009. Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics. 2nd edition. PrenticeHall.
2. Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural Language Processing. MIT Press.

REFERENCE BOOKS

1. Jurafsky and Martin, "Speech and Language Processing", 2 nd Edition, Prentice Hall, 2008. Manning and Schutze, "Statistical Natural Language Processing", MIT Press, 2001.
2. James Allen, “Natural Language Understanding”, The Benajmins/Cummings Publishing Company,1998. Cover, T. M. and J. A. Thomas, “Elements of Information Theory”, 2nd Edition, Wiley, 2006.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**21DS3607**					
TITLE OF THE COURSE	**EMBEDDED IOT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- `To introduce various topics of computer vision with their applications.
- Combining the analytics with CV which helps in various Video Analytics processing

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Demonstrating a foundational understanding of IoT concepts	**L3**
CO 2	Analyze the use of communication protocols in IOT and M2M technologies	**L4**
CO 3	Configure and interface Raspberry Pi with various components and demonstrating proficiency in hardware connectivity	**L3**
CO 4	Design and implement IoT solutions for specific domains	**L5**
CO 5	Explore the concepts of Industry 4.0 and technologies beyond traditional IoT	**L5**

COURSE CONTENTS

MODULE 1	**8 HRS**

Introduction-Definition & Characteristics of IoT, Physical Design of IoT- Things in IoT, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies- Wireless Sensor Networks, Embedded Systems, IoT Levels & Deployment Templates.	
MODULE 2	**9 HRS**
IoT and M2M- SPI, I2C communication, Introduction toM2, Difference between IoT and M2M, SDN Network Function Virtualization IoT Platforms Design Methodology IoT Design Methodology-Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification , Service Specifications , IoT Level Specification, Functional View Specification , Operational View Specification , Device & Component Integration , Application Development, IoT Physical Devices & Endpoints	
MODULE 3	**8 HRS**
Raspberry Pi & Raspberry Pi Interfaces – Features of Raspberry Pi, Serial, , Interfacing of LED, Switch and Light Sensor (LDR) with Raspberry Pi	
MODULE 4	**7 HRS**
Domain Specific IoTs-Home Automation, Cities-Smart Parking, Environment-Weather Monitoring, Smart Grids, Smart Irrigation, Machine Diagnosis & Health & Lifestyle -Health & Fitness Monitoring, Wearable Electronics	
MODULE 5	**8 HRS**
IoT & Beyond: Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques, data- intensive IoT for continuous recognition applications, Internet of Everything	

TEXTBOOKS

1. "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry" by Maciej Kranz

REFERENCE BOOKS

2. Internet of Things, A Hands on Approach, by Arshdeep Bahga & Vijay audisetti, UniversityPress
3. The Internet of Things, by Michael Millen,Pearson

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**21DS3609**					
TITLE OF THE COURSE	**SOCIAL NETWORK ANALYSIS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To understand the concept of semantic web and related applications.
- To learn knowledge representation using ontology.
- To understand human behaviour in social web and related communities.
- To learn visualization of social networks.

COURSE OUTCOMES

CO NO.	**OUTCOMES**	**BLOOM'S TAXONOMY LEVEL**
CO 1	Understand the foundational concepts and history of social network analysis, including network theory, sociometry, and the entry of social physicists in the field.	**L2**
CO 2	Analyze and interpret social networks using sociograms and matrices, identifying cliques and communities within the network.	**L3**
CO 3	Examine the dynamics of balance and group interactions within social networks, and explore the concepts of informal organization and community relations.	**L2**
CO 4	Apply formal models of community and kinship to analyze social networks, and recognize the role of formal methods in social network analysis.	**L2**

CO 5	Gain practical knowledge of data collection techniques for social network analysis, including observation, document analysis, and using computer programs for network analysis.	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
Introduction to Social Network Analysis: The data used in social network analysis, network theory, The History of Social Network Analysis, The sociogram and sociometry, Balance and group dynamics, Informal organisation and community relations, Matrices and cliques, Formal models of community and kinship, Formal methods triumphant, Entry of the social physicists	
MODULE 2	**9 HRS**
Data Collection for Social Network Analysis: Making observations, using documents, Boundaries in relational data, Positional and reputational approaches, Organising and Analysing Network Data, Matrices and relational data, Matrix conventions, An analysis of directorship data, Direction and value in relational data, Computer programs for social network analysis	
MODULE 3	**8 HRS**
Terminology for Network Analysis: The language of network analysis, joining up the lines, The flow of information and resources, Density of connections, Density in egonets, Problems in density measures, Popularity, Mediation and Exclusion, Local and overall centrality, Mediation and betweenness, Centrality boosts centrality, Centralisation and graph centres, The absolute centre of a graph, Bank centrality in corporate networks	
MODULE 4	**7 HRS**
Groups, Factions and Social Divisions: Identifying subgraphs, the components of a network, intersecting social circles, Components and citation circles, Structural Locations, Classes and Positions, The structural equivalence of points, Clusters and similarity, Divide and CONCOR, Divisions and equivalence, Regular equivalence in roles and functions, Corporate interlocks and participations.	
MODULE 5	**7 HRS**
Social Change and Development: Structural change and unintended consequences, Small-world networks, Modelling social change, Testing explanations, Visualising and Modelling, Taking space seriously, Using multi-dimensional scaling, Principal components and factors, Non-metric methods, How many dimensions, Worth a thousand words, Elites, communities and influence, Business elites and bank power	

TEXT BOOKS:

1. John Scott-Social Networks Analysis, 2017.

2. Borko Furht, ―Handbook of Social Network Technologies and Applications‖, 1st Edition, Springer, 2010

REFERENCE BOOKS:

1. Guandong Xu ,Yanchun Zhang and Lin Li, ―Web Mining and Social Networking – Techniques and applications‖, First Edition, Springer, 2011.

COURSE CODE	**21DS3608**					
TITLE OF THE COURSE	**MOOC**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	--	-	--	**39**	**3**

Course Outcomes:

1. Enabling students to obtain certificates to make students employable in the industry or pursue a higher education program.
2. Relevant exposure to tools and technologies are being offered.

Massive Open Online Courses (MOOCs) – Guidelines & Policy

1. Students shall enroll the MOOC courses that is available on the NPTEL/SWAYAM (Swayam.gov.in) platform whenever it notifies (twice in a year).
2. The list of NPTEL / SWAYAM courses related to Computer Science & Engineering that is in line with the students interest will be announced at the departmental level for enrollment.
   a. That is, the predefined list of courses is provided by the department to the students, and only those courses shall be considered and not others.
3. Students shall also enroll in Coursera / Udemy / Udacity / Infosys Spring Board, where DSU can consider the grades / marks provided by these platforms if they are proctored ones. Examinations are to be conducted by DSU if proctored assessments are not conducted by these platforms.
4. The MOOCs courses option shall be considered only for students having a minimum CGPA of **6.75.**
5. The interested student has to enroll as per the guidelines of the NPTEL / SWAYAM or other platforms mentioned in item 3 within enrollment end date.
6. The credits assigned would depend on the number of weeks. The department shall consider 12 weeks course to map for 03 Credits.
7. A faculty member shall be appointed as SPOC to keep a track of students undertaking courses and collect certificates from students upon completion on the platforms mentioned above.
8. Student has to pursue and acquire a certificate for a MOOCs course and after successful completion, the student shall submit the certificate to the Department and credits shall be transferred to the grade card accordingly based on the items 1-3 above.
9. The examination fee for obtaining the certificate shall be borne by the student.
10. In case a student fails to complete the MOOC course, then the student shall repeat the same on the NPTEL/SWAYAM or other platforms mentioned in item 3 or the student may opt for department elective with permission of the department chair.

11. Following is the proposed range for the award of grades towards the credits transfer.

Range: Consolidated MOOC Score (Assignment+ Proctored exam)	**Proposed Grade Point**	**Grade**
90-100	10	O
80-89	9	A+
70-79	8	A
60-69	7	B+
55-59	6	B
50-54	5	C
40-49	4	P
Less than 40	0	F

SEMESTER	**VII**
YEAR	**IV**
COURSE CODE	**21DS4701**
TITLE OF THE COURSE	**IMAGE PROCESSING AND COMPUTER VISION**

SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- `To introduce various topics of computer vision with their applications.
- Combining the analytics with CV which helps in various Video Analytics processing

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Apply linear algebra principles to solve computer vision problems	**L3**
CO 2	Analyze and evaluate the components and working principles of a digital camera	**L4**
CO 3	Apply segmentation algorithms to partition images into meaningful regions	**L3**
CO 4	Analyze and evaluate different parameters used in video analytics	**L5**
CO 5	Evaluate different parameters used in video analytics	**L5**

COURSE CONTENTS

MODULE 1	**8 HRS**
COMPUTER VISION FOUNDATIONS:	

Image Processing - Colour - Linear Algebra Primer - Pixels and Filters - Edge Detection - Features and Fitting - Feature Descriptors - Image Resizing - Segmentation - Semantic Segmentation - Clustering - Object recognition - Dimensionality Reduction - Face Identification - Visual Bag of Words - Object Detection from Deformable Parts - Semantic Hierarchies and Fine Grained Recognition - Motion - Tracking - Deep Learning.)	
MODULE 2	**7 HRS**
IMAGE FORMATION: Geometric primitives and transformations – Photometric image formation – The digital camera – Point operators – Linear Filtering – More neighborhood operators – Fourier transforms – Pyramids and wavelets – Geometric transformations – Global optimization..	
MODULE 3	**9 HRS**
3D VISION: Feature detection and matching – Segmentation – Edge detection - 2D and 3D feature based alignment – Pose estimation – Geometric intrinsic calibration – Triangulation Methods for 3D Vision - 3D reconstruction – Image based rendering, Image Recognition – Object Detection – Space, Instance and Category Recognition	
MODULE 4	**7 HRS**
VIDEO ANALYTICS AND ITS APPLICATIONS: Introduction to Video Analytics, Analysis Parameters-Real Time Security & User Insights, Storage analysis for Processed Video Data. Case Study: Analysis on Facial Surveillance, License Plate Recognition	
MODULE 5	**8 HRS**
APPLICATIONS OF COMPUTER VISION: Image Processing, Machine Learning – Information Retrieval – Neuroscience – Robotics – Speech Recognition – Cognitive Sciences – Graphics, Algorithms, Systems and Theory – Pattern Recognition – Computer Graphics.	

TEXTBOOKS

1. Forsyth, D. A. and Ponce, J., "Computer Vision: A Modern Approach", Prentice Hall, 2 ndEd. 2011.
2. Gonzalez, R. C. and Woods, R. E., "Digital Image Processing", Prentice Hall, 3rdEd, 2009.

REFERENCE BOOKS

1. Trucco, E. and Verri, A., "Introductory Techniques for 3-D Computer Vision", Prentice Hall, 1998.
2. Website Link: http://www.3vr.com/

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**21DS4702**					
TITLE OF THE COURSE	**CLOUD DATA ANALYTICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- Understand the basic concepts of data security, how it has evolved, and some key techniques used today.
- Have 1st depth view of Perimeter Security, Authentication and Access management, Cryptography, Malware, Secure Programming etc
- Explore the subject through prescribed book, case studies, hands on experience, extra readings for alternate view or real time application.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Define and understand the characteristics and need for big data analytics, as well as its classification and challenges	**L2**
CO 2	Analyze the role of networks, web services, and virtualization in cloud computing	**L4**
CO 3	Analyze case studies of big data applications in social media (e.g., Twitter) and e-commerce blogs	**L4**
CO 4	Apply MapReduce for processing big data and work with different data serialization formats	**L3**
CO 5	Understand the concepts of cloud dataflow, data ingestion, and storage in cloud environments	**L1**

COURSE CONTENTS

MODULE 1	8 HRS
Introduction to cloud computing - Major benefits of cloud computing - Emerging cloud technologies and services - Different ways to secure the cloud - Risks and challenges with the cloud - What is cloud analytics? Parameters before adopting cloud strategy - Technologies utilized by cloud computing Big data analytics - Introduction & Overview of business intelligence, Data science and Analytics, Meaning and Characteristics of big data analytics, Need of big data analytics, Classification of analytics, Challenges to big data analytics, Importance of big data analytics.	
MODULE 2	**9 HRS**
Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models (XaaS), Deployment Models, Public cloud, Private cloud, Hybrid cloud, Community cloud Cloud Enabling Technologies Virtualization - Load Balancing - Scalability & Elasticity – Deployment –Replication – Monitoring - Software Defined Networking - Network Function Virtualization	
MODULE 3	**8 HRS**
NOSQL Data Management: Introduction to NoSQL – aggregates, aggregate data models – key- value and document data models –graph databases – schema less databases – materialized views – distribution models – sharding –– versionstamps – Map reduce: partitioning and combining. Compute Services— Amazon Elastic Compute Cloud, Database Services Amazon Relational Data Store - Amazon DynamoDB. Case study: Big data for twitter, Big data for E-Commerce blogs.	
MODULE 4	**7 HRS**
Hadoop MapReduce and YARN framework - Introduction to Hadoop and MapReduce, Processing data with Hadoop using MapReduce. Introduction to YARN, its Components, Need and Challenges of YARN, Dissecting YARN, MapReduce application. Data serialization and Working with common serialization formats, Big data serialization formats.	
MODULE 5	**7 HRS**
Data Ingestion and Storing: Cloud Dataflow - The Dataflow programming model - Cloud Pub/Sub - Cloud storage - Cloud SQL - Cloud BigTable - Cloud Spanner - Cloud Datastore - Persistent disks . Case Study: Implementation of Cloud Computing Technology in Education Sector , Apache Hbase/Hive/Pig	

Text Books:

1. Sanket Thodge, Cloud Analytics with Google Cloud Platform, Packt Publishing, 2018.

2. Arshdeep Bahga and Vijay Madisetti, Cloud computing - A Hands-On Approach, Create Space Independent Publishing Platform, 2014.

Reference Books:

1. Deven Shah, Kailash Jayaswal, Donald J. Houde, Jagannath Kallakurchi, Cloud Computing - Black Book,

Wiley, 2014.

2. Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2014.
3. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**21DS4704**					
TITLE OF THE COURSE	**DEEP LEARNING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To understand the basic building blocks and general principles that allows one to design Deep learning algorithms
- To become familiar with specific, widely used Deep learning networks
- To introduce building blocks of Convolution neural network architecture
- To learn to use deep learning tools and framework for solving real-life problems

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Understanding the mathematical background for building various deep learning models	**L2**
CO 2	Designing and optimizing the different deep learning algorithms which are more appropriate for various types of learning tasks in various domains	**L3**
CO 3	Implement a CNN learning algorithms and solve real-world problems deep learning tools and framework	**L3**
CO 4	Apply RNN learning algorithm for various application	**L3**

CO 5	Designing the Deep generative models for the Image and video applications and analyzing the recent advances in GANS	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
Mathematical background for Deep learning- Introduction to ANN: ANN, Forward Propagation, Backward Propagation, Multilayer Perceptrons-hidden layers, activation functions, Model Selection, underfitting, overfitting, weight decay, dropout, Softmax Regression	
MODULE 2	**7 HRS**
Computational Graphs– Layers and Blocks, shallow neural network, deep neural network, Optimization for training Deep Models, self-organizing maps, . Case study	
MODULE	**9 HRS**
Foundations of Convolutional Neural Networks- Convolution operation, Convolutional Layers, Object Edge Detection in Images, Padding and Stride, Multiple Input and Multiple Output Channels, 1 × 1 Convolutional Layer, Pooling, Convolutional Neural Networks (LeNet), GoogleNet, AlexNet. Case study	
MODULE 4	**8 HRS**
Introduction to RNN: Basics of RNN, Rnns Computational Graph across Time, RNN's For Sequence Modeling- Language Modeling, Backpropagation Through Time, Standard RNN Gradient Flow, LSTM Network **Applications of RNN:** Music Generation, Sentiment Classification, Machine Translation, Environment Modeling, Stock Market Prediction, Next Word Prediction.	
MODULE 5	**8 HRS**
Deep Generative models: Generative Modelling, Autoencoders, Variational Autoencoders, Latent Perturbations, Image and Video Applications **GANs:** Generative Adversarial Networks – Intuition behind Gans, Training Gans, Recent Advances In Gans	

TEXTBOOKS

1. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola, "Dive into Deep Learning", Amazon, 2020
2. François Chollet, "Deep Learning Python", Manning Publications, 2018

REFERENCE BOOKS

1. Josh Patterson, "Deep Learning: A Practitioner's Approach", O'Reilly Media; 1st edition (August 19, 2017)

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**21DS4705**					
TITLE OF THE COURSE	**BUSINESS INTELLIGENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To understand the fundamentals of Business Intelligence
- To identify the appropriateness and need Analysis the data
- To learn the preprocessing, mining and post processing of the data
- To understand various methods, techniques and algorithms in Business Intelligence

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Understanding the influence of data in business intelligence	
CO 2	Apply basic, intermediate and advanced techniques to analysis the data	
CO 3	Analyze the output generated by the process of Business Intelligence	
CO 4	Explore the hidden patterns in the data	
CO 5	Applying the business intelligence principles to the real world problems	

COURSE CONTENTS

MODULE 1	8 HRS
Business Intelligence: Effective and timely decisions – Data, information and knowledge – Role of mathematical models – Business intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence.	
MODULE 2	**9 HRS**
Knowledge Delivery: The business intelligence user types, Standard reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, dimensional analysis. Visualization: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Visualization	
MODULE 3	**8 HRS**
Decision Making Concepts: Concepts of Decision Making, Techniques of Decision Support System (DSS), Types of Decision Support System (DSS), Development of Decision Support System (DSS), Applications of DSS, Role of Business Intelligence in DSS	
MODULE 4	**7 HRS**
Business Intelligence Applications: Data analytics, business analytics, ERP and Business Intelligence, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications	
MODULE 5	**8 HRS**
Real Time Applications and use cases using BI TOOLS: POWERBI, TABLEAU AND SAP	

Textbooks:

1. R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support,10th Edition. Pearson/Prentice Hall, 2015.ISBN-13: 978-0-13-305090-5, ISBN-10: 0- 13-305090-4;
2. Business Process Automation, Sanjay Mohapatra, PHI.

Reference Books:

1. Larissa T. Moss, S. Atre, “Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making”, Addison Wesley, 2003.
2. Carlo Vercellis, “Business Intelligence: Data Mining and Optimization for Decision Making”, Wiley Publications, 2009.

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**21DS4803**					
TITLE OF THE COURSE	**DATA PRIVACY AND CYBER SECURITY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- Understand the basic concepts of data security, how it has evolved, and some key techniques used today.
- Have 1st depth view of Perimeter Security, Authentication and Access management, Cryptography, Malware, Secure Programming etc
- Explore the subject through prescribed books, case studies, hands on experience, extra readings for alternate view or real time application.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Analyze and break monoalphabetic substitution ciphers and principles and components of public-key cryptography	**L4**
CO 2	Demonstrate knowledge of basic features of data hiding in text, apply data hiding techniques such as watermarking and mimic functions	**L3**
CO 3	Apply techniques such as LSB encoding, BPCS steganography, spread spectrum steganography, and robust data hiding in JPEG images to hide information in images,	**L3**

CO 4	Apply watermarking techniques to protect music scores, detect malicious tampering, and hide data in binary and fax images	**L3**
CO 5	Apply advanced data hiding techniques such as audio watermarking, echo hiding, steganographic file systems	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
Monoalphabetic Substitution Ciphers: Letter Distributions, Breaking a Monoalphabetic Cipher,The Pigpen Cipher. **Public-Key Cryptography**:- Diffie-Hellman-Merkle Keys, Public-Key Cryptography, Rabin Public-Key Method, Sharing Secrets: Threshold Schemes, The Four Components, Authentication, Elliptic Curve Cryptography	
MODULE 2	**9 HRS**
Data Hiding in Text: Basic Features, Applications of Data Hiding, Watermarking, Intuitive Methods, Simple Digital Methods, Data Hiding in Text, Innocuous Text, Mimic Functions	
MODULE 3	**8 HRS**
Data Hiding in Images: LSB Encoding, BPCS Steganography, Lossless Data Hiding, Spread Spectrum Steganography, Data Hiding by Quantization, Signature Casting in Images, Robust Data Hiding in JPEG Images	
MODULE 4	**7 HRS**
INTRODUCTION TO CYBER SECURITY: Cyber Attacks, Défense Strategies, and Techniques, Guiding Principles, Authentication, Confidentiality and Integrity, Viruses, Worms, and Other Malware, Firewalls, Intrusion Prevention and Detection, DDoS Attacks Prevention/Detection, Web Service Security.	
MODULE 5	**7 HRS**
DIGITAL FORENSICS: Understanding Computer Forensics: Introduction, Historical Background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber forensics and Digital Evidence, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation.	

TEXT BOOK:

1. Data Privacy and Security, David Salomon, 2003 Springer-Verlag New York, Inc.
2. A Short Introduction to the World of Cryptocurrencies Berentsen and Fabian Schä
3. Bitcoin: A Peer-to-Peer Electronic Cash System, Satoshi Nakamoto, www.bitcoin.org

REFERENCES:

1. William Stallings – Cryptography and Network Security 5th edition
2. Cryptography and Network Security : Atul Kahate, Mc Graw Hill Edition

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**21DS4804**					
TITLE OF THE COURSE	**BLOCKCHAIN AND CRYPTOCURRENCY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- Understand the basic concepts of data security, how it has evolved, and some key techniques used today.
- Have 1st depth view of Perimeter Security, Authentication and Access management, Cryptography, Malware, Secure Programming etc
- Explore the subject through prescribed books, case studies, hands on experience, extra readings for alternate view or real time application.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Describe the basic concepts and technology used for blockchain	**L4**
CO 2	Explore the usage of merkle tree, cryptography and mining in Blockchain	**L3**
CO 3	Usage of smart contracts in real world applications.	**L3**
CO 4	Understanding of cryptocurrency related concepts	**L2**
CO 5	Understanding Bitcoin system and implement Bitcoin mining concepts	**L3**

COURSE CONTENTS

MODULE 1	8 HRS
INTRODUCTION TO BLOCKCHAIN: Distributed systems, P2P network Architecture of Blockchain, Generic elements of a blockchain: How blockchain works, Benefits, features, and limitations of blockchain How blockchain accumulates blocks, types of blockchain, Distributed ledger, Consensus mechanisms-Proof of work, Proof of Stake, Proof of Authority, CAP theorem, Decentralization, Disintermediation, Ecosystem - Storage, Communication and Computation, Dapps	
MODULE 2	**9 HRS**
CRYPTOGRAPHY AND SMART CONTRACTS: Symmetric cryptography (DES, AES), Asymmetric cryptography, Public and Private keys, Algorithms - RSA, Hash functions, SHA, ECDSA Smart contracts - Benefits of Smart contracts, Solidity programming-Types, Literals, Enums, Function types, Reference types, mappings, Global variables, Control structures (Events, Inheritance, Libraries, Functions), Compile, verify and Deploy.	
MODULE 3	**8 HRS**
ETHEREUM BLOCKCHAIN: The Ethereum network, Components of the Ethereum ecosystem, Ethereum Virtual Machine – Execution Environment, Opcodes and their meaning, Structure of a Block, Genesis Block, Merkle tree, Geth, Transactions, Transaction receipts, Nonce, Gas - gasPrice, gasLimit, Ether, Mining, Wallets, Ethereum network (main net, test net)	
MODULE 4	**7 HRS**
INTRODUCTION TO CRYPTOCURRENCIES: cash, digital cash, electronic payment systems, stone money of yap, bitcoin blockchain, consensus mechanism, monetary policy, Bitcoin Transactions, transaction capability, legitimacy, consensus, outlook and risks	
MODULE 5	**7 HRS**
BITCOIN: Electronic cash system, Introduction, Transactions, Timestamp server, Proof of work, network, incentive, reclaiming disk space, simplified payment verification, privacy, Introduction to Bitcoin(BTC) Mining.	

TEXT BOOK:

1. Imran Bashir, "Mastering Blockchain", Third Edition, Published by Packt Publishing Ltd, 2020.
2. A Short Introduction to the World of Cryptocurrencies Berentsen and Fabian Schä
3. Bitcoin: A Peer-to-Peer Electronic Cash System, Satoshi Nakamoto, www.bitcoin.org

REFERENCES:

1. RiteshModi" Solidity Programming Essentials, First Edition, Published by Packt Publishing Ltd, April 2018
2. E-resources : https://github.com/chaincodelabs/bitcoin-curriculum.git

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**21DS4805**					
TITLE OF THE COURSE	**HIGH PERFORMANCE COMPUTING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- Understand the fundamentals of parallel computing: Learn the principles and potential benefits of parallel computing and recognize the fundamental laws governing parallelism, including Gustafson-Barsis's Law.
- Plan for parallelization: Learn how to approach a new project for parallel computing, implement version control for code management, and use profiling to analyze the gap between system capabilities and application performance.
- Master parallel algorithms and patterns: Analyze parallel algorithms and performance models, comprehend the significance of hash functions and spatial hashing, and understand patterns like prefix sum (scan) for efficient parallel computing.
- Explore GPU architectures and concepts: Familiarize yourself with vectorization and single instruction, multiple data (SIMD) concepts, understand GPU architectures and their role in accelerated computational platforms, and explore different GPU memory spaces.
- Gain practical GPU programming skills: Learn about the GPU programming model, GPU parallelism, and data decomposition, understand how to optimize GPU resource usage, and apply these concepts to a real-world case study like D atmospheric simulation or unstructured mesh applications.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL

CO 1	Demonstrate a comprehensive understanding of parallel computing concepts, including the reasons for using parallelism and the potential benefits it offers in various computing applications.	**L2**
CO 2	Develop proficiency in planning for parallelization, including project preparation, version control implementation, and performance profiling to optimize application performance on parallel systems.	**L2,L3**
CO 3	Apply parallel algorithms and patterns to efficiently solve computing problems, analyzing algorithmic complexity, and choosing appropriate parallel approaches for specific tasks.	**L3**
CO 4	Gain practical knowledge of GPU architectures, vectorization methods, and programming models, enabling the utilization of GPU resources effectively to accelerate computational tasks.	**L2**
CO 5	Successfully implement GPU programming techniques to parallelize and optimize computational tasks, with hands-on experience working on a real-world case study, such as atmospheric simulation or unstructured mesh applications, using parallel computing methodologies.	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
Introduction to parallel computing, Why parallel computing? the potential benefits of parallel computing, Parallel computing cautions, The fundamental laws of parallel computing Breaking through the parallel limit, Gustafson-Barsis's Law, How does parallel computing work, Categorizing parallel approaches	
MODULE 2	**9 HRS**
Planning for parallelization: Approaching a new project: The preparation Version control: Creating a safety vault, Profiling: Probing the gap between system capabilities and application performance, Planning: A foundation for success Implementation: Where it all happens, Commit: Wrapping it up with quality, Performance limits and profiling Characterizing your application: Profiling, Data design and performance models	
MODULE 3	**8 HRS**
Parallel algorithms and patterns: Algorithm analysis for parallel computing applications, Performance models versus algorithmic complexity, Parallel algorithms, What is a hash function? Spatial hashing: A highly-parallel algorithm Using perfect hashing for spatial mesh operations, Prefix sum (scan) pattern and its	

importance in parallel computing, Parallel global sum: Addressing the problem of associativity, Future of parallel algorithm research	
MODULE 4	**7 HRS**
Vectorization: FLOPs for free, Vectorization and single instruction, multiple data (SIMD) overview, Hardware trends for vectorization, Vectorization methods. GPU architectures and concepts, The CPU-GPU system as an accelerated computational platform, Integrated GPUs: An underused option on commodity-based systems, Dedicated GPUs: The workhorse option, The GPU and the thread engine, Characteristics of GPU memory spaces, Measuring the GPU stream benchmark, The PCI bus: CPU to GPU data transfer overhead, bandwidth, Multi-GPU platforms and MPI	
MODULE 5	**7 HRS**
GPU programming model, GPU programming abstractions, GPU parallelism, Data decomposition into independent units of work: An ND Range or grid Subgroups, warps, or wavefronts execute in lockstep, Work item: The basic unit of operation, The code structure for the GPU programming model, The concept of a parallel kernel, How to address memory resources in your GPU programming model, Optimizing GPU resource usage, Reduction pattern requires synchronization across work groups, Asynchronous computing through queues Case study: D atmospheric simulation, Unstructured mesh application	

TEXT BOOK:

1. Parallel and High Performance Computing by Robert Robey, Yuliana Zamora
2. Introduction-to-High-Performance-Computing-for-Scientists-and-Engineers/Hager-Wellein/p/book/9781439811924

REFERENCES:

1. "Introduction to High Performance Computing for Scientists and Engineers" by Georg Hager and Gerhard Wellein
2. "Parallel Programming: Concepts and Practice" by Barry Wilkinson and Michael

OPEN ELECTIVE SYLLABUS OFFERED FROM DATA SCIENCE

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**21OE0030**					
TITLE OF THE COURSE	**STATISTICAL TOOLS AND TECHNIQUES OF DATA SCIENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- **Understand** the data science process and the different types of data, including data preprocessing techniques such as data cleaning, data reduction, and data transformation.
- **Familiarize** with Python libraries, specifically for data science tasks, using Pycharm as the development environment
- **Gain** knowledge of parametric tests, such as the Z-test, one-sample T-test, paired T-test, independent sample T-test, ANOVA, MANOVA, and their significance levels and power values. Also, **learn** about non-parametric tests, including the chi-square test, Fisher's test, Mann-Whitney U test, Kruskal-Wallis rank test, and Wilcoxon sign rank test.
- **Study** classification models, including logistic regression, discriminant regression analysis, support vector machines (SVM), naive Bayes, random forests, CHAID analysis, decision trees, k-nearest neighbors, and neural networks. **Understand** their principles, strength of associations, maximum likelihood estimation, and the use of confusion matrices.
- **Explore** unsupervised learning techniques, such as principal component analysis (PCA), reliability tests, KMO tests, eigenvalue interpretation, and clustering methods like K-means clustering and agglomerative clustering.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	To Summarize the data using visual & summary analytics and common probability distributions	L2
CO 2	To make inference about a sample & population using hypothesis tests.	L2
CO 3	To fit, interpret, and assess regression models and classification with one or more predictors.	L4
CO 4	To assess the data integrity and data relevancy to a specific application	L3
CO 5	To understand the unsupervised learning and clustering models	L2

COURSE CONTENTS

MODULE 1	8 HRS
INTRODUCTION: Overview of the Data science process. Different types of data Data Pre-processing: Data Cleaning- Missing values, Noisy data. Data cleaning as a process. Data Reduction: principal component analysis. Data Transformation: Strategies overview. Data transformation by normalization. Discretization by binning. Introduction Python Libraries (Pycharm).	
MODULE 2	**9 HRS**
EXPLORATORY DATA ANALYSIS AND HYPOTHESIS TESTING: Exploratory Data Analysis: Central Tendency Dispersions, Data Visualization: Histogram, Box Plot, Correlation Plot, Scatter Plot, Line Chart, Bar Chart, Pie Chart, Bubble Chart. Handling unbalanced datasets, Hypothesis Testing: Confidence Intervals, Constructing a hypothesis, Null Hypothesis & Alternative Hypothesis.	
MODULE 3	**8 HRS**
PARAMETRIC AND NON-PARAMETRIC TESTS: Parametric test: Z test, One Sample T-TEST, Paired T-TEST, ANOVA, MANOVA. Non parametric test: Chi Square Test, Fisher's Test, Mann-Whitney U test	
MODULE 4	**7 HRS**
CLASSIFICATION MODELS: Classification Models: Logistic Regression, Test of Associations, Maximum likelihood estimation, Confusion matrix, Support Vector Machines (SVM), Naive Bayes, Random Forests: Bagging & Boosting, Decision trees, k-Nearest Neighbors, Neural Network	
MODULE 5	**7 HRS**
UNSUPERVISED LEARNING:	

Unsupervised Learning: Principal component analysis, Reliability Test, Rotation and Extraction steps, Clustering Methods: K Means clustering, Agglomerative Clustering

TEXT BOOKS:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Wiley
2. Jiawei Han, Micheline Kember and Jian Pei, Data Mining Concepts and Techniques, 3rd edition, Elsevier, 2012
3. Statistics for Managers Using Microsoft Excel , 8th Edition, by David M. Levine , David F. Stephan , and Kathryn A. Szabat , Publisher: Pearson

REFERENCE BOOKS:

1. Data Mining in excel: Lecture Notes and cases by Galit Shmueli, Publisher: Wiley
2. Hastie, Tibshirani, Friedman, “The Elements of Statistical Learning” (2nd ed)., Springer, 2008

SCHOOL OF ENGINEERING

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Department of

CSE (Data Science)

SCHEME AND SYLLABUS

B.Tech. PROGRAMME– 2022 BATCH

With Effective From 2022-23

Definitions / Descriptions

Definition of Credit:	
1 Hour Lecture (L) Per Week	01 Credit
1 Hour Tutorial (T) Per Week	01 Credit
1 Hour Practical (P) Per Week	0.5 Credit
1 Hour Project (J) Per Week	0.5 Credit

Course code and Definition:	
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management Courses
IPCC	Integrated Professional Core Course
PCC	Professional Core Courses
PEC	Professional Elective Courses
OEC	Open Elective Courses
SEC	Skill Enhancement Courses
UHV	Universal Human Value Course
PROJ	Project Work
INT	Internship

Implementation of National Education Policy (NEP) 2020 for the B.Tech students of Batch 2022-2026

The implementation of Curriculum follows NEP 2020 and addresses the following features and categories of courses:

1. Student Centric flexible curriculum.
2. Interdisciplinary Courses,
3. Multi-disciplinary Courses,
4. Ability Enhancement Courses,
5. Skill Enhancement Courses,
6. Value Added Courses,
7. Product Design and Development,
8. Internship (Rural Internship, Industry Internship, Research/Development Internship), and
9. Multiple Exit and Multiple Entry
    - Certificate in Engineering after completion of first year.
    - Diploma in Engineering after completion of second year.
    - Advanced Diploma in Engineering after completion of third year.
    - Degree in Engineering after completion of fourth year.

III SEMESTER														
S. N	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical	Project	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1	BSC	22DS2301	Transforms and Numerical Techniques	MAT	3	0	0	0	03	60	40	100	**3**
2	IPCC	22DS2302	Data Structures	CSE	3	0	2	0	05	60	40	100	**4**
3	IPCC	22DS2303	Digital Logic Design	ECE	3	0	2	0	05	60	40	100	**4**
4	PCC	22DS2304	Discrete Mathematics and Graph Theory	CSE	3	0	0	0	03	60	40	100	**3**
5	PCC	22DS2305	Foundations of Data Science	DS	3	0	2	0	05	60	40	100	**4**
6	AEC	22LSXXXX	Liberal Studies	All Dept.	1	0	0	0	01	50	--	50	**1**
7	SEC	22DS23XX	Skill Enhancement Course – I	DS	1	0	2	0	03	100	--	100	**2**
			Total		**17**	**0**	**08**	**0**	**25**	**450**	**200**	**650**	**21**

LIBERAL STUDIES LIST - B.TECH PROGRAMME – 2022-23 Batch

Sl. No.	Course Code	Course Title	Offering dept
1	22LS0001	Introduction to Drama	Any department
2	22LS0002	Introduction to Dance	
3	22LS0003	Introduction to Music	
4	22LS0004	Introduction to Photography	
5	22LS0005	Introduction to Japanese language	
6	22LS0006	Law for Engineers	
7	22LS0007	Introduction to Painting	
8	22LS0008	Communication Through Sanskrit	
9	22LS0009	Vedic Mathematics	
10	22LS0010	Fundamentals of Critical Thinking	
11	22LS0011	Introduction to Film Studies	
12	22LS0012	Practicing Yoga & Meditation	
13	22LS0013	Cyber Crimes, Policies & Laws	
14	22LS0014	Holistic Medicine	
15	22LS0015	3 D Modelling using Tinkercad	

Skill Enhancement Course – I		
1	22DS2306	Programming in C++
2	22DS2307	Data Analytics and Visualization Tools (ALTAIR)

IV SEMESTER

S. N	Course Type	Course Code	Course Name	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture L	Tutorial T	Practical P	Project J	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	BSC	22DS2401	Probability & Statistics	MAT	3	0	0	0	03	60	40	100	**3**
2	IPCC	22DS2402	Design and Analysis of Algorithms	CSE	3	0	2	0	05	60	40	100	**4**
3	PCC	22DS2403	Database Management System	CSE	3	0	2	0	05	60	40	100	**4**
4	PCC	22DS2404	Web Technologies	DS	3	0	2	0	05	60	40	100	**4**
5	IPCC	22DS2405	Computer Organization and Architecture	CSE	3	0	0	0	03	60	40	100	**3**
6	AEC	22DS2406	Special Topics	DS	0	0	0	04	04	100	--	100	**2**
7	SEC	22DS24XX	Skill Enhancement Course – II	DS	1	0	2	0	03	100	--	100	**2**
			Total		**16**	**0**	**08**	**4**	**28**	**500**	**200**	**700**	**22**

Skill Enhancement Course – II		
1	22DS2407	OOPS with JAVA
2	22DS2408	Python Scripting

TRANSFORMS AND NUMERICAL TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	22DS2301	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–J	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Apply** their knowledge of Laplace transforms and inverse Laplace transforms to proficiently solve linear ordinary differential equations with constant coefficients, facilitating the analysis and modelling of complex systems.
2. **Analyze** periodic functions using Fourier series, assessing the convergence properties and precision of the series expansion, thereby enhancing their ability to understand and manipulate periodic phenomena.
3. **Utilize** complex exponential form, Fourier transforms of basic functions, and Fourier sine and cosine transforms to solve problems involving Fourier integrals, developing proficiency in applying these techniques to various mathematical scenarios.
4. **Employ** numerical methods, including Euler's Method, Runge-Kutta 4th order, Adams-Bashforth, and Adams-Moulton Methods, to solve differential equations and effectively analyze dynamic systems, enabling them to model real-world phenomena and make accurate predictions.
5. **Apply** finite difference methods, including the Crank-Nicolson method and appropriate techniques for hyperbolic PDEs, to effectively solve different types of partial differential equations (PDEs) such as elliptic, parabolic, and hyperbolic equations, enhancing their problem-solving skills in the context of differential equations and their applications.

Teaching-Learning Process (General Instructions) These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes. 1. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes. 2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying. 3. Show ***Video/animation*** films to explain functioning of various concepts. 4. Encourage ***Collaborative*** (Group Learning) Learning in the class. 5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class. 6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it. 7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them. 8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.	
UNIT – I: Laplace Transform and Inverse Laplace Transform	**09 Hours**
Laplace Transforms of Elementary functions (without proof), ***(Text Book-1: Chapter 6: 203 to 207).*** Laplace Transforms of $e^{at}f(t), t^n f(t)$ and $\frac{f(t)}{t}$, Periodic functions, Unit step function and impulse functions ***(Text Book-1: Chapter 6:208-230)***. Inverse Laplace Transforms- By the method of Partial Fractions, Logarithmic and Trigonometric functions, Convolution Theorem, Inverse Laplace transform using Convolution Theorem ***(Text Book-1: Chapter 6: 238)***. Solution to Differential Equations by Laplace Transform. ***(Text Book-1: Chapter 238-242)***.	
UNIT – II: Fourier Series	**09 Hours**
Periodic Functions, Trigonometric Series	

(Text Book-1: Chapter 11: 495). Fourier series Standard function, Functions of any Period 2L, Even and Odd functions, Half-range Expansions. ***(Text Book-1: Chapter 11: 483-492)*** Practical Harmonic analysis (calculate average power and RMS values of periodic waveforms)	
UNIT – III: Fourier Transform	**06 Hours**
Calculation of Fourier integrals using complex exponential form ***(Text Book-1: Chapter 11: 510).*** Fourier transform of basic functions ***(Text Book-1: Chapter 11: 510-516).*** Fourier sine and cosine transforms. ***(Text Book-1: Chapter 11: 518-522).***	
UNIT – IV: Numerical Methods for Solving Ordinary Differential Equations	**07 Hours**
Euler's Method-Basic principles of Euler's method for solving first-order ODEs ***(Text Book-1: Chapter 1:10-12).*** Runge-Kutta 4th order ***(Text Book-1: Chapter 21:904).*** Multistep Methods-Explanation of multistep methods (Adams-Bashforth, Adams–Moulton Methods) ***(Text Book-1: Chapter 21:911-913).*** Second-Order ODE. Mass–Spring System (Euler Method, Runge–Kutta Methods) ***(Text Book-1: Chapter 21:916-918).***	
UNIT – V: Numerical Methods for Partial Differential Equations	**08 Hours**
Classification of PDEs (elliptic, parabolic, hyperbolic), ***(Text Book-1: Chapter 21:922-923).*** Finite Difference Methods (Laplace and Poisson Equations), Derivation of finite difference approximations ***(Text Book-1: Chapter 21:923-927).*** Crank–Nicolson Method ***(Text Book-1: Chapter 21:938-941).*** Method for Hyperbolic PDEs ***(Text Book-1: Chapter 21:943-945).***	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Apply** Laplace transforms and inverse Laplace transforms to solve linear ordinary differential equations with constant coefficients, demonstrating proficiency in system analysis and modelling.	L3
2	**Analyze** periodic functions using Fourier series and evaluate the convergence properties and precision of the series expansion.	L2 & L3
3	**Solve** problems involving Fourier integrals by applying complex exponential form, Fourier transforms of basic functions, and Fourier sine and cosine transforms.	L3
4	**Utilize** numerical methods such as Euler's Method, Runge-Kutta 4th order, Adams-Bashforth, and Adams-Moulton Methods to solve differential equations and analyze dynamic systems	L2 & L3
5	**Apply** finite difference methods, including the Crank-Nicolson method and appropriate techniques for hyperbolic PDEs, to solve various types of partial differential equations (PDEs) such as elliptic, parabolic, and hyperbolic equations.	L3

Table: Mapping Levels of COs to POs / PSOs

COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2	1					1					
CO2	3	2	2						1					
CO3	3	2	2	1					1					
CO4	3	2	2	1					1					
CO5	3	2	2	1					1					

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, Wiley India.

REFERENCE BOOKS:

1. Higher Engineering Mathematics, B.S. Grewal, 2015, 43rd Edition, Khanna Publishers.
2. Higher Engineering Mathematics, John Bird, 2017, 6 th Edition, Elsevier Limited.

E-Resources:

1. https://nptel.ac.in/courses/111106139
2. https://nptel.ac.in/courses/111101164
3. https://nptel.ac.in/courses/111105038

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DATA STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	22DS2302	**Credits**	:	04
Hours / Week	:	03 Hours	**Total Hours**	:	39(Th)+26(P) Hours
L–T–P-J	:	3–0–2-0			

Prerequisites:

Proficiency in a C programming language.

Course Objectives:

This Course will enable students to:

1. **Understand** the basic approaches for analysing and designing data structures.
2. **Introduce** dynamic memory allocation and C language concepts required for building data structures
3. **Develop** essential skills to construct data structures to store and retrieve data quickly and **efficiently**.
4. **Utilize** different data structures that support different sets of operations which are suitable for various applications.
5. **Explore & Implement** how to insert, delete, search and modify data in any data structure- Stack, Queues, Lists, Trees.
6. **Develop** applications using the available data structure as part of the course for mini-project.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.

3. Show ***Video/Animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**
IINTRODUCTION: Introduction to Data Structure, Classification, C Structure and Union, Array Definition, Representation, Operations (Insertion, Deletion, Search and Traversal), Two/Multidimensional Arrays, sparse matrix, C Pointers TB1: 1.1, 2.2, 2.5 ; TB2: 1.1, 1.2,1.3.1-1.3.4; RB1: 5.1 – 5.12, 6.4	
UNIT – II	**09 Hours**
INTRODUCTION TO ADT: **Stack:** Definition, Array Representation of Stack, Operations on Stacks. **Applications of Stack:** Expression evaluation, Conversion of Infix to Postfix, Infix to Prefix Recursion, Tower of Hanoi **Queue:** Definition, Representation of Queues, Operations of Queues, Circular Queue. **Applications of Queue:** Job Scheduling, A Maze Problem TB1: 3.1,3.2, 3.3,3.4,3.5 ; TB2: 2.1, 2.2, 2.3, 3.2, 3.3	
UNIT – III	**09 Hours**
DYNAMIC DATA STRUCTURES: **Linked List:** Types, Representation of Linked Lists in Memory. Traversing, Searching, Insertion & Deletion from Linked List. Circular List, Doubly Linked List, Operations on Doubly Linked List (Insertion, Deletion, Traversal). **Applications:** Stack & Queue Implementation using Linked Lists. **Case Study**: Josephus problem. TB2: 4.2,4.3,4.5	
UNIT – IV	**08 Hours**

TREES: Basic Terminology, Binary Trees and their representation, Complete Binary Trees, Binary Search Trees, Threaded Binary Trees, Operations on Binary Trees (Insertion, Deletion, Search & Traversal). TB1: 5.1,5.2,5.3,5.5,5.7 **Applications:** Expression Evaluation **Case Study:** Game Tree TB2: 5.5.3,5.5.4,5.6	
UNIT – V	**05 Hours**
Efficient Binary Search Trees: Optimal Binary Search Trees, AVL Trees, Red Black Trees, Splay Trees. **Case Study**: B Trees TB1: 10.1,10.2,10.3,10.4, 11.2	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Demonstrate** the key C programming concepts such as pointers, structures, unions and arrays data structures to perform operations such as insertion, deletion, searching, sorting, and traversing.	L3
2	**Utilize** the fundamental concepts of stacks and queues to solve the standard applications like tower of Hanoi, conversion and evaluation of expressions, job scheduling and maze.	L3
3	**Implement** Singly Linked List, Doubly Linked List, Circular Linked Lists, stacks and queues using linked list**.**	L3
4	**Develop** critical thinking and problem-solving skills by designing and implementing efficient algorithms for Non-linear tree data structure and perform insertion, deletion, search and traversal **operations** on it.	L3

5	**Apply** advanced techniques, such as balancing algorithms for AVL trees, Splay trees and Red-Black trees to maintain the balance and efficiency of binary trees.	L3

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3												2	
CO2	3		3									2	2	
CO3	3		3									2	2	
CO4	3	2	3									2	2	
CO5	3	2	3									2	2	

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS (TB):

1. Ellis Horowitz, Susan Anderson-Freed, and Sartaj Sahni, "Fundamentals of Data structures in C", 2nd Edition, Orient Longman, 2008.
2. A.M. Tannenbaum, Y Langsam, M J Augentien "Data Structures using C", 1st Edition, Pearson, 2019.

REFERENCE BOOKS:

1. Brian. W. Kernighan, Dennis. M. Ritchie, "The C Programming Language", 2nd Edition, Prentice-Hall, 1988.
2. Gilbert & Forouzan, "Data Structures: A Pseudo-code approach with C", 2nd Edition, Cengage Learning,2014.

3. Jean-Paul Tremblay & Paul G. Sorenson, "An Introduction to Data Structures with Applications", 2nd Edition, McGraw Hill, 2013.
4. R.L. Kruse, B.P. Learly, C.L. Tondo, "Data Structure and Program design in C", 5th Edition, PHI ,2009.

E-Resources:

1. https://nptel.ac.in/courses/106102064
2. https://www.coursera.org/learn/data-structures?specialization=data-structures-algorithms
3. https://www.udemy.com/topic/data-structures/free/
4. https://www.mygreatlearning.com/academy/learn-for-free/courses/data-structures
5. https://cse01-iiith.vlabs.ac.in/
6. https://kremlin.cc/k&r.pdf

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving using group discussion.
2. Role play E.g., Stack, Queue, etc.,
3. Demonstration of solution to a problem through programming.
4. Flip class activity E.g., arrays, pointers, dynamic memory allocation, etc.,

LABORATORY EXPERIMENTS

Total Contact Hours: 26

Following are experiments to be carried out using either C programming language

1. To Implement C programs with concepts of pointers, structures.
2. To implement multidimensional array Matrix Multiplication.
3. To search elements in data structure with different search methods.
4. To implement stack, queue and their variations using arrays.
5. To implement stack, queue and their variations using singly linked lists
6. To implement conversion & evaluation of expression using stacks.

7. To Implement doubly circular Linked Lists and variations and use them to store data and perform operations on it.
8. To Implement Addition/multiplication of 2 polynomial using linked lists
9. To implement binary tree traversal techniques.

OPEN-ENDED EXPERIMENTS

1. A man in an automobile search for another man who is located at some point of a certain road. He starts at a given point and knows in advance the probability that the second man is at any given point of the road. Since the man being sought might be in either direction from the starting point, the searcher will, in general, must turn around many times before finding his target. How does he search to minimize the expected distance travelled? When can this minimum expectation be achieved?
2. The computing resources of a cloud are pooled and allocated according to customer demand. This has led to increased use of energy on the part of the service providers due to the need to maintain the computing infrastructure. What data structure will you use for allocating resources which addresses the issue of energy saving? Why? Design the solution.
3. Mini-Project on applying suitable data structure to a given real-world problem.

DIGITAL LOGIC DESIGN
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Course Code	:	22DS2303	**Credits**	:	04
Hours / Week	:	03 Hours	**Total Hours**	:	39(Th) + 26(P) Hours
L–T–P-J	:	3–0–2-0			

Course Learning Objectives:
This Course will enable students to:

1. **Translate** the elements of digital logic functions to digital system abstractions using Verilog.
2. **Illustrate** simplification of Boolean expressions using Karnaugh
3. **Model** combinational logic circuits for arithmetic operations and logical operations
4. **Analyse** and model sequential elements flip-flops, counter, shift registers.
5. **Outline** the concept of Mealy Model, Moore Model and apply FSM to solve a given design problem.

Teaching-Learning Process (General Instructions)
These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up

with their own creative ways to solve them.

8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**
INTRODUCTION: Number System- Binary, Hexa, Decimal, Octal and its conversion. Canonical Notation - SOP & POS forms, Minimization of SOP and POS forms. ***(Text Book-1: Chapter 1: 1.2 to 1.4, Chapter 2: 2.6)*** **ARITHMETIC CIRCUITS AND VERILOG MODELLING** Adders: Half adder, full adder, Ripple carry adder, parallel adder /subtractor, fast adders-CLA, comparator- 2 bit. Simplification using K-Maps ***(Text Book-2: Chapter 5: 5.2, 5.3.3, 5.4,5.5.2, 5.5.3)*** Introduction to Verilog, Syntax of Verilog coding, Modelling styles in Verilog, Verilog Operators, Test bench for simulation ***(Text Book-3: Chapter 1: 1.1, 1.2.2, 1.3.1, 1.3.2, 1.3.3, 1.4.2, 1.5.1.2, 1.5.2.2, 1.5.3.2, 1.5.4.2, 1.6.2)***	
UNIT – II	**07 Hours**
Combinational Circuit Building Multiplexers 4:1, 8:1, decoders 3:8, 2:4, demultiplexers 1:4, encoders 8:3, 4:2, code converters- B to G and G to B- Simplification using K-Maps **Verilog for combinational circuits**, if else, case-casex, casez, for loop, generate. ***(Text Book-2: Chapter 6: 6.1, 6.2, 6.3, 6.4, 6.6)***	
UNIT – III	**08 Hours**
Sequential Circuits-1 Basic Latch, Gated latches, Flip Flops SR, D, JK, T, master-slave flip-flops JK, Characteristic equations, 0's and 1's Catching Problem, Race round condition, Switch debounce, shift registers- SISO, SIPO, PISO, PIPO, Setup time, Hold time, Propagation Delay ***(Text Book-2: Chapter 7: 7.1, 7.2,7.3, 7.4,7.5,7.6, 7.8)***	
UNIT – IV	**08 Hours**

Sequential Circuits-2
Binary counters – asynchronous and synchronous, mod-n counter, ripple counter- 4 bit.
Verilog blocking and non-blocking,
Mealy Model, Moore Model, State machine notation, Construction of Finite State Machine.
(Text Book-2: Chapter 7: 7.9, 7.11, 7.12.3, 7.12.4, 8.1, 8.2, 8.3, 8.4)

UNIT – V	**08 Hours**

Introduction to Electronic Design Automation:
FPGA Design Flow, ASIC Design flow, architectural design, logic design, simulation, verification and testing, 3000 Series FPGA architecture.
Applications:
Design 4 Bit ALU, 7 Segment display, Vending Machine, 3 Pipeline.
(Text Book-4: Chapter 1)

Laboratory Experiments

Experiments are conducted using Verilog tool /Kits

1.	Introduction to Xilinx tool, FPGA flow
2.	Adder – HA, FA using data flow and behaviour modelling styles
3.	Adder – HA, FA using structural modelling style
4.	Combinational designs – I (blocking and non-blocking/looping examples) **a.** Multiplexer: 4:1, 8:1 MUX. **b.** De Multiplexer: 1:4, 1:8 DEMUX.
5.	Combinational designs – II (different types of case statements) **c.** Encoder with and without Priority: 8:3 and 4:2. **d.** Decoder: 3:8 and 2:4.
6.	Design of 4-bit ALU
7.	Flip Flop: D FF, T FF, JK FF
8.	Design of Mod – n Up/Down Counter with Synchronous reset
9.	Design of Mod – n Up/Down Counter with Asynchronous reset.
10.	Design of Universal shift Register using FSM

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Interpret** Boolean Expressions of digital design in simplified form	L2
2	**Build** the various elements of digital logic system with Verilog	L3
3	**Construct** Combinational and Sequential logic circuits	L3
4	**Analyse** the hardware model of a digital system at different levels of abstraction in Verilog	L4
5	**Evaluate** the functionality of digital design by implementing on FPGA kits	L5
6	**Design digital** systems using FSM	L3

Table: Mapping Levels of COs to POs / PSOs															
Cos	**Program Outcomes (POs)**											**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**-**	**-**
CO2	**3**	**2**	**1**	**2**	**3**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**2**	**1**	**-**
CO3	**3**	**2**	**3**	**1**	**2**	**-**	**-**	**1**	**1**	**-**	**1**	**1**	**2**	**1**	**-**
CO4	**3**	**3**	**2**	**3**	**3**	**1**	**-**	**1**	**-**	**1**	**2**	**1**	**2**	**2**	**1**
CO5	**3**	**3**	**2**	**3**	**3**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**2**	**2**	**1**
CO6	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**1**	**2**	**2**	**2**	**2**	**2**	**1**	**2**

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. M. Morris Mano Michael D. Ciletti , "Digital Design with an Introduction to the Verilog HDL", 6th Edition, Pearson Education, 2014.

2. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog design", McGraw Hill, 2014.
3. Nazein M. Botros, "HDL programming (VHDL and Verilog)", Dreamtech Press, 2006.
4. Douglas J Smith, "HDL Chip Design", Doone publications 1996.

REFERENCE BOOKS:

1. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2014.
2. Donald D. Givone, "Digital Principles and Design", McGraw Hill, 2015.
3. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, 2016.

E-Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105165/
2. https://nptel.ac.in/courses/117105080

Activity Based Learning (Suggested Activities in Class)

1. Design problem solving and Programming using group discussion. E.g., Traffic light controller, Digital Clock, Elevator.
2. Demonstration of solution to a problem through simulation.

DISCRETE MATHEMATICS AND GRAPH THEORY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	:	22DS2304	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39Hours
L–T–P–J	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Learn** the set theoretic concept and its application in theory of computation.
2. **Determine** the concepts of mathematical induction, recursive relations and their application.
3. **Illustrate** the association of functions, relations, partial ordered set and lattices with problems related to theoretical computer science and network models.
4. **Discuss** the basics of graph theory and its application in computer networks. Learn the concepts of counting techniques and its application.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainmentof the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different type of teaching methods may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** Adopt the Active learning that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinkingskills such as the ability to evaluate, generalize, and analyse information rather than simplyrecall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come upwith their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**

SET THEORY: Sets and subsets, Operations on Sets: Basic set operations, algebraic properties of sets, The Addition Principle **RELATIONS AND ITS PROPERTIES:** Relations and their properties, N-Ary Relations and their applications, Representing relations. ***Textbook – 2: 1.1, 1.2 ; Textbook – 1: 7.1., 7.2, 7.3***	
UNIT – II	**06 Hours**
RELATIONS AND ORDER RELATIONS: Closure of relations, Equivalence Relations, Partial Orderings, Functions, The Growth of Functions. **Self-Study:** Transitive Closure and Warshall's Algorithm. ***Textbook – 1: 7.4., 7.5, 7.6, 3.2***	
UNIT – III	**08 Hours**
MATHEMATICAL INDUCTION AND RECURSION: Mathematical Induction, Recurrence Relations:Rabbits and the Fibonacci Numbers, The Tower of Hanoi, Code word Enumeration, Solving LinearRecurrence Relations **Self-Study:** Basic Connectives and Truth Tables ***Textbook-1: 4.1;6.1, 6.2;*****1.1**	
UNIT – IV	**09 Hours**
GRAPH THEORY: Graphs and Graph Models. Graph Terminology and Special Types of Graphs: Basic Terminology, Some Special Simple Graphs, Bipartite Graphs, Complete Bipartite Graphs. Representing Graphs and graph isomorphism: Adjacency lists, Adjacency Matrices, Incidence Matrices, Connectivity: Paths, Connectedness in Undirected and Directed Graphs, Vertex and Edge connectivity and their applications. ***Textbook-1: 8.1, 8.2, 8.3, 8.4***	
UNIT – V	**08 Hours**
GRAPHS AND ITS APPLICATIONS: Euler and Hamilton Paths and their applications, Planar Graphs and their Applications, Graph Coloring and its applications. ***Textbook-1: 8.5, 8.7, 8.8***	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Identify** the membership of the Set and Relations and perform basic Algebraic operations	L3
2	**Illustrate** the concept of Mathematical Induction and create linear recurrence relations for the given problem	L4

3	**Construct** different types of graphs based on the properties and the real time applications of graph theoretical concepts	L3
4	**Analyze** the methods for optimizing the solution for graph coloring problem, Eulerian and Hamiltonian circuits/planes	L4

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

XT BOOKS:

1. Kenneth H. Rosen, "Discrete Mathematics and its applications", Tata McGraw Hill, 2003.
2. Bernard Kolman, Robert C. Busby, Sharon Ross, "Discrete Mathematical Structures", 3rdEdition, PHI 2001.

REFERENCE BOOKS:

1. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics", IV Edition, PearsonEducation, Asia, 2002.
2. J. P. Tremblay, R. Manohar, "Discrete Mathematical Structures with applications tocomputer Science", Tata McGraw Hill, 1987.
3. J K Sharma, "Discrete Mathematics", 3rd edition, 2013, Macmillan India Ltd.

E-Resources:

1. Discrete Mathematics with Algorithms by M. O. Albertson, J. P. Hutchinson - J. 1988,Wiley.
2. Discrete Mathematics for Computer Science, Gary Haggard, John Schlipf, Sue Whitesides,Thomson Brooks/Cole, 2006.

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1	2					1	1	1		2	2	1
CO2	3	3	2					1	1	1		2	2	1
CO3	3	3	3					1	1	1		1	2	1
CO4	3	3	3					1	1	1		2	2	1
Avg	3	2.5	2.5					1	1	1		1.75	2	1

3. http://ocw.mit.edu/courses/mathematics/

4. http://www.nptelvideos.in/2012/11/discrete-mathematical-structures.html
5. http://cglab.ca/~discmath/notes.html
6. https://www.cs.odu.edu/~toida/nerzic/content/web_course.html

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion.
2. Demonstration of solution to a problem using graph theory.

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FOUNDATIONS OF DATA SCIENCE
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	:	22DS2305	**Credits**	:	04
Hours / Week	:	03 Hours	**Total Hours**	:	65 Hours
L–T–P	:	3–0–2-0			

Prerequisites:

Proficiency in a Python and R programming language.

Course Learning Objectives:

This Course will enable students to:

1. **Familiarize** with Python libraries, specifically for data science tasks, using Pycharm as the development environment
2. **Gain** knowledge of parametric tests, such as the Z-test, one-sample T-test, paired T-test, independent sample T-test, ANOVA, MANOVA, and their significance levels and power values. Also, **learn** about non-parametric tests, including the chi-square test, Fisher's test, Mann-Whitney U test, Kruskal-Wallis rank test, and Wilcoxon sign rank test.
3. **Study** classification models, including logistic regression, discriminant regression analysis, support vector machines (SVM), naive Bayes, random forests, CHAID analysis, decision trees, k-nearest neighbors, and neural networks. **Understand** their principles, strength of associations, maximum likelihood estimation, and the use of confusion matrices.
4. **Explore** unsupervised learning techniques, such as principal component analysis (PCA), reliability tests, KMO tests, eigenvalue interpretation, and clustering methods like K-means clustering and agglomerative clustering.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
3. Show ***Video/Animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.

5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**
INTRODUCTION: Overview of the Data science process. Different types of data Data Pre-processing: Data Cleaning- Missing values, Noisy data. Data cleaning as a process. Data Reduction: principal component analysis. Data Transformation: Strategies overview. Data transformation by normalization. Discretization by binning. (Text Book-1: Chapter1) (Text Book-2: Chapter 3)	
UNIT – II	**09 Hours**
EXPLORATORY DATA ANALYSIS AND HYPOTHESIS TESTING: Exploratory Data Analysis: Central Tendency (Text Book-1: Chapter 3-3.1), Dispersions, Five number Distributions, Cross Tabulations. Data Visualization: Histogram, Box Plot, Correlation Plot, Scatter Plot, Line Chart, Bar Chart, Pie Chart, Bubble Chart, Decision Tree, Cluster Charts.(Text Book-1:Chapter 2.3,2.4,2.5) Hypothesis Testing: Confidence Intervals (Text Book-1:Chapter 8), Constructing a hypothesis, Null Hypothesis; Alternative Hypothesis, Type I and Type II errors, Power Value(Text Book-1: Chapter 9)	
UNIT – III	**08 Hours**
PARAMETRIC AND NON-PARAMETRIC TESTS: Parametric test: Z test, One Sample T-TEST, Paired T-TEST, Independent Sample T-TEST, ANOVA, MANOVA, Level of significance, Power of a test.(Text Book-1:Chapter 9, Chapter 11) Non parametric test: Chi Square Test, Kruskal-Wallis Rank Test, Wilcoxon sign rank.(Text Book-1: Chapter 12)	
UNIT – IV	**07 Hours**
Overview of R- Basic Features of R, R Conventions- R for Basic Math- Arithmetic- Logarithms and Exponentials, E-Notation- Assigning Objects- Vectors- Creating a Vector- Sequences, Repetition, Sorting, and Lengths- Subsetting and Element Extraction- Vector-Oriented Behaviour. Defining a Matrix – Defining a Matrix- Filling Direction- Row and Column Bindings- Matrix DimensionsSubsetting- Row, Column, and Diagonal Extractions- Omitting and Overwriting- Matrix Operations and Algebra	

UNIT – V	07 Hours
Advanced R- Lists of Objects-Component Access-Naming-Nesting-Data Frames-Adding Data Columns and Combining Data Frames-Logical Record Subsets-Some Special Values-Infinity-NaN-NA-NULL, Attributes-Object-Class-Is-Dot Object-Check. Plotting with Coordinate Vectors-Graphical Parameters-Automatic Plot Types-Title and Axis Labels, Color-Line and Point Appearances-Plotting Region Limits-Adding Points, Lines, and Text to an Existing Plot-ggplot2 Package-Quick Plot with qplot-Setting Appearance Constants with Geoms READING AND WRITING FILES- R-Ready Data Sets- Contributed Data Sets- Reading in External Data Files- Writing Out Data Files and Plots- Ad Hoc Object Read/Write Operations	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	To Summarize the data using visual & amp; summary analytics and common probability distributions	L3
2	To make inference about a sample & population using hypothesis tests.	L3
3	To fit, interpret, and assess regression models and classification with one or more predictors.	L3
4	To apply statistical analysis using R Programming	L3
5	Understanding and analyzing the Data using R packages	L3

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	3										2	
CO2	3	3	3										2	
CO3	3	3	3										2	
CO4	3	3	3										2	
CO5	2	3	3										2	

3: Substantial (High) 2: Moderate (Medium) 1: Poor (Low)

TEXT BOOKS:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Wiley
2. Tilman M.Davies,"THE BOOK OF R - A FIRST PROGRAMMING AND STATISTICS" Library of Congress Cataloging-in-Publication Data,2016

REFERENCE BOOKS:

1. Data Mining in excel: Lecture Notes and cases by Galit Shmueli, Publisher: Wiley
2. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd ed)., Springer, 2008

E-Resources:

1. https://www.simplilearn.com/pgp-data-science-certification-bootcamp-program

Practical Experiments:

Design a R/Python:
1. Program to import iris dataset and display head, tail, summary, interquartile range and structure.
2. Program for data cleaning and find missing values in iris dataset.
3. Program for exploratory data analysis(EDA)
4. Program to plot correlation matrix and covariance plot for iris dataset.

5. Program for dimensionality reduction using principal component analysis for iris dataset.
6. Implement a program to select required features from iris dataset using chi square test
7. Build a python program for iris dataset using different classification algorithms.
8. Implement a program for Simple Linear Regression and Multiple Linear Regression
9. Program for One-way ANOVA and Two-Way ANOVA.

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PROBABILITY AND STATISTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	22DS2401	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P–J	:	3–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Apply** statistical principles and probability concepts to solve complex problems in real-world scenarios involving uncertainty and randomness.
2. **Evaluate** and select appropriate probability distributions and statistical techniques to analyze and interpret data accurately in various applications.
3. **Justify** the use of estimation methods and hypothesis testing techniques for drawing meaningful inferences about population parameters.
4. **Analyze** and interpret sample test results for different statistical relationships, such as means, variances, correlation coefficients, regression coefficients, goodness of fit, and independence, to make informed decisions.
5. **Identify** sample tests using appropriate statistical procedures to investigate the significance of observed data and communicate findings effectively.

Teaching-Learning Process (General Instructions)
These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I : Probability	**09 Hours**
Definitions of Probability, Addition Theorem, Conditional Probability, Multiplication Theorem, Bayes' Theorem of Probability	
UNIT – II: Random Variables and their Properties and Probability Distributions	**09 Hours**
Discrete Random Variable, Continuous Random Variable, Joint Probability Distributions Their Properties, Probability Distributions: Discrete Distributions: Binomial, Poisson Distributions and their Properties; Continuous Distributions: Exponential ,Normal, Distributions and their Properties.	
UNIT – III: Estimation and testing of hypothesis	**06 Hours**
Sample, Populations, Statistic, Parameter, Sampling Distribution, Standard Error, Unbiasedness, Efficiency, Maximum Likelihood Estimator, Notion & Interval Estimation.	
	07 Hours

UNIT – IV: Sample Tests-1	
Large Sample Tests Based on Normal Distribution , Small Sample Tests : Testing Equality of Means, Testing Equality of Variances, Test of Correlation Coefficient	
UNIT – V: Sample Tests-2	**08 Hours**
Test for Regression Coefficient; Coefficient of Association, 2 – Test for Goodness of Fit, Test for Independence.	

Course Outcome	**Description**	**Bloom's Taxonomy Level**
At the end of the course the student will be able to:		
1	**Apply** the principles of probability to solve complex problems in various real-world scenarios.	L2 & L3
2	**Solve** and **compare** different probability distributions, including discrete and continuous random variables, in order to make informed decisions and predictions.	L2 & L3
3	**Apply** statistical estimation techniques, such as maximum likelihood estimation and interval estimation, to draw meaningful inferences about population parameters from sample data.	L3
4	**Examine** hypothesis testing methods, including large and small sample tests, to assess the significance of observed data and draw valid conclusions.	L4
5	**Analyze** statistical relationships and perform sample tests to assess the Equality of means in different populations, Correlation coefficients between variables to determine the strength and direction of the relationship. Independence of variables using appropriate statistical tests to assess the absence of any relationship.	L4

Table: Mapping Levels of COs to POs / PSOs														
COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	2	2		2				1					
CO 2	3	2	2		2				1					
CO 3	3	2	2						1					
CO 4	3	2	2		2				1					
CO 5	3	2	2		2				1					

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Probability & Statistics for Engineers and Scientists, Walpole, Myers, Myers, Ye. Pearson Education.

REFERENCE BOOKS:

1. Probability, Statistics and Random Processes T. Veerarajan Tata McGraw – Hill
2. Probability & Statistics with Reliability, Queuing and Computer Applications, Kishor S. Trivedi, Prentice Hall of India ,1999

E-Resources:

1. https://nptel.ac.in/courses/106104233
2. https://nptel.ac.in/courses/117103067
3. https://nptel.ac.in/courses/103106120
4. https://www.coursera.org/learn/probability-intro#syllabus
5. https://nptel.ac.in/courses/111104073

Activity Based Learning (Suggested Activities in Class)

1. Tools like Python programming, R programming can be used which helps students to develop a skill to analyze the problem and provide a solution.

2. Regular Chapter wise assignments/ Activity/Case studies can help students to have critical thinking, developing an expert mind set, problem-solving and teamwork.

Following are Assignments/ Activities Can be carried out using either R programming language or Python Programming or excel solver.

1. There are n people gathered in a room. What is the probability that at least 2 of them will have the same birthday? (Use excel solver, R Programming, Python Programming)
   a. Use simulation to estimate this for various n., and Produce Simulation Graph.
   b. Find the smallest value of n for which the probability of a match is greater than 0.5.
   c. Explore how the number of trials in the simulation affects the variability of our estimates.
2. **Case Study 1: Customer Arrivals at a Coffee Shop**
   a. A coffee shop wants to analyze the number of customer arrivals during its morning rush hour (7:00 AM to 9:00 AM). The shop has been recording the number of customer arrivals every 15 minutes for the past month.
   b. Data: The data consists of the number of customer arrivals recorded at the coffee shop during each 15-minute interval for the past month.
   c. Here is a sample of the data:

Time Interval	ıstomer Arrivals
00 AM - 7:15 AM	6
15 AM - 7:30 AM	4
30 AM - 7:45 AM	9
45 AM - 8:00 AM	7
00 AM - 8:15 AM	5
15 AM - 8:30 AM	8
30 AM - 8:45 AM	10
45 AM - 9:00 AM	6

   analyze the customer arrivals and determine the probability distribution that best fits the data. Specifically, explore both discrete and continuous probability distributions, including the binomial, Poisson, exponential, and normal distributions.
3. **Case Study 2: Comparing the Performance of Two Groups**
   a. Suppose you are a data analyst working for a company that manufactures a new energy drink. The marketing team conducted a promotional campaign in two different cities (City A and City B) to determine the effectiveness of the campaign in increasing sales. The sales data for a random sample of customers in each city was collected over a week. Your task is to compare the average sales between the two cities and test whether there is a significant difference in the variance of sales.

b. **Data**: Let's assume the following sample data for the number of energy drinks sold in each city:

City A: [30, 28, 32, 29, 31, 33, 34, 28, 30, 32]

City B: [25, 24, 26, 23, 22, 27, 29, 30, 26, 24]

perform a two-sample t-test to test the equality of means and a test for equality of variances using Python's SciPy library.

4. **case study 3:** testing independence between two categorical variables.

   a. Data: Sample of 100 employees, and each employee is classified as either Male or Female. They were asked to rate their job satisfaction on a scale of 1 to 5, where 1 represents low satisfaction and 5 represents high satisfaction. The data is as follows:

Employee	Gender	Job Satisfaction
1	Male	4
2	Female	3
3	Male	2
4	Female	5
...	...	...
100	Female	4

   b. Test for independence between gender and job satisfaction, use the chi-squared test in R.

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DESIGN AND ANALYSIS OF ALGORITHMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	22DS2402	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39(Th)+26(P) Hours
L–T–P–J	:	3–0–2–0			

Course Learning Objectives:

This Course will enable students to:

1. **Analyze** the non-recursive and recursive algorithms and to represent efficiency of these algorithms in terms of the standard Asymptotic notations.
2. **Acquire** the knowledge of Brute Force and Divide and Conquer techniques to design the algorithms and apply these methods in designing algorithms to solve a given problem.
3. **Master** the Decrease and Conquer, Transform and Conquer algorithm design techniques, and Time versus Space Trade-offs.
4. **Learn** Greedy methods and dynamic programming methods and apply these methods in designing algorithms to solve a given problem.
5. **Understand** the importance of Backtracking and Branch and Bound algorithm design techniques to solve a given problem.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.

6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**08 Hours**
INTRODUCTION: What is an Algorithm? Fundamentals of Algorithmic Problem Solving. ***(Text Book-1: Chapter 1: 1.1 to 1.2)*** **FUNDAMENTALS OF THE ALGORITHMS EFFICIENCY:** Analysis Framework, Asymptotic Notations and Standard notations and common functions ***(Text Book-2: Chapter 3: 3.1, 3.2)***, Mathematical Analysis of Non-recursive and Recursive Algorithms, ***(Text Book-1: Chapter 2: 2.1, 2.3, 2.4,)***	
UNIT – II	**08 Hours**
BRUTE FORCE: Background, Selection Sort, Brute-Force String Matching. TSP ***(Text Book-1: Chapter 3: 3.1, 3.2)*** **DIVIDE AND CONQUER:** General method, Recurrences: The substitution method, The recursion-tree method, The master method. ***(Text Book-2: Chapter 4: 4.4, 4.5***), Merge sort, Quick sort, Binary Search, Multiplication of large integers, **Case study:** Strassen's Matrix Multiplication. ***(Text Book-1: Chapter 4: 4.1 to 4.3, 4.5)***	
UNIT – III	**06 Hours**
DECREASE & CONQUER: General method, Insertion Sort, Graph algorithms: Depth First Search, Breadth First Search, Topological Sorting **TRANSFORM AND CONQUER:** **Case study:** Heaps and Heap sort. **TIME AND SPACE TRADEOFFS:**	

Input Enhancement in String Matching: Horspool's algorithm, Hashing: Open and Closed hashing. ***(Text Book-1: Chapter 5: 5.1 to 5.3, Chapter 6: 6.3 to 6.4, Chapter 7: 7.2 to 7.3)***	
UNIT – IV	**9 Hours**
GREEDY TECHNIQUE: General method of Greedy technique, Single-Source Shortest Paths: General method, The Bellman-Ford algorithm, Single-Source Shortest Paths in DAGs, Dijkstra's Algorithm ***(Text Book-2: Chapter 24: 24.1 to 24.3).*** Minimum Spanning Trees: Prim's Algorithm, Optimal Tree problem: Huffman Trees; **Case study:** Kruskal's Algorithm. Fractional Problem ***(Text Book-1: Chapter 9: 9.1, 9.2, 9.4).*** **DYNAMIC PROGRAMMING:** General method, The Floyd-Warshall Algorithm, Johnson's algorithm for sparse graphs ***(Text Book-2: Chapter 25: 25.1 to 25.3)***, The Knapsack problem ***(Text Book-1: Chapter 8: 8.4).***	
UNIT – V	**08 Hours**
LIMITATIONS OF ALGORITHMIC POWER P, NP and NP-complete problems ***(Text Book-1: Chapter 11: 11.3***) **BACKTRACKING:** General method, N-Queens problem, Subset-sum problem. ***(Text Book-1: Chapter 12: 12.1***) **BRANCH AND BOUND:** General method, Travelling Salesman problem, Approximation algorithms for TSP. **Case study:** Knapsack Problem. ***(Text Book-1: Chapter 12: 12.2, 12.3***)	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Exemplify** the algorithm design techniques and standard Asymptotic notations. Analyze non-recursive and recursive algorithms to obtain worst-case running times of algorithms using asymptotic analysis	L3
2	**Interpret** the brute-force, divide-and-conquer paradigms and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.	L3
3	**Demonstrate** the Decrease and Conquer, Transform and Conquer algorithm design techniques and analyze the performance of these algorithms.	L3
4	**Identify and interpret** the greedy technique, dynamic-programming paradigm as to when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize dynamic-programming algorithms and analyze them	L3
5	**Illustrate** the Backtracking, Branch and Bound algorithm design paradigms and explain when an algorithmic design situation calls for it. Recite algorithms that employ these paradigms. **Summarize** the limitations of algorithmic power.	L3

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3	3										2		3
CO 2	3	3	2									2		3
CO 3	3	3										1		3
CO 4	3	3	2									2		3
CO 5	3	3										1		3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Anany Levitin, "Introduction to the Design & Analysis of Algorithms", 2nd Edition, Pearson Education, 2011.
2. Thomas H. Cormen, Charles E.Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, PHI, 2014.

REFERENCE BOOKS:

1. Horowitz E., Sahni S., Rajasekaran S, "Computer Algorithms", Galgotia Publications, 2001.
2. R.C.T. Lee, S.S. Tseng, R.C. Chang & Y.T.Tsai, "Introduction to the Design and Analysis of Algorithms A Strategic Approach", Tata McGraw Hill, 2005.

E-Resources:

1. https://nptel.ac.in/courses/106/101/106101060/
2. http://cse01-iiith.vlabs.ac.in/
3. http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=IntroToAlgorithms
4. https://www.coursera.org/specializations/algorithms

Activity Based Learning (Suggested Activities in Class)

1. Real world problem solving and puzzles using group discussion. E.g., Fake coin identification, Cabbage puzzle, Konigsberg bridge puzzle etc.,

2. Demonstration of solutions to a problem through programming.

LABORATORY EXPERIMENTS

Total Contact Hours: 26

Following are experiments to be carried out using either C programming language or Object-oriented programming language:

1. Apply divide and conquer method and Design a C program to implementation of Binary Search algorithm.
2. Sort a given set of n integer elements using the Merge Sort method and compute its time complexity. Demonstrate this algorithm using the Divide-and-Conquer method.
3. Sort a given set of n integer elements using Quick Sort method and compute its time complexity. Demonstrate this algorithm using the Divide-and-Conquer method.
4. Incorporate the array data structure and demonstrate whether a given unweighted graph is connected or not using the DFS method.
5. Implement the graph traversal technique using the BFS method to print all the nodes reachable from a given starting node in an unweighted graph.
6. Compute the Transitive Closure for a given directed graph using Warshall's algorithm.
7. For a given weighted graph, construct an All-Pairs Shortest Paths problem using Floyd's algorithm and implement this algorithm to find the shortest distance and their shortest paths for every pair of vertices.
8. Implement 0/1 Knapsack problem using Dynamic Programming Memory Functions technique
9. Find Minimum Cost Spanning Tree for a given weighted graph using Prim's and Kruskal's algorithm.
10. From a given vertex in a weighted connected graph, determine the Single Source Shortest Paths using Dijkstra's algorithm.
11. Mini project proposal should be submitted and Implementation should be done based on the problem stated in the proposal

Open ended experiments

1. Implement Fractional Knapsack problem using Greedy Method.
2. Implement N-Queens problem using Backtracking technique.
3. implementation of Traveling Salesman problem using Dynamic programming

DATABASE MANAGEMENT SYSTEM

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	22DS2403	**Credits**	:	04
Hours / Week	:	03 Hours	**Total Hours**	:	39(Th)+26(P) Hours
L–T–P–J	:	3–0–2–0			

Course Learning Objectives:

This course will enable students to:

1. **Acquire** the concept of databases, Entity-Relationship Model and relational model for creating and designing databases for the real-world scenario.
2. **Develop** queries to extract data from the databases using a structured query language.
3. **Differentiate** SQL and NoSQL.
4. **Demonstrate** the operations on MongoDB, Database connectivity with front end and **Optimize** the Database design using Normalization Concepts.
5. **Understand** the importance of Transaction Management, Concurrency control mechanism and recovery techniques.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods that teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only the traditional lecture method but a different *type of teaching method* that may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note-taking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain the functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher-order Thinking questions in the class.

6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the student's understanding.	
UNIT – I	**10 Hours**
INTRODUCTION TO DATABASE SYSTEMS : Introduction, Characteristics of the Database Approach, Advantages of using DBMS Approach, Data Models, Schemas, Instances and Data Independence, Three Schema Architecture, various components of a DBMS. ***(Text Book-1: Chapter 1: 1.1 to 1.4, 1.6, Chapter 2: 2.1,2.2, 2.4)*** **ENTITY-RELATIONSHIP MODEL:** Entity Types , Entity Sets , Attributes and Keys, Relationship types, Relationship Sets , Roles and Structural Constraints; Weak Entity Types; ER Diagrams ***(Text Book-1: Chapter 7: 7.3, 7.4, 7.5, 7.7)***.	
UNIT – II	**07 Hours**
RELATIONAL MODEL : Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update operations and Dealing with Constraint Violations. ***(Text Book-1: Chapter 3: 3.1 to 3.3).*** **SQL –THE RELATIONAL DATABASE STANDARD:** SQL Data Definition and Data types, Specifying constraints in SQL, Basic Queries in SQL-Data Definition Language in SQL, Data Manipulation Language in SQL; ***(Text Book-1: Chapter 4: 4.1 to 4.4).***	
UNIT – III	**08 Hours**
SQL –THE RELATIONAL DATABASE STANDARD: Additional Features of SQL; Views (Virtual Tables) in SQL; Database Programming Issues and Techniques ; ***(Text Book-1: Chapter 4: 4.5; Chapter 5: 5.1 to 5.4).*** **SQL AND NOSQL DATA MANAGEMENT:** Triggers, Database connectivity using Python, SQL vs NoSQL, Introduction to MongoDB, ***(Text Book-1: Chapter 5: 5.2,5.3***)***(Text Book-2 Chapter 1: 1.1 to 1.5***)	
UNIT – IV	**07 Hours**
NOSQL DATA MANAGEMENT: Data Types, Data Modelling, CRUD Operations. ***(Text Book-2 Chapter 1: 1.1 to 1.5***) **DATABASE DESIGN:**	

Design Guidelines, Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form; ***(Text Book-1: Chapter 14: 14.1 to 14.5)***	
UNIT – V	**07 Hours**
TRANSACTION MANAGEMENT The ACID Properties; Transactions and Schedules; Concurrent Execution of Transactions; Concurrency Control Mechanisms; Error recovery methods. ***(Text Book-1: Chapter 20: 20.1 to 20.5, Chapter 21: 21.1 to 21.3, Chapter 22: 22.1 to 22.4***)	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Use** the basic concepts of database management system in the design and creating database blueprint using E-R model and relational model.	L3
2	**Formulate** SQL and NoSQL queries for building structure and unstructured databases	L3
3	**Demonstrate** database connectivity using vendor specific drivers	L3
4	**Apply** normalization techniques to design relational database management system	L3
5	**Adapt** Transaction Management, concurrency control and recovery management techniques in database management systems.	L3

Table: Mapping Levels of COs to POs / PSOs														
COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	-	-	-	-	-	2	2	-	2	3	-
CO2	3	2	1	-	3	-	-	-	2	2	-	2	3	-
CO3	2	2	2	-	3	-	-	-	2	2	-	2	3	-
CO4	3	1	2	-	1	-	-	-	2	2	-	2	3	-
CO5	2	1	-	-	-	-	-	-	2	2	-	2	3	-

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Elmasri and Navathe, ”Fundamentals of Database Systems“, Seventh Edition, Pearson Education, 2021, 2015.
2. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", First Edition, Pearson Education, Inc. 2012.

REFERENCE BOOKS:

1. Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, Third Edition, McGraw-Hill, 2003.
2. Silberschatz, Korth and Sudharshan: “Database System Concepts”, Seventh Edition, Mc-GrawHill, 2019.
3. C.J. Date, A. Kannan, S. Swamynatham: “An Introduction to Database Systems”, Eight Edition, Pearson Education, 2012.

E-Resources:

1. http://nptel.ac.in/courses/106106093/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-830-database-systems-fall-2010/lecture-notes/
3. http://agce.sets.edu.in/cse/ebook/DBMS%20BY%20RAGHU%20RAMAKRISHNAN.pdf
4. http://iips.icci.edu.iq/images/exam/databases-ramaz.pdf

5. https://db-class.org/
6. https://www.w3schools.com/mongodb/

Activity Based Learning (Suggested Activities in Class)

1. Database designing and data extraction using group discussion.
2. Collaborative Activity is minor project development with a team of 4 students.

LABORATORY EXPERIMENTS

Total Contact Hours: 26

Following are experiments to be carried out using either oracle or mysql, Mongo Db .

1. Design any database with at least 3 entities and establish proper relationships between them. Draw suitable ER/EER diagrams for the system. Apply DCL and DDL commands.
2. Design and implement a database and apply at least 10 Different DML Queries for the following task.
   a. For a given input string display only those records which match the given pattern or a phrase in the search string. Make use of wild characters and like operators for the same. Make use of Boolean and arithmetic operators wherever necessary
3. Write SQL statements to join tables and retrieve the combined information from tables.
4. Execute the Aggregate functions count, sum, avg, min, max on a suitable database. Make use of built in functions according to the need of the database chosen .
5. Retrieve the data from the database based on time and date functions like now(), date(), day(), time() etc., Use of group by and having clauses.
6. Write and execute database triggers. Consider row level and statement level triggers.
7. Write and execute a program to perform operations on MongoDb Database.
8. Write and execute a program to perform CRUD operations.

Open Ended Experiments

1. Consider the Table "employees", write a SQL query to remove all the duplicate emails of employees keeping the unique email with the lowest employee id,return employee id and unique emails .

table: employees

employee_id	employee_name	email_id
101	Liam Alton	li.al@abc.com
102	Josh Day	jo.da@abc.com
103	Sean Mann	se.ma@abc.com
104	Evan Blake	ev.bl@abc.com

105 |Toby Scott ljo.da@abc.com |

2. A salesperson is a person whose job is to sell products or services. Consider the table "Sales" [given below]. Write a SQL query to find the top 10 salespeople that have made the highest sale. Return their names and total sale amount.

Table: sales

TRANSACTION_ID	SALESMAN_ID	SALE_AMOUNT
501	18	5200.00
502	50	5566.00
503	38	8400.00
599	24	16745.00
600	12	14900.00

Table: salesman

SALESMAN_ID	SALESMAN_NAME
11	Jonathan Goodwin
12	Adam Hughes
13	Mark Davenport
59	Cleveland Hart
60	Marion Gregory

WEB TECHNOLOGIES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	22DS2404		**Credits**	:	03
Hours / Week	:	03 Hours		**Total Hours**	:	39 + 26 Hours
L–T–P	:	3–0–2–0				

Prerequisites: ***NIL***

Course Learning Objectives:

This Course will enable students to:

1. **Understand** the fundamentals of front end web technologies using HTML 5 and CSS3
2. **Apply** Cascading Style Sheets and XHTML to the idea of a web application.
3. **Understand** the principles of client-side programming and understand how to use JavaScript to implement them in order to create dynamic web sites.**Usage** of wide variety of testing techniques in an effective and efficient manner
4. **Implement** the principles of server side programming using Node.js, Mongo dB
5. **Apply** the Node.js framework -Express.JS to create web applications faster and smarter

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teachers can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture methods, but different *types of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
3. Show ***Video/Animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**04 Hours**

Mark-up Language (HTML5): Introduction to HTML and HTML5 - Formatting and Fonts -Commenting Code – Anchors – Backgrounds –(Text Book 1, Chapter 1 Images – Hyperlinks – Lists – Tables – HTML Forms, Audio, Video Tag.	
UNIT – II	**04 Hours**
CSS3: Levels of style sheets; Style specification formats; Selector forms; Property value forms; Font properties; List properties; Color; Alignment of text; Background images, Conflict Resolution, CSS Box Model.CSS3 features: Box Shadow, Opacity, Rounded corners, Attribute selector.	
UNIT – III	**06 Hours**
JavaScript: Overview of JavaScript; Object orientation and JavaScript; General syntactic, characteristics; Primitives, operations, and expressions; Screen output and keyboard input. Control statements; Arrays; Functions, Constructors; A brief introduction on pattern matching using regular expressions, DOM Events	
UNIT – IV	**06 Hours**
Node JS: Introduction to NodeJS, Set up Dev Environment, Node JS Modules, Node Package Manager, File System, Events, Database connectivity using Mongo DB. **AngularJS:** Power Features of AngularJS, MVC Architecture: Conceptual Overview, Setting up the Environment, The Anatomy of an AngularJS app, First Application. Number and String Expressions, Object Binding and Expressions, Working with Arrays, Understanding Data binding, Modular Programming, Controllers, Attaching Properties and Functions to Scope, Adding Logic to the Controller, Adding Instance Functions and Properties to Controllers.	
UNIT – V	**06 Hours**
Express.JS Introducing Express: Basics of Express, Express JS Middleware: Serving Static Pages, Listing Directory Contents, Accepting JSON Requests and HTML Form Inputs, Handling Cookies. **React JS** Basics & Features, Setup and Hello World Application, Components and Props, Function and Class Components, Rendering Components, Comment Box in React, Handling Events.	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	Develop proficiency in creating structured web pages using HTML5 elements, formatting, fonts, images, hyperlinks, lists, tables, and forms.	L4
2	Gain a thorough understanding of CSS3 for styling web pages, including selectors, properties, fonts, colors, and the CSS box model.	L3
3	Acquire skills in JavaScript for client-side scripting, including control statements, arrays, functions, regular expressions, and DOM events.	L2
4	Understand the fundamentals of Node.js, Angular.js including module usage, file system operations, event handling, and database connectivity with MongoDB.	L2
5	Gain proficiency in building web applications with React, Express.js, including serving static pages, handling JSON requests, listing directory contents, and managing cookies.	L3

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3		2										2	
CO 2	3		3										2	

CO 3	3	3	1										2	
CO 4	3	3	1										2	
CO 5	3	3	1										2	

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXT BOOKS:

1. Robert W. Sebesta , "Programming the World Wide Web", 7th Edition, Pearson Education, 2008.
2. Basarat Ali Syed," Beginning Node.js ",Apress ,2014

E-BOOKS / ONLINE RESOURCES:

1. https://www.geeksforgeeks.org/html/
2. https://www.geeksforgeeks.org/css/
3. https://www.geeksforgeeks.org/javascript/

Activity Based Learning (Suggested Activities in Class)

1. Frontend Development
2. Database Management
3. Deployment and DevOps

List of Lab Programs **26 Hrs**

1. Programs on basics of HTML
2. Programs on CSS with HTML
3. Programs on NodeJS and AngularJS
4. Programs on ReactJS
5. Mini Project on Frontend Design

COMPUTER ORGANIZATION AND ARCHITECTURE
[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Course Code	:	22DS2405	**Credits**	:	03
Hours / Week	:	03 Hours	**Total Hours**	:	39 Hours
L–T–P-J	:	3–0–0-0			

Course Learning Objectives:

This Course will enable students to:

1. **Understand** the Architecture and programming of ARM microprocessors.
2. **Develop** program using Arm instruction set and appreciate the advanced features provided in the ARM
3. **Understand** the exception handling techniques.
4. **Study in** detail the concept of instruction level parallelism and concepts of pipelining.
5. **Understand** various cache memory mapping techniques and memory Organization.

Teaching-Learning Process

1. ***Lecture method*** along with traditional lecture method, different *types of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *incorporating* brainstorming, discussing, group work, focused listening, formulating questions, note taking, annotating, and roleplaying.
3. Showing ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, asking Higher order Thinking questions in the class in the form of Quiz and writing programs with complex solutions.
6. Showing the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.

UNIT – I	**05 Hours**

An Overview of Computing Systems:
History of Computers, The Computing Device,
The ARM7TDMI Programmers' Model:
Introduction, Data types, Processor Modes, Registers, Program Status Registers, The vector Table.
Assembler Rules and Directives: Structure of Assembly Language Modules, Registers, Directives and Macros.
Loads, Stores and Addressing: LODS and STORES instructions, Operand Addressing , ENDIANNES
Text Book-1: 1.1 to 1.3; 2.1 to 2.6 ; 4; 5.3, 5.4, 5.5

UNIT – II	**05 Hours**

Constants and Literal Pools: The ARM Rotation Scheme, Loading Constants and address into Registers
Logic and Arithmetic: Flags and their Use, Compare instructions, Data Processing Instructions
Loops and Branches: Branching, Looping, Conditional Execution, Straight-Line Coding

Subroutines and Stacks: Stack, Subroutines, Passing parameters to subroutines, The ARM APCS.
(Text Book-1: 6.1 to 6.4; 7.1 to 7.4; 8.2 to 8.6; 10.1 to 10.5

UNIT – III	**05 Hours**

Mixing C and Assembly Language: Inline Assembler Embedded Assembler, Calling Between C and Assembly.

Exception Handling: Interrupts, Error Conditions, Processor Exception Sequence, The Vector Table, Exception Handlers, Exception Priorities, Procedures for Handling Exceptions.
(Text Book-1: 11.1 to 11.8; 14.1 to 14.4

UNIT – IV	**12 Hours**

Pipelining: Basic and Intermediate Concepts Introduction, The Major Hurdle of Pipelining, How Pipelining Implemented, What makes Pipelining hard to Implement, Extending the MIPS Pipeline to Handle Multicycle Operations, The MIPS R4000 Pipeline, Cross Cutting Issues. ***Text Book-2: C.1 to C.7***	
UNIT – V	**12 Hours**
Memory Hierarchy: *Introduction, Cache Performance, Six basic cache Optimizations, Virtual Memory, Protection and examples of Virtual Memory, Fallacies and Pitfalls.* ***Text Book-2: B.1 to B.6***	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Apply** knowledge of the internal architecture and organization of ARM microprocessors to utilize their components and functionalities.	L3
2	**Apply** the instruction set of the ARM Microprocessor by writing Assembly language programs.	L3
3	**Analyze and compare** the various exception handling techniques.	L4
4	**Examine** the concept of instruction-level parallelism and **analyze** the principles of Pipelining techniques.	L4
5	**Compare** and C**ontrast** memory hierarchy and its impact on computer cost/performance.	L4

Table: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	3		2										2	
CO 2	3		3		1								2	
CO 3	3	3	1										2	
CO 4	3	3	1										2	
CO 5	3	3	1										2	

3: Substantial (High) 2: Moderate (Medium) 1: Poor (Low)

TEXT BOOKS:

1. William Hohl, "ARM Assembly Language", 2nd Edition, CRC Press, 2009.
2. John L Hennessy, David A Patterson, "Computer Architecture, A Quantitative Approach", 5th Edition, Morgan Kaufmann publishers, 2012.

REFERENCE BOOKS:

1. David A Patterson, John L Hennessy, "Computer Organization and Design", 4th Edition, Morgan Kaufmann publishers, 2010.
2. Steve Furber, "ARM System-on-chip Architecture", 2nd Edition, Pearson Publications, 2000.
3. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, "Computer Organization", 5th Edition, Tata McGraw Hill, 2002.

E-Resources:

1. https://www.udemy.com/topic/arm-cortex-m/
2. https://www.edx.org/school/armeducation
3. https://onlinecourses.nptel.ac.in/noc22_cs93/preview

Activity Based Learning (Suggested Activities in Class)

1. Mini project implementation using Assembly Language Programming.
2. Demonstration of solutions to a problem through programming.

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LIBERAL STUDIES LIST - B.TECH PROGRAMME – 2022-23 Batch

Sl. No.	Course Code	Course Title	Offering dept
1	22LS0001	Introduction to Drama	Any department
2	22LS0002	Introduction to Dance	
3	22LS0003	Introduction to Music	
4	22LS0004	Introduction to Photography	
5	22LS0005	Introduction to Japanese language	
6	22LS0006	Law for Engineers	
7	22LS0007	Introduction to Painting	
8	22LS0008	Communication Through Sanskrit	
9	22LS0009	Vedic Mathematics	
10	22LS0010	Fundamentals of Critical Thinking	
11	22LS0011	Introduction to Film Studies	
12	22LS0012	Practicing Yoga & Meditation	
13	22LS0013	Cyber Crimes, Policies & Laws	
14	22LS0014	Holistic Medicine	
15	22LS0015	3 D Modelling using Tinkercad	

INTRODUCTION TO DRAMA [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III					
Course Code	:	22LS0001	**Credits**	:	01
Hours /Week	:	01 Hour	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Students will learn about theatre and performing arts and transform simple stories into wonderful scripts.
2. Students will be equipped with key critical thinking skills, performance skills, speaking and writing skills.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I: Introduction to Drama	**03 Hours**

Drama, as an artistic medium, has the power to transcend boundaries and ignite conversations that delve deep into the core of human existence. In the realm of liberal studies, drama serves as a transformative tool, challenging societal norms and exploring various perspectives on critical issues. By harnessing the raw emotions, complex characters, and thought-provoking narratives, drama enriches the study of liberal arts by encouraging active engagement, fostering empathy, and promoting a nuanced understanding of the world we inhabit.

UNIT – II: Embracing Critical Thinking	**03 Hours**

Drama within the framework of liberal studies provides a platform for critical thinking. Through the portrayal of multifaceted characters and intricate storylines, students are exposed to a multitude of viewpoints, forcing them to question their own beliefs and biases. The analysis of themes, subtext, and dramatic techniques encourages students to think

critically about social, political, and moral dilemmas presented in the performances. This process nurtures an intellectual curiosity that transcends the boundaries of the stage and expands into the wider world.	
UNIT – III: Fostering Empathy and Understanding	**03 Hours**
One of the fundamental tenets of liberal studies is to cultivate empathy and understanding. Drama achieves this by allowing students to embody diverse characters and experience life through their perspectives. By engaging in improvisation, role-playing, and character analysis, students gain a deeper understanding of different cultural, historical, and social contexts. This immersive experience fosters empathy by bridging the gap between personal experiences and the experiences of others, cultivating a sense of shared humanity and interconnectedness.	
UNIT – IV: Social Commentary and Advocacy	**02 Hours**
Drama within liberal studies serves as a vehicle for social commentary and advocacy. By exploring social issues such as discrimination, inequality, and justice, drama becomes a powerful tool for initiating conversations and inspiring action. Through the examination of theatrical texts and the creation of original performances, students develop the skills to articulate their perspectives and communicate their ideas effectively. This process empowers them to become advocates for change and contribute to a more inclusive and just society.	
UNIT – V: Collaboration and Communication Skills	**02 Hours**
Drama requires collaborative efforts and effective communication among actors, directors, designers, and technicians. In the context of liberal studies, drama serves as a microcosm of the real world, where teamwork and effective communication are essential. Students learn to listen actively, express their ideas clearly, and negotiate differing opinions to achieve a common goal. These skills are transferable to various aspects of life, empowering students to become effective collaborators, leaders, and active participants in their communities.	

Course Outcome	Description
At the end of the course the student will be able to:	
1	**Understand** the elements of drama performance.
2	**Analyse** the structure, form, and conceptual ideas of drama techniques.
3	**Express** drama as a means of creating and communicating meaning.

TEXT BOOKS:

1. Sohini Roychowdhury, Indian Stage Stories Connecting Civilizations (A Telling of the Story of Indian Stage and how it connects to the World), SHUBHI PUBLICATIONS, GURGAON 2023.

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INTRODUCTION TO DANCE [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III					
Course Code	:	22LS0002	**Credits**	:	01
Hours/Week	:	01 Hour	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. To understand the elements of dance performance.
2. To interpret the elements of dance movement music, and conceptual ideas that together compose dance performances.
3. To analyse the structure, form, and conceptual ideas of dance techniques.
4. To understand and perform the basic Modern Dance concepts.
5. To gain knowledge in Classic/Semi Classic/Western Dance and various dance forms.
6. To Understand intermediate level dance technique.
7. To gain a critical understanding of dance as a form of human cultural expression.
8. To express dance as a means of creating and communicating meaning.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
2. Show ***Video/animation*** films to explain functioning of various concepts.
3. Encourage ***Collaborative*** (Group Learning) Learning in the class.

UNIT – I: Introduction to Dance & Elements of dance performance.	**02 Hours**
UNIT – II: Composing dance	**02 Hours**
UNIT – III: Dance Techniques with dance movement music & understanding the modern dance	**03 Hours**
UNIT – IV: Dance Formation & Knowledge on Classic/Semi Classic/Western Dance and various dance forms.	**03 Hours**
UNIT – V: Choreographic Principles & Understanding dance as the important skill of creating and communicating meaning	**03 Hours**

Course Outcome	Description
At the end of the course the student will be able to:	
1	An introduction to the history and cultural context of different dance styles, helping students appreciate the cultural significance of dance forms.
2	Develop a fundamental understanding of dance techniques, including posture, alignment, balance, and coordination.
3	Increased self-confidence and self-esteem through the mastery of dance movements and the ability to perform in front of others.

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INTRODUCTION TO MUSIC [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III					
Course Code	:	22LS0003	**Credits**	:	01
Hours/Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P-J	:	1–0–0-0			

Course Learning Objectives:

This Course will enable students to:

1. To understand the basic terminologies of Music
2. Appreciate the importance of Music in Engineers Life.
3. Apply Music knowledge in carrying out projects related to signal processing.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.

Module-1: Basic Terminologies of Music	**07 Hours**
Define Music, Types of Music, Types Musical Instruments, Music Terminologies: Raag, Taal, Shruthi, Swara, Vaadi Swara, Samvaadi Swara, Varjitha Swara, Shudha/Komala/ Teevra Swara, Aaroha, Avaroha, Pakkad, Lakshana Geethe, Swara Geethe, Chota Khyal.	
Module-2: Raag	**05 Hours**
Raag Bhoop: Introduction to raag bhoop, Swara geethe, Chotha Khyal Raag Saranga: Introduction to Raag Saranga, Swarageethe. Lakshanageethe	
Module-3: Taal	**01 Hours**
Introduction to Taal: Teental and Ektal with details	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Classify types of Music
2	Rephrase the Terminologies of Music
3	Take part in performances in Music by involving in Singing, Helping Singers, organizing the event.

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INTRODUCTION TO PHOTOGRAPHY
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Course Code	:	22LS0004	**Credits**	:	01
Hours /Week	:	01 Hour	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Understanding Camera Basics: Teach students the fundamental components of a camera, including its settings, modes, and functions, helping them become comfortable with their equipment.
2. Mastering Technical Skills: Provide comprehensive knowledge about exposure (aperture, shutter speed, ISO), focus, white balance, and other technical aspects to ensure students can control the outcome of their photographs effectively.
3. Lighting Mastery: Cover the principles of natural and artificial lighting, including how to manipulate and control light for different effects, moods, and subjects.
4. Visual Storytelling: Train students to use photography as a means of storytelling by capturing a series of images that convey a narrative, emotion, or theme.
5. Genre Exploration: Introduce students to various photography genres such as portrait, landscape, macro, street, wildlife, and more, allowing them to discover their interests and strengths.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I	**07 Hours**
Basics of photography and its scope relating to their career opportunities.	
UNIT – II	**06 Hours**
A detailed introduction about camera, lens, types of photography, essentiality of natural light.	

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

1	Demonstrate a solid understanding of camera settings, exposure (aperture, shutter speed, ISO), focus, and other technical aspects of photography.
2	Ability to work with different lighting conditions and manipulate light effectively to achieve desired effects.
3	Demonstrate competence in a specific photography genre (portrait, landscape, macro, etc.).

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INTRODUCTION TO THE JAPANESE LANGUAGE [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III					
Course Code	:	22LS0005	**Credits**	:	01
Hours /Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:
1. To learn the hiragana and katakana writing systems.
2. To learn and understand the culture of Japanese society.
3. To understand simple sentences and basic Japanese grammar.
4. To acquire the ability to communicate in Japanese.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.
1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.

UNIT – I: Basics of the Japanese language	**13 Hours**

Hiragana/Katakana: Reading and writing hiragana and katakana.
Kanji Characters: understanding the idea of a pictogram (as opposed to a phonogram), reading and writing the kun- and on- readings of some commonly used kanji: Days of the week characters, numbers and a few others.
Verbs, particles and sentence structure: Sentence structure, particles, combining multiple particles, question and answer form, polite vs standard form.
Vocabulary:
Asking for directions, making purchases at shops, asking for something to be done and other phrases useful during travel to Japan as well as other basic phrases.
Basics of Japanese culture:
1. Basics of Japanese standards for politeness and societal norms.
2. Formal introductions, awareness of different social situations and the norms followed in such situations, formalities such as exchanging business cards and senpai-kouhai relationships.
3. Formal, polite form of self-introduction, common greetings and responses.

Course Outcome	Description
At the end of the course the student will be able to:	
1	**Demonstrate** a basic understanding of the Japanese language.
2	**Demonstrate** an understanding of basic Japanese cultural norms.
3	**Apply** the Japanese language in simple, polite tongue.
4	**Demonstrate** the ability to read Hiragana and Katakana characters, as well as a few Kanji characters.

TEXT BOOKS:

1. Japanese for busy people - I, revised 3rd edition, The Association for Japanese-Language Teaching (AJALT), Kodansha USA, 2020.

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LAW FOR ENGINEERS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Course Code	:	22LS0006	**Credits**	:	01
Hours /Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. The aim of the course is providing general exposure to the students about the elementary knowledge of law that would be of utility in their profession; to enable the students to appreciate the importance of law and its impact on business and society.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

Module I: Introduction to Law	**02 Hours**
Define Law, Need for law, objects & Branches of law, Constitutional Law with emphasis on Fundamental Rights, Directive Principles of State Policy and Fundamental Duties	
Module II: General Principles of Contract under Indian Contract Act, 1872	**03 Hours**
Indian Contract Act 1872, Essentials of valid contract act (Sec 10), Kinds of contracts ; types of offer, acceptance, free consent, coercion, undue influence, Breach of contract, remedies of breach of contract.	
Module III: Law Relating to Intellectual Property	**04 Hours**
Concept of Property, Types of Property; Introduction to IPR; Types of IPR: Copyrights, Patents, Trademarks, Designs, Trade Secrets, Infringement of IPRs.	
Module IV: Privacy in Governance and Transparency Confidentiality in Government	**04 Hours**
Right to Information Act, 2005, Offences and penalties under the Information Technology Act 2000, Industrial Disputes Act, 1947; The Employees' State insurance act, 1948, Payment of Wages Act, 1936.	

Course Outcome	Description
At the end of the course the student will be able to:	
1	To present a problem oriented in depth knowledge of Laws for Engineers.
2	To address the underlying concepts and methods behind Laws for Engineers.
3	Understand the Indian Legal System and Basics of different laws
4	Understand, explore, and acquire practical insight of legal system and its application in engineering profession

TEXT BOOKS:

1. M.P. Jain (2005), Indian Constitutional Law, Wadhwa & Co.
2. Agarwal H.O. (2008), International Law and Human Rights, Central Law Publications.
3. S.K. Kapur (2001), Human Rights under International Law and Indian Law, Central Law Agency.
4. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing.

REFERENCE BOOKS:

1. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House
2. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
3. K.M. Desai (1946), The Industrial Employment (Standing Orders) Act
4. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House

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INTRODUCTION TO PAINTING [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Course Code	: 22LS0007	**Credits**	: 01
Hours /Week	: 01 Hour	**Total Hours**	: 13 Hours
L–T–P–J	: 1–0–0–0		

Course Learning Objectives:

This Course will enable students to:

1. Introduction to canvas.
2. Acrylica colour and water colour.
3. Opaque colour and transparent colour.
4. Painting on canvas.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
2. Show ***Video/animation*** films to explain functioning of various concepts.
3. Encourage ***Collaborative*** (Group Learning) Learning in the class.

UNIT – I:	**07 Hours**
Introduction to canvas, Study water, Transparent –painting method, Wet paper spreading method, Basic study about "Opaque Colour" painting, Painting on canvas, Simple landscape painting, Indian traditional painting using opaque colours.	

UNIT – II:	**06 Hours**
Study of difference between opaque colour and transparent painting, use different materials on canvas like Sponge, Hard brush, Plastic etc.., Creative art on canvas, Study of Acrylic paint, Indian –Tribe art (Warli art), Semimodern painting on canvas.	

Course Outcome	**Description**
At the end of the course the student will be able to:	
1	Canvas introduction, study of water colour, wet paper spreading, Painting on canvas, simple landscape painting.
2	Difference between transparent colour and opaque colour, Indian tribe art, semimodern painting, use of different method and Materials on canvas.

Importance of Painting and Benefits of learning:

1. Increases creativity.
2. Helps reduce stress.
3. Subtly impact on subconscious mind and helps to get clarity.
4. Activate right brain.
5. Improves communication and management skills.

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COMMUNICATION THROUGH SANSKRIT
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Course Code	:	22LS0008	**Credits**	:	01
Hours /Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. To understand the basics of a new language like Sanskrit
2. To understand the basic characters, words, sentences etc
3. To understand the grammar to some extent with terminologies like shabda, vachana, vibhakti etc
4. To understand the process of formation of simple sentences.
5. To translate from English to Sanskrit and vice-versa for better communication
6. To practice speaking in Sanskrit.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.

UNIT 1: Introduction to Sanskrit language	**03 Hours**
Introduction to Sanskrit, characters, formation of words, learning numbers, 'a' karanta, 'aa' karanta, 'i' karanta, 'ee' karanta and 'u' karanta, pullinga (masculine) and streelinga (feminine) words.	

UNIT 2: Various shabdaha	**03 Hours**
Running different anta shabdaha for eight vibhaktis and three vachanas.	

UNIT 3: Basic lessons from Text book	**03 Hours**
Basic words, formation of sentences, translation to English from Sanskrit and vice versa. The sentence formation with vibhakti and vachana. Exercises and activities.	

UNIT 4: Simple sentence formation	**02 Hours**
Formation of sentences in Sanskrit, Strike conversation with friends, parents, seniors, bus conductor, auto river, vegetable vendor etc.	

UNIT 5: Practice communication in Sanskrit	**02 Hours**
Initiation of communication in Sanskrit, translation between languages.	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Know** a new language	
2	**Understands** the characters, words and sentences	
3	**Learns** grammatical / syntax rules and regulations	
4	Gets information on shabda, vachana, vibhakti etc	
5	Communicate in Sanskrit	

TEXT BOOKS:

1. "Sanskrit Bharati" – 'Sanskritam Vadatu', Gandhi Vidya Sansthanam, Rajghat, Varanasi
2. Infant Reader, "Sanskrita Baladarshaha" Published by R S Vidyadhar & Sons, Book sellers and Publishers, Kalpathi, Palakkad -678003**.**

REFERENCE BOOKS:

1. Sabda Manjari, **Published by R S Vidyadhar & Sons, Book sellers and Publishers, Kalpathi, Palakkad -678003.**

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VEDIC MATHEMATICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III					
Course Code	:	22LS0009	**Credits**	:	01
Hours /Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. **Remembering (Knowledge)**: identify key numerical patterns and properties in Vedic Mathematics.
2. **Understanding (Comprehension)**: interpret the relationship between conventional arithmetic and Vedic methods.
3. **Applying (Application):** Utilize Vedic techniques to perform rapid mental calculations for addition, subtraction, multiplication, and division and apply Vedic methods to solve real-life mathematical problems and puzzles.
4. **Analyzing (Analysis):** Analyse the advantages and limitations of Vedic Mathematics in comparison to traditional methods, differentiate between various Vedic sutras and their specific applications.
5. **Creating (Synthesis)**: Design innovative approaches by combining multiple Vedic sutras to solve complex mathematical problems.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.

UNIT 1: Basic Operations of Mathematics	**07 Hours**
Basic addition and subtraction, Addition of 1, 11, 111, 1111,11111,…….., Addition of 0.1, 0.11, 0.111, 0.1111, 0.11111,………., Multiplication of two numbers near the base & sub-base, Multiplication of two numbers whose sum of digits in unit place is 10 and sum of the digits in ten's place is 10, Multiplication of a number by 9,99,999,9999,99999,999999………., Division of a number by 9,99,999,9999,99999,999999, Multiplication of two numbers by vertically and crosswise method.	

UNIT 2: Square & Cube of a Number	**06 Hours**
Square of a number ending with '5', Square of 1, 11, 111, 1111, ……..,Square of a number near the base, Square of a number near sub-base, Cube of a number, Square root of a perfect square…….., Cube root of a perfect cubic number.	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Develop enhanced mental calculation abilities. They will learn techniques to perform calculations like addition, subtraction, multiplication, and division mentally and quickly.
2	Understanding of Ancient Mathematical Concepts: Provides insight into the mathematical knowledge and practices of ancient India.
3	Stimulate mental agility and improve cognitive skills, as participants engage in exercises that require mental gymnastics.

TEXT BOOKS:

1. "Vedic Mathematics" by Bharati Krishna Tirthaji, Motilal Banarsidass Publishers, ISBN: 978-8120801646.

REFERENCE BOOKS:

1. Magical World of Mathematics, V G Unkalkar, Vandana Publishers, 2017, ISBN:819026608.
2. The Teaching of Vedic Mathematics- Dr. S. K. Kapur, Lotus Press, 2016, ISBN: 9788183820431.
3. Vedic Mathematics Made Easy" by Dhaval Bathia, ISBN: 978-8129116116.

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FUNDAMENTALS OF CRITICAL THINKING
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Course Code	:	22LS0010	**Credits**	:	01
Hours /Week	:	01 Hour	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. To enable framework to think critically about core subjects for better decisions with fewer mistakes.
2. To motivate and inculcate transformational learning in an ongoing basis towards inclination to shift their thinking of project work in a research framework with effective team work.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I: Etymology and Definitions, Needs, enablement of knowledge and methods	**03 Hours**
UNIT – II: Common denominators	**02 Hours**
UNIT – III: Tests and values	**02 Hours**
UNIT – IV: Process of identifying key findings from research survey in problem solving	**02 Hours**
UNIT – V: Problem-solving approaches	**02 Hours**
UNIT – VI: Case study – Scenario Presentations in Jigsaw learning method	**02 Hours**

Course Outcome	Description
At the end of the course the student will be able to:	
1	Recognize relevant definitions of knowledge and methods to articulation of ideas and identify diverting Arguments.
2	To develop a systematic approach for to enable quality of thinking and what they design and produce in articulating assumptions, selecting appropriate hypothesis and methods of experiments through critical thinking dispositions

REFERENCE BOOKS:

1. ID2_W Baytiyeh, H. and M.K. Naja. 2017. "Students' Perceptions of the Flipped Classroom Model in an Engineering Course: A Case Study." *European Journal of Engineering Education* 42 (6): 1048-1061. doi: 10.1080/03043797.2016.1252905.
2. ID9 Chang, P. and D. Wang. 2011. "Cultivating Engineering Ethics and Critical Thinking: A Systematic and Cross-Cultural Education Approach Using Problem-Based Learning". *European Journal of Engineering Education* 36 (4): 370–390. doi: 10.1080/03043797.2011.596928
3. Godfrey, P., R. Deakin Crick and S. Huang. 2014. "Systems Thinking, Systems Design and Learning Power in Engineering Education." *International Journal of Engineering Education* 30 (1): 112–127.
4. *Conducting Research Literature Reviews: From the Internet to Paper: Arlene Fink - UCLA, Los Angeles, USA: 5th edition:*

INTRODUCTION TO FILM STUDIES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Course Code	:	22LS0011	**Credits**	:	01
Hours /Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P-J	:	1–0–0-0			

Course Learning Objectives:

This Course will enable students to:

1. **Acquire** fundamental knowledge of the principles of critical analysis of film as a text (With the overview of Indian cinema after Independence)
2. **Develop** analytical and interpretative minds, and transform them into spoken and written modes of expression i.e., Debates, group discussions, writing, reviews, and scripts
3. **Apply** the writing strategies for writing film reviews.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.

Module – I	**07 Hours**

History and Scope of Indian Cinema- the Beginnings (1896-1912)- The Silent Era (1913-1930), Growth of the Industry (1931-1947)-Post-Independence- Indian Cinema-Film aesthetics: Realism, Authorship, Language of the Film (Film, Language & Montage), Narrative Comprehension – Representations and Debates -Film and other arts- Career Prospects in Indian Cinema.

Module – II	**06 Hours**

Basic Frame- Shot-Scene-Sequence-Visual Grammar- Pioneers of film, Silent to audio era- The language of Cinema-Camera- Cinematography – Important functions and terms of Cinematography. –Science and Art of Lighting- Different Lightings-Cinematographic tools-Editing- What is a script? – Thinking process- Theatre Directions- Creating and Developing a script- Adapting a script- Character spin-off- Creating a sequel- Characterization- Qualities of a scriptwriter- Themes and social Obligations- Hands-on Experience.

Course Outcome	Description
At the end of the course the student will be able to:	
1	**Acquire** fundamental knowledge of the principles of critical analysis of film as a text (With the overview of Indian cinema after Independence)
2	**Develop** analytical and interpretative minds, and translate them into spoken and written modes of expression i.e. Debates, group discussions, writing, reviews, and scripts
3	**Develop** communicative competence – Competence in speaking and writing from different domains and **applying** an interdisciplinary approach in perception and expression.

TEXT BOOKS:

1. Saran, Renu. "History of Indian Cinema". Diamond Books, 2012. Print.
2. Valicha, Kishore. "The Moving Image: A study of Indian Cinema". Orient Longman Limited, 1988. Print.
3. Vasudevan, Ravi. "The Melodramatic Public: Film form and Spectatorship in Indian Cinema". Orient Black Swan, 2012. Print.
4. Jain, Manju. "Narratives of Indian cinema". Primus Books, 2009. Print.

REFERENCE BOOKS:

1. Dwyer, Rachel. "Cinema India: The Visual Culture of Hindi film". Rutgers University Press, 2002. Print.
2. Corrigan, Timothy. "A Short Guide to Writing About Film". 9th Edition, Pearson Global Edition. Print.
3. Joseph M. Boggs and Dennis W. Petrie. "The Art of Watching Films". Boston: McGraw-Hill, 2008. Print.
4. Richard, Barsam. "Looking at movies: An introduction to film". New York: W.W. Norton & Co., 2007. Print.
5. James, Monaco. "How to read a film: Movies, Media and Multimedia: Language, History, Theory". New York: Oxford University Press, 2000. Print.

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YOGA AND MEDITATION
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Course Code	:	22LS0012	**Credits**	:	01
Hours/Week	:	01 Hour	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Promoting positive health and holistic wellness.
2. Imparting skills to introduce Yoga awareness for health among general public.
3. To enable students to become competent and committed professionals willing to perform as Yoga performer.
4. To make student to use competencies and skills needed for becoming effective Yoga individual.
5. To enable student to understand the type of Yoga.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I: Introduction to Yoga and Yogic Practices	**02 Hours**

Yoga: Etymology, definitions, aim, objectives and misconceptions, Yoga: Its Origin, history and development, Rules and regulations to be followed by Yoga Practitioners, Introduction to major schools of Yoga (Jnana, Bhakti, Karma, Patanjali, Hatha), Introduction to Yoga practices, Introduction to Surya Namaskar.

UNIT – II: Foundation of Yoga and Meditation	**02 Hours**

Yoga, Diet and Nutrition
Practical – I (Yogasana and Meditation I
Practical II (Shatkarma, Pranayam and Meditation II)

UNIT – III: Types & techniques of Meditation II	**02 Hours**

Meditation

- Meditation- Introduction, definition
- Concentration and meditation
- OM Meditation

Types of Meditation

- Tantra: Yantra and Mantra for meditation

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- Japa (chanting) meditation
- AjapaJapa Meditation
- Shoonya Meditation
- Yoga Nidra

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<tr><td>UNIT – IV: Relationship between Meditation & Yoga (Mental Health Aspects)</td><td>02 Hours</td></tr>
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Yoga and Mental Health

- Define mental health, Holistic health, Medical & Yogic perspective

Mental Hygiene

- Mental Hygiene and roll of yoga in mental hygiene
- Relationship between mind and body

Meditation – Yoga

- Swara yoga – the balance of life
- The mind and personality

Yoga & Stress Management

- Human Psyche: Yogic and modern concept, Behaviour and consciousness frustration, Conflicts.
- Concept of stress according to modern science and yoga
- Stress and Personality
- Role of yoga in life management

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<tr><td>UNIT – V: Yogasana, Pranayam and Meditation Practical’s</td><td>3+2 Hours</td></tr>
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Yogasanas

- **Standing Asana:** Tadasana, Trikonasana, Urdhahastotanasana, Vrikshasana, Ardhchakrasna, Padhastanasana, Ashwasthasana.
- **SittingAsana:** Padmasana, Vakrasana, Ardhamatsyendrasana, Janusirsasana, Paschimottanasana, Vajrasana, Ushtrasana, Shasankasana, Gomukhasana ,Mandukasana, Bhadrasana, Singhasana.
- **Prone Lying Asana:** Bhujangasana, Shalabhasana, Dhanurasana, Makarasana
- **Supine Lying Asana:** Pawanmuktasana and its variation, setubandhasana, sarvangasana, Ardhahalasana, Uttanpadasana, Halasana, Naukasana , Cakrasana , Markatasana, Shavasana.

Surya Namaskar

- Surya Namaskara.

Pranayama

- Breath Awareness.
- Yogic Breathing.
- Nadishodhan Pranayama.
- Suryabhedi.
- Ujjayi.
- Shitali.
- Sitkari.
- Bhastrika.
- Bhramari.

Bandha and Mudra

- JalandharaBandha, UddiyanaBandha, MulaBandha, Tri Bandha.
- Yoga Mudra, Shanmukhi Mudra, shambhavi mudra, VipareetKarni Mudra.

Course Outcome	Description
At the end of the course the student will be able to:	
1	Development of relaxation techniques.
2	Improved concentration and cognitive function.
3	Promotion of overall health and well-being.

Text Book and Reference Book:

1. Concentration and Meditation by swami SivanandaSaraswati
2. Yoga and Kriya by Swami SatyanandaSaraswati
3. Yoga &Mental Health by R. S. Bhogal
4. Yoga & Modern Psychology by KaivalyadhamAsharam
5. Yoga for Stress Management by Sri Venkatkrishnan
6. Yoga for Stress Relief by Swami Shivapramananda
7. Yoga Nidra by Swami StyanandaSaraswati
8. Certification of Yoga Professionals – Official Guid book

CYBER CRIME, POLICIES, LAWS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Course Code	:	22LS0013	**Credits**	:	01
Hours /Week	:	01 Hour	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. Understand Cybercrime Fundamentals.
2. Explore Cybercrime Investigation Techniques.
3. Discuss Cybersecurity Incident Response.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
6. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
7. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I: Introduction to Cyber Security	**02 Hours**
Basic Cyber Security fundamentals, Types of Cyber Attacks, The 7 layers of Cyber Security, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, types of active attacks, passive Attacks, Software attacks, hardware attacks, Cyber Threats-, Cyber Crime, Cyber terrorism, Cyber Espionage.	
UNIT – II: Cyberspace and the Law & Cyber Forensics	**04 Hours**
Introduction, Cyber Security Regulations, Roles of International Law, Cyber forensics, Digital forensics lifecycle: Types of forensics investigation, challenges in computer forensics.	
UNIT – III: Cybercrime: Mobile and Wireless Devices	**03 Hours**
Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era.	

UNIT – IV: Cyber Security: Organizational Implications	04 Hours
Drama within liberal studies serves as a vehicle for social commentary and advocacy. By exploring social issues such as discrimination, inequality, and justice, drama becomes a powerful tool for initiating conversations and inspiring action. Through the examination of theatrical texts and the creation of original performances, students develop the skills to articulate their perspectives and communicate their ideas effectively. This process empowers them to become advocates for change and contribute to a more inclusive and just society.	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Analyse cyber-attacks, types of cybercrimes, cyber laws and also how to protect them self and ultimately the entire Internet community from such attacks.
2	Interpret and forensically investigate security incidents.
3	Apply policies and procedures to manage Privacy issues.

TEXT BOOKS:

1. Nina Godbole and SunitBelpure, Cyber Security Understanding Cyber Crimes,Computer Forensics and Legal Perspectives, Wiley
2. B.B.Gupta,D.P. Agrawal, Haoxiang Wang, Computer and CyberSecurity: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335,2018.

REFERENCE BOOKS:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&FGroup.

Holistic Medicine [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – III**					
Course Code	:	22LS0014	**Credits**	:	01
Hours /Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

Course Learning Objectives:

This Course will enable students to:

1. To develop an understanding of the principles and philosophies that underpin holistic medicine.
2. To develop an understanding about the theories behind these therapies and their potential benefits and risks.
3. Explore the role of nutrition, exercise, sleep, stress management, and other lifestyle factors in promoting health and preventing illness.
4. Promote an understanding of how cultural and social factors can influence health beliefs and practices.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

1. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
2. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
3. Show ***Video/animation*** films to explain functioning of various concepts.
4. Encourage ***Collaborative*** (Group Learning) Learning in the class.
5. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.

UNIT 1: Understanding our immune system, importance of nutrients and minerals	**03 Hours**
Understanding Immunity, types of immunity, keys organs involved in immune system, key cells of immune system, about vitamin and nutrients, essential nutrients required for our body, natural ways to boost immunity.	
UNIT 2: Detoxification and Gut Health	**03 Hours**
About detoxification and its importance, colon cleansing, about good bacteria and bad bacteria, why gut health is important, how gut health is related to many diseases, how to improve gut health.	
UNIT 3: Power of fasting	**03 Hours**
About fasting, types of fasting, benefits of fasting, power of forgiveness and meditation.	
UNIT 4: Health starts from your kitchen	**02 Hours**

About home remedies, food as medicine, healthy food and drinks, life style changes, why exercise is important?	
UNIT 5: Acupressure	**02 Hours**
About acupressure, various pressure points of body, benefits and uses of acupressure.	

Course Outcome	Description
At the end of the course the student will be able to:	
1	Describe the collective factors of health and their impact on holistic health and wellness.
2	Understand existing research to examine the use and effectiveness of holistic health practices.
3	Apply health and wellness practices to enhance one's own personal well-being.

TEXT BOOK:

1. Back to the Roots: Celebrating Indian Wisdom and Wellness by Luke Coutinho.
2. Eat Smart Move More Sleep Right Paperback – 1 January 2011 by Luke Coutinho
3. Nimma Kaigalalli Arogya - Vol 1 & Vol2 by Devendra Vora.

REFERENCES:

1. https://www.youtube.com/c/LukeCoutinho

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3 D MODELLING USING TINKERCAD [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III					
Course Code	:	22LS0015	**Credits**	:	01
Hours / Week	:	01 Hours	**Total Hours**	:	13 Hours
L–T–P–J	:	1–0–0–0			

<u>Course Objectives:</u>

This Course will enable students to:

7. To **understand** the basic concepts and functions of 3D view.
8. To **understand** the modelling of 3 D objects
9. To **analyze** modelling of designs and animation.

Teaching-Learning Process (General Instructions)

These are sample new pedagogical methods, where teacher can use to accelerate the attainment of the various course outcomes.

6. ***Lecture method*** means it includes not only traditional lecture method, but different *type of teaching methods* may be adopted to develop the course outcomes.
7. ***Interactive Teaching:*** *Adopt the* ***Active learning*** that includes brainstorming, discussing, group work, focused listening, formulating questions, notetaking, annotating, and roleplaying.
8. Show ***Video/animation*** films to explain functioning of various concepts.
9. Encourage ***Collaborative*** (Group Learning) Learning in the class.
10. To make ***Critical thinking***, ask at least three Higher order Thinking questions in the class.
11. Adopt ***Problem Based Learning***, which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
12. Show the ***different ways to solve*** the same problem and encourage the students to come up with their own creative ways to solve them.
13. Discuss how every ***concept can be applied to the real world*** - and when that's possible, it helps improve the students' understanding.

UNIT – I: Introduction of 3D modelling & Design, TinkerCAD Basics	**02 Hours**
Read the Class Introduction Presentation, Create a TinkerCAD Account, "Place It" "View It" "Move It" "Rotate It" "Size It Up" "Group It" "Align It"	
UNIT – II: Review and More Basics, First Projects	**02 Hours**
"Learning the Moves" "Camera Controls" "Scale, Copy, and Paste" "Creating Holes" Tutorial, Read Assignment Descriptions and Rubric, Key Ring Project, Dice Project, Dice from Scratch Project	

UNIT – III: Hands on Project & Designs on case study	03 Hours
# case study project on designing a living room, setting up of virtual classroom & building a fort structure	
UNIT – IV: Creating Portfolio in TinkerCad	**03 Hours**
Project, Read Portfolio Information Presentation, Complete Portfolio	
UNIT – V: Intrdocution to Arduino & mini Circuots using Circuit design TinkerCad	**03 Hours**
Android Circuit design using tinker cad, Introduction to circuit designing, Android Song Teller – Project, Android smart notice board	

Course Outcome	Description	Bloom's Taxonomy Level
At the end of the course the student will be able to:		
1	**Understand** the basics of 3 D design.	L2
2	**Designing and drafting** in Tinkercad software.	L2
3	**Acquire** the knowledge & study about various additive manufacturing techniques (3D File setup).	L2
4	**Understand** about design technology and innovation.	L3
5	**Design** some basics Arduino circuits.	L3

Table: Mapping Levels of COs to POs / PSOs														
COs	**Program Outcomes (POs)**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	2	2	1					1					
CO2	3	2	2						1					
CO3	3	2	2	1					1					
CO4	3	2	2	1					1					
CO5	3	2	2	1					1					

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

Text Book:

1. 3D Printing with Autodesk 123D, Tinkercad, and MakerBot, 1st Edition, 0071833471 · 9780071833479, By Lydia Sloan Cline © 2015 | Published: November 6, 2014

Reference Book:

1. The 2020-2025 World Outlook for 3D Mapping and 3D Modeling, Philip M. Parker Ph.D

2. Blender 3D By Example A project-based guide to learning the latest Blender 3D, EEVEE rendering engine, and Grease Pencil, 2nd Edition Oscar Baechler, Xury Greer-2020

E-Resources:

1. **www.tinkercad .com**

DAYANANDA SAGAR UNIVERSITY

SCHOOL OF ENGINEERING

SCHEME & SYLLABUS
FOR
BACHELOR OF TECHNOLOGY (B.Tech.) – 2020

COMPUTER SCIENCE & ENGINEERING

(DATA SCIENCE)

(CSE – DS)

(WITH EFFECT FROM 2020-21)

SCHEME - B.TECH – 2020-21 ONWARDS

III SEM - COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	122	20CS2301	DISCRETE MATHEMATICAL STRUCTURES	CR	3	-	-	-	3	*	***
2	122	20CS2302	DATA STRUCTURES	CR	3	-	-	-	3	I/II	20EN1103
3	122	20CS2303	DIGITAL ELECTRONICS & LOGIC DESIGN	CR	3	-	-	2	4	*	***
4	122	20CS2304	DATABASE MANAGEMENT SYSTEMS	CR	3	-	-	-	3	*	***
5	122	20CS2305	COMPUTATIONAL THINKING WITH PYTHON	CR	3	-	-	-	3	*	***
6	122	20CS2306	AGILE SOFTWARE ENGINEERING	CR	2	-	-	2	3	*	***
7	122	20CS2307	DATA STRUCTURES LAB	CR	-	-	2	-	1	*	***
8	122	20CS2308	DATABASE MANAGEMENT SYSTEMS LAB	CR	-	-	2	-	1	*	***
9	122	20CS2309	MANAGEMENT AND ENTREPRENEURSHIP	CR	2	-	-	-	2	*	***
10	122	20CS2310	LIBERAL STUDIES – I	CR	1	-	-	-	1	*	***
					20	**-**	**04**	**04**	**24**		

CR – CREDIT, AU – AUDIT, L – LECTURE, T – TUTORIAL, P – PRACTICAL, S/P – SEMINAR/PROJECT, C – NO. OF CREDITS

SCHEME - B.TECH – 2020-21 ONWARDS

IV SEM - COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/P	C	SEM	COURSE CODE
1	122	20CS2401	PROBABILITY AND STATISTICS	CR	3	-	-	-	3	*	***
2	122	20CS2402	OBJECT ORIENTED DESIGN AND PROGRAMMING	CR	3	-	-	-	3	*	***
3	122	20CS2403	PRINCIPLES OF MICROPROCESSORS AND COMPUTER ORGANIZATION	CR	4	-	-	-	4	*	***
4	122	20CS2404	FINITE AUTOMATA & FORMAL LANGUAGES	CR	3	-	-	2	4	*	***
5	122	20CS2405	INTRODUCTION TO NETWORKS & CYBERSECURITY	CR	3	-	-	-	3	*	***
6	122	20DS2401	DATA SCIENCE – I	CR	3	-	-	-	3	*	***
7	122	20CS2407	OBJECT ORIENTED PROGRAMMING LAB	CR	-	-	2	-	1	*	***
8	122	20CS2408	MICROPROCESSORS LABORATORY	CR	-	-	2	-	1	*	***
9	122	20CS2409	SPECIAL TOPICS - I	CR	-	-	-	4	2	*	***
10	122	20CS2410	LIBERAL STUDIES – II	CR	1	-	-	-	1	*	***
					20	**-**	**04**	**06**	**25**		

CR – CREDIT, AU – AUDIT, L – LECTURE, T – TUTORIAL, P – PRACTICAL, S/P – SEMINAR/PROJECT, C – NO. OF CREDITS

V SEM - COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)

SL	PROGRAM CODE	COURSECODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	122	20CS3501	COMPUTER NETWORKS	CR	3	-	2	-	4	*	***
2	122	20CS3502	DESIGN AND ANALYSIS OF ALGORITHMS	CR	3	-	-	-	3	*	***
3	122	20CS3503	OPERATING SYSTEMS	CR	3	1	-	-	4	*	***
4	122	20CS3504	MACHINE LEARNING	CR	3	-	2	-	4	*	***
5	122	20DS35XX	PROFESSIONAL ELECTIVE-1	CR	3	-	-	-	3	*	As Indicated in Elective List
6	122	20OE00XX	OPEN ELECTIVE-1	CR	3	-	-	-	3	*	As Indicated in open List
7	122	20CS3505	DESIGN AND ANALYSIS OF ALGORITHMS LAB	CR	-	-	2	-	1	*	***
8	122	20CS3506	OPERATING SYSTEMS LAB	CR	-	-	2	-	1	*	***
9	122	20CS3507	SPECIAL TOPICS -II	CR		-	-	4	2	*	***
					18	1	8	4	25		

V SEM-PROFESSIONAL ELECTIVE – I

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/ P	C	SEM	COURSE CODE
1	20DS3501	DATA WAREHOUSE AND KNOWLEDGE MINING	03	-	-	-	03		
2	20DS3502	FULL STACK DEVELOPMENT	03	-	-	-	03		

VI SEM - COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	122	20CS3601	COMPILER DESIGN AND SYSTEM SOFTWARE	CR	3	1	-	-	4	*	***
2	122	20DS3601	DATA ANALYTICS WITH HADOOP	CR	3	-	-	-	3	*	***
3	122	20DS3602	DATA SCIENCE II	CR	3	-	-	-	3	IV	Data Science I
4	122	20DS36XX	PROFESSIONAL ELECTIVE-2	CR	3	-	-	-	3	*	AS INDICATED IN ELECTIVE LIST
5	122	20DS36XX	PROFESSIONAL ELECTIVE-3	CR	3	-	-	-	3	*	
6	122	20OE00XX	OPEN ELECTIVE-2	CR	3	-	-	-	3	*	***
7	122	20CS3604	COMPILER DESIGN AND SYSTEM SOFTWARE LAB	CR	-	-	2	-	1	*	***
8	122	20DS3603	DATA SCIENCE LAB	CR	-	-	2	-	1		
					17	01	06	-	21		

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits

VI SEM-PROFESSIONAL ELECTIVE –2

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20DS3604	PATTERN ANALYSIS IN DATA SCIENCE	03	-	-	-	03		
2	20DS3605	BUSINESS INTELLIGENCE	03	-	-	-	03		

VI SEM-PROFESSIONAL ELECTIVE – 3

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20CS3606	SOFT COMPUTING	03	-	-	-	03		
2	20DS3606	NATURAL LANGUAGE PROCESSING TOOLS & TECHNIQUES	03	-	-	-	03		

VII SEM - COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	122	20DS47XX	PROFESSIONAL ELECTIVE – 4	CR	3	-	-	-	3	AS INDICATED IN ELECTIVE LIST	
2	122	20DS47XX	PROFESSIONAL ELECTIVE – 5	CR	3	-	-	-	3		
3	122	20OEXXXX	OPEN ELECTIVE-3	CR	3	-	-	-	3	*	***
4	122	20DS4701	PROJECT PHASE – I	CR	-	-	-	6	3	*	***
					9	**-**	**-**	**6**	**12**	*	***

VII SEM-PROFESSIONAL ELECTIVE –4

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20DS4702	ARTIFICIAL INTELLIGENCE	03	-	-	-	03	*	***
2	20DS4703	IMAGE PROCESSING AND COMPUTER VISION	03	-	-	-	03	*	***
3	20DS4704	EMBEDDED IOT	03	-	-	-	03	*	***

VII SEM-PROFESSIONAL ELECTIVE – 5

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20DS4705	DEEP LEARNING	03	-	-	-	03	*	***
2	20DS4706	CLOUD COMPUTING	03	-	-	-	03	*	***
3	20DS4707	SOCIAL NETWORK ANALYSIS	03	-	-	-	03	*	***

VIII SEM - COMPUTER SCIENCE & ENGINEERING (DATA SCIENCE)

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					PREREQUISITE	
					L	T	P	S/ P	C	SEM	COURSE CODE
1	122	20DS48XX	PROFESSIONAL ELECTIVE – 6	CR	3	-	-	-	3	AS INDICATED IN ELECTIVE LIST	
2	122	20DS4801	PROJECT PHASE – II	CR	-	-	-	12	6	*	***
3	122	20DS4802	INTERNSHIP	CR	-	-	-	6	3	*	***
					3	**-**	**-**	**18**	**12**	*	***

VIII SEM-PROFESSIONAL ELECTIVE – 6

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20DS4803	DATA PRIVACY AND CYBER SECURITY	3	-	-	-	3	*	***
2	20DS4804	BLOCK CHAIN & CRYPTO CURRENCY	3	-	-	-	3	*	***
3	20DS4805	HIGH PERFORMANCE COMPUTING	3	-	-	-	3	*	***

SL	COURSE CODE	COURSE TITLE	SCHEME OF TEACHING					PREREQUISITE	
			L	T	P	S/P	C	SEM	COURSE CODE
1	20OE0033	BUSINESS ANALYTICS	3	-	-	-	3	*	***

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2301**					
TITLE OF THE COURSE	**DISCRETE MATHEMATICAL STRUCTURES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- Solve problems using relations and generating functions.
- Understand and Construct mathematical arguments.
- Use propositional and predicate logic in knowledge representation and program verification.
- Develop recursive algorithms based on mathematical induction.
- Know essential concepts in graph theory and related algorithms.
- Apply knowledge of discrete mathematics in Elementary Number Theory and problem solving.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Classify functions, basic set theory relations.	L4
CO2	Demonstrate the correctness of an argument using propositional and predicate logic, laws and truth tables.	L2
CO3	Compare and differentiate graphs in different geometries related to edges.	L4
CO4	Apply mathematical induction, counting principles, recursion, elementary number theory.	L3
CO5	Apply and solve Euclidean Division Algorithm and Chinese Remainder Theorem.	L3

COURSE CONTENT:	
MODULE 1	**9Hrs**
RELATIONS AND FUNCTIONS: Relation and Types of relations, Closure Properties, Equivalence Relations, Partial Ordering Relations, n-ary relations, Functions: one-to-one, onto and invertible functions, sequences, indexed classes of sets, recursively defined functions, cardinality Counting Principles: Permutation, combination, the pigeon hole principle,inclusion-exclusion principle Self – Learning Component: Set theory definition and	

Properties	
MODULE 2	**8Hrs**
LOGIC: Propositions and truth tables, tautologies and contradictions, logical equivalence, algebra of propositions, logical implications, predicate logic, theory of inference for propositional logic and predicate logic. Introduction to Predicate Calculus.	
MODULE 3	**9Hrs**
NUMBER THEORY : Properties of Integers: Introduction, order and inequalities, absolute value, mathematical induction, division algorithm, divisibility, primes, greatest common divisor, Euclidean algorithm, fundamental theorem of arithmetic, congruence relation, congruence equations and Chinese Reminder Theorem (CRT).	
MODULE 4	**7Hrs**
GRAPH THEORY: Graphs and multi-graphs, sub-graphs, isomorphic and homomorphic graphs, paths, connectivity, Euler and Hamilton paths, labelled and weighted graphs, complete, regular and bipartite graphs, planar graphs.	
MODULE 5	**9Hrs**
TREES AND GRAPH COLORING: Trees: Definitions-properties - fundamental theorems of trees-rooted trees-binary trees-spanning trees- Kruskal's Algorithm- Prims Algorithm- Cut-Set, BFS and DFS. Coloring of planar graphs, Chromatic Number- Chromatic partitioning- The four Color Problem-Five-color and Four-color theorem- Thickness and crossing.	

TEXT BOOKS :

1. K. H. Rosen, Discrete Mathematics & its Applications, 7th Ed., Tata McGraw-Hill, 2007.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall India (PHI).

REFERENCES:

1. M.Huth and M. Ryan, Logic in Computer Science, Cambridge University N.Press, 2004.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2302**					
TITLE OF THE COURSE	**DATA STRUCTURES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/II	20EN1103	FUNDAMENTALS OF PROGRAMMING

COURSE OBJECTIVES :

- To introduce the concept of data structure and its applications
- To introduce C language concepts required for data structures
- To design data structure operations to solve problems
- To introduce applications of data structures
- To introduce non-primitive data structures
- To analyse the complexity of a data structure
- To introduce static and dynamic memory allocation using C language
- To explain linear data structures – stack, queue, linked list
- To explain non-linear data structures – trees and graphs
- To train students to design an application as part of the course mini- project using their choice of data structure using C language.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Outline basic C program design for data structures	L2
CO2	Iimplement stack & queue data structure and their applications	L3
CO3	Apply concepts of dynamic memory allocation to real-time Problems	L3
CO4	Implement tree data structure and its applications	L3
CO5	Implement graph data structure and its applications	L3
CO6	Outline the concepts of file structures	L2

COURSE CONTENT:	
MODULE 1	**8Hrs**
INTRODUCTION TO DATA STRUCTURES: Definition, Types, Algorithm Design, C Pointers, C Structure, Array Definition, Representation of Linear Array in Memory, Array Operations (Insertion, Deletion, Search and Traversal), Single Dimensional Arrays, Two Dimensional Arrays, Function Associated with Arrays, Arrays as Parameters, Recursive Functions.	
MODULE 2	**9Hrs**
INTRODUCTION TO STACK AND QUEUE: **Stack:** Definition, Array Representation of Stack, Operations Associated with Stacks- Push & Pop, Applications of Stack: Recursion, Polish expressions, Conversion of Infix to Postfix, Infix to Prefix, Postfix Expression Evaluation, Tower of Hanoi. **Queue:** Definition, Representation of Queues, Operations of Queues- QInsert, QDelete, Priority Queues, Circular Queue.	
MODULE 3	**9Hrs**
DYNAMIC DATA STRUCTURE: **Linked List:** Types, Introduction to Singly Linked lists: Representation of Linked Lists in Memory, Traversing, Searching, Insertion & Deletion from Linked List. Doubly Linked List, Operations on Doubly Linked List (Insertion, Deletion, Traversal). Applications: Polynomial Representation & Basic Operations, Stack & Queue Implementation using Linked Lists.	
MODULE 4	**9Hrs**
TREES & GRAPHS: **Trees:** Basic Terminology, Binary Trees and their Representation, Complete Binary Trees, Binary Search Trees, Operations on Binary Trees (Insertion, Deletion, Search & Traversal), Application: Expression Evaluation. **Graphs:** Terminology and Representations, Graphs & Multigraphs, Directed Graphs, Sequential Representation of Graphs, Adjacency Matrices, Graph Transversal, Connected Components and Spanning Trees.	
MODULE 5	**7Hrs**
FILE STRUCTURES: Physical storage media, File Organization, Linked Organization of File, Inverted File, Organization Records into Blocks, Sequential Blocks, Indexing & Hashing, Multilevel Indexing, Tree Index, Random File, Primary Indices, Secondary Indices.	

TEXT BOOKS :

1. A M Tannenbaum, Y Langsam, M J Augentien “Data Structures using C”, Pearson, 2013
2. R.L. Kruse, B.P. Leary, C.L. Tondo, “Data Structure and Program Design in C” PHI

REFERENCES :

1. Horowitz Anderson-Freed, and Sahni, “Fundamentals of Data structures in C”, 2nd Edition, Orient Longman, 2008
2. Data Structures and Algorithm analysis in C by Mark Allen Weiss, Published by Addison Wesley (3rd Indian Reprint 2000).
3. D E Knuth, The Art of Computer Programming, Volume 1, Addison-Wesley Publishing, 2013

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2303**					
TITLE OF THE COURSE	**DIGITAL ELECTRONICS & LOGIC DESIGN**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**2**	**42**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- To understand various number systems and conversion from one to other number systems
- To introduce basic postulates of Boolean algebra
- To manipulate expressions into POS or SOP form.
- To introduce the methods for simplifying Boolean expressions like K-Map and Quine Mclusky
- To understand the concept of don't care conditions and how they can be used to further optimize the logical functions
- To design simple combinational circuits such as multiplexers, decoders, encoders
- To understand the differences between combinational and sequential Logic circuits
- To familiar with basic sequential logic component-SR Latch
- To understand the basics of various types of memories.
- To present the working of various Flip- Flops (T flip-flop, D flip-flop, R-S flip-flop, JK flip-flop)
- To get familiarized with State Diagram, State Table, State Assignment
- To design combinational circuits using programmable logic devices.
- To design sequential circuits such as different types of Counters, Shift Registers

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate the knowledge of binary number systems, logic families, Boolean algebra and logic gates	L2
CO2	Analyze different methods used for simplification of Boolean expressions	L4
CO3	Design combinational logic circuits using combinational logic elements	L3
CO4	Design combinational circuits using Programmable Logic Devices	L3
CO5	Analyze sequential logic elements in the design of synchronous and asynchronous systems	L4
CO6	Design sequential systems composed of standard sequential modules, such as counters and registers	L3

COURSE CONTENT:	
MODULE 1	**9Hrs**
NUMBER SYSTEMS: BCD number representation, Unsigned and signed number representation, Binary arithmetic. **BOOLEAN ALGEBRA AND SIMPLIFICATION:** Laws of Boolean algebra, Theorems of Boolean algebra, Boolean/Switching functions and their implementation. **SIMPLIFICATION OF BOOLEAN EXPRESSIONS AND FUNCTIONS:** Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs Quads, and Octets,Karnaugh Simplifications, Don't-care Conditions. Product-of-sums Method, Product-of-sums simplifications, Simplification by Quine-McClusky Method.	
MODULE 2	**8Hrs**
DESIGN OF COMBINATIONAL LOGIC CIRCUITS: Modular combinational logic elements- Multiplexers and Demultiplexers, Decoders,Magnitude comparator, BCD converter, Encoders, Priority encoders.	
MODULE3	**7Hrs**
PROGRAMMABLE LOGIC: Programmable Logic Arrays, Design of Combinational Circuits using Programmable Logic Devices (PLDs): Programmable Read Only Memories (PROMs), Programmable Logic Arrays (PLAs), Programmable Array Logic (PAL) devices.	
MODULE 4	**9Hrs**
INTRODUCTION TO SEQUENTIAL CIRCUITS : Introduction to Sequential Circuits. Combinational Vs sequential circuits, Clock, Clock Triggering, Memory elements and their excitation functions – Latches, T flip-flop, D flip-flop, R-S flip-flop. JK flip-flop and their excitation requirements, State diagram,state table and state equation, Design of synchronous sequential circuits like Sequence Detectors and binary counters.	
MODULE 5	**9Hrs**
APPLICATION OF LOGIC CIRCUITS SEQUENTIAL CIRCUITS (REGISTERS AND COUNTERS): Registers-Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In - Serial Out, Parallel In -Parallel Out, Universal Shift Register, Applications of Shift Registers, Asynchronous and Synchronous Counters	

TEXT BOOKS :

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 6th Edition,N.Pearson Education, 2018
2. Donald.P. Leach, Albert Paul Malvino & Goutam Saha: Digital Principles and Applications, 8th Edition, Tata McGraw Hill, 2015

REFERENCES :

1. D Sudhaker Samuel: Illustrative Approach to Logic Design, Sanguine-Pearson, 2010.
2. Charles H. Roth: Fundamentals of Logic Design, Jr., 7th Edition, Cengage Learning, 2014
3. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2304**					
TITLE OF THE COURSE	**DATABASE MANAGEMENT SYSTEMS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- To learn data models, conceptualize and depict a database system using ER diagram
- To understand the internal storage structures in a physical DB design
- To know the fundamental concepts of transaction processing techniques

COURSE OUTCOMES

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Demonstrate the basic elements of a relational database management system	L2
CO2	Identify the data models for relevant problems	L2
CO3	Apply normalization for the development of application software's	L3
CO4	Use Structured Query Language (SQL) for database manipulation.	L3
CO5	Understand transactions and their properties (ACID)	L2
CO6	Design and develop a large database with optimal query processing	L6

COURSE CONTENT:	
MODULE 1	**8Hrs**
Introduction: Purpose of Database System-–Views of data–data models, database management system, three-schema architecture of DBMS, components of DBMS. E/R Model - Conceptual data modeling - motivation, entities, entity types, attributes relationships, relationship types, E/R diagram notation, examples.	

MODULE 2	9Hrs
Relational Model: Relational Data Model - Concept of relations, schema-instance distinction, keys, referential integrity and foreign keys, relational algebra operators, SQL -Introduction, data definition in SQL, table, key and foreign key definitions, update behaviors. Querying in SQL, notion of aggregation, aggregation functions group by and having clauses. .	
MODULE 3	**9Hrs**
Database Design: Dependencies and Normal forms, dependency theory –functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, 4NF, and 5NF	
MODULE 4	**9Hrs**
Transactions: Transaction processing and Error recovery - concepts of transaction processing, ACID properties, concurrency control, locking based protocols for CC, error recovery and logging, undo, redo, undo-redo logging and recovery methods.	
MODULE 5	**7Hrs**
Embedded SQL: triggers, procedures and database connectivity. Introduction to NoSQL	

TEXT BOOKS :

1. Silberschatz, Henry F. Korth, and S. Sudharshan, "Database System Concepts", 5thEd, Tata McGraw Hill, 2006.
2. J. Date, A. Kannan and S. Swamynathan, "An Introduction to Database Systems", 8thed, Pearson Education, 2006.

REFERENCES :

1. Ramez Elmasri and Shamkant B. Navathe, "Fundamentals of Database Systems", Fourth Edition, Pearson/Addision Wesley, 2007
2. Raghu Ramakrishnan, "Database Management Systems", Third Edition, McGraw Hill, 2003
3. S. K. Singh, "Database Systems Concepts, Design and Applications", First
T. Edition, Pearson Education, 2006

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2305**					
TITLE OF THE COURSE	**COMPUTATIONAL THINKING WITH PYTHON**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- To understand basic concepts of computational thinking.
- To introduce python programming for problem solving.
- To introduce different debugging and unit testing tools.
- To solve real world problems using python data structures.
- Learn to handle files and exception handling in python.
- To explore Python's object-oriented features.
- To build Web services and Networked programs in python.
- To train students to design an application as part of the course mini- project using computational thinking with python.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand basic concepts of computational thinking.	L2
CO2	Outline basic python programming for problem solving.	L2
CO3	Apply computational thinking to solve real world programs using Python	L3
CO4	Build python programs using core data structures like list, dictionaries and tuples	L3
CO5	Implement object oriented concepts using python	L3
CO6	Design applications related to web services and network Programming.	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**

INTRODUCTION TO COMPUTATIONAL THINKING AND PYTHON: Introduction to computational thinking: Stages of Computational thinking, Design using Flowcharts, Implementation, Testing Python Basics: Values, expressions and statements, Conditional execution, Functions Iterations	
MODULE 2	**9Hrs**
PYTHON ENVIRONMENT AND DATA STRUCTURES : Python Environment: Usage of Debugging and Unit Testing tools in python, Introduction to Github, Executing the python programs using Jupyter notebooks, Python Data Structures: Strings, Arrays, Lists, Tuples, Sets and Dictionaries	
MODULE 3	**9Hrs**
PYTHON FILES AND EXCEPTION HANDLING: Files: File types, modes, File functions, File attributes, File positions, Looping over file, Exception Handling: Try-Except, Exception syntax, examples, Types of exception with except, multiple exceptions with except, Try-Finally, Raise exceptions with arguments, Python built-in exceptions, User-defined exceptions, Assertions	
MODULE 4	**9Hrs**
PYTHON OBJECTS : Classes and Objects: Creating classes, Using Objects, Accessing attributes, Classes as Types, Introduction to Multiple Instances, Inheritance.	
MODULE 5	**7Hrs**
Applications of Python Applications: Networked Programs, Using web services	

TEXT BOOKS :

1. "Python for Everybody-Exploring Data Using Python 3", Dr. Charles R. Severance,
2. "Introduction to Computing & Problem Solving with Python",Jeeva Jose,P.Sojan Lal, Khanna Book Publishing; First edition (2019).

REFERENCES :

1. "Computer Science Using Python: A Computational Problem- Solving Focus", Charles Dierbach, Introduction John Wiley, 2012.
2. "Introduction to Computation and Programming Using Python", John V Guttag,Prentice Hall of India, 2015.
3. "How to think like a Computer Scientist, Learning with Python", Allen Downey,Jeffrey Elkner and Chris Meyers, Green Tea Press, 2014.
4. "Learning to Program with Python", Richard L. Halterman, 2011.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2306**					
TITLE OF THE COURSE	**AGILE SOFTWARE ENGINEERING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**2**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- Agile methodology, Scrums, Sprints.
- Agile testing, test automation, DevOps.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Compare and contrast the differences between Agile and other project management methodologies	L4
CO2	Interpret and apply various principles, phases and activities of the Scrum methodology	L3
CO3	Define the benefits of using an Agile approach to managing projects	L2
CO4	Understand Agile Testing principles for real life situations and learn the basics of SAFe for scaled agile	L2
CO5	Identify and use various tools for Agile development and DevOps principles for CI/CD	L3

COURSE CONTENT:

MODULE 1	**9Hrs**

INTRODUCTION TO AGILE :

Introduction to Software engineering, SDLC, Software process models- waterfall, V model, Iterative model, Spiral model; Introduction to Agile: Agile versus traditional method comparisons and process tailoring; Introduction to Agile, Various Agile methodologies -Scrum, XP, Lean, and Kanban, Agile Manifesto.

MODULE 2	**9Hrs**

SCRUM AND SPRINT:

Scrum: Scrum process, roles - Product Owner, Scrum Master, Team, Release manager, Project Manager, product manager, architect, events, and artifacts; Product Inception: Product vision, stakeholders, initial backlog creation; Agile Requirements – User personas, story mapping, user stories, 3Cs, INVEST, acceptance criteria, sprints, requirements, product backlog and backlog grooming; Test First Development; Pair Programming and Code reviews;

MODULE 3	9Hrs
AGILE PROJECT MANAGEMENT: Sprint Planning, Sprint Reviews, Sprint Retrospectives, Sprint Planning - Agile release and iteration (sprint) planning, Develop Epics and Stories, Estimating Stories, Prioritizing Stories (WSJF technique from SAFe), Iterations/Sprints Overview. Velocity Determination, Iteration Planning Meeting, Iteration, Planning Guidelines, Development, Testing, Daily Stand-up Meetings, Progress Tracking, Velocity Tracking, Monitoring and Controlling: Burn down Charts, Inspect & Adapt (Fishbone Model), Agile Release Train	
MODULE 4	**7Hrs**
AGILE TESTING : Testing: Functionality Testing, UI Testing(Junit, Sonar), Performance Testing, Security Testing, A/B testing; Agile Testing: Principles of agile testers; The agile testing quadrants, Agile automation, Test automation pyramid; Test Automation Tools - Selenium, Traceability matrix;	
MODULE 5	**8Hrs**
DEVOPS: DevOps: Continuous Integration and Continuous Delivery; CI/CD: Jenkins, Git/Github Creating pipelines, Setting up runners Containers and container orchestration (Dockers and Kubernetes) for application development and deployment; Build tools - maven; Checking build status; Configuration management - puppet, chef, ansible; Fully Automated Deployment; CM - Continuous monitoring with Nagios; Introduction to DevOps on Cloud	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Setting up Devops Environment
2. Writing Requirements Document, Requirement Analysis (user stories)
3. Estimation and Scrum Planning
4. Implementation and Testing Using Iterative Sprint Model
5. Test Automation using Selenium
6. Unit Testing using Junit or Sonar or Python Test framework
7. CI/CD using Jenkins as Orchestrion platform
8. Containerzation using Docker or Kubernetes

TEXT BOOKS :

1. Essential Scrum: A Practical Guide to the Most Popular Agile Process Kenneth S.Rubin 2012, published by Addison-Wesley Professional
2. Agile Software Development: The Cooperative Game Alistair Cockburn 2nd Edition, 2006, Addison-Wesley Professional

REFERENCES :

1 Scrum and XP from the Trenches Henrik Kniberg 2nd Edition, 2015, Published by C4Media, publisher of InfoQ.com
2. Agile Project Management: Creating Innovative Products, Second Edition By Jim Highsmith, Addison-Wesley Professional, 2009
3. Agile Project Management: Managing for Success, By James A. Crowder, Shelli Friess,Springer

2014
4. Learning Agile: Understanding Scrum, XP, Lean, and Kanban, By Andrew Stellman, Jennifer Greene, 2015, O Reilly
5. DevOps: Continuous Delivery, Integration, and Deployment with DevOps: Dive ... By Sricharan Vadapalli, Packt, 2018
6. Agile Testing: A Practical Guide For Testers And Agile Teams, Lisa Crispin, Janet Gregory, Pearson, 2010
7. More Agile Testing: Learning Journeys for the Whole Team By Janet Gregory, Lisa Crispin, Addison Wesley, 2015
8. DevOps: Puppet, Docker, and Kubernetes By Thomas Uphill, John Arundel, Neependra Khare, Hideto Saito, Hui-Chuan Chloe Lee, Ke-Jou Carol Hsu, Packt, 2017

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CS2309**					
TITLE OF THE COURSE	**MANAGEMENT & ENTREPRENEURSHIP**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**30**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- Identify and analyze the factors that contribute to the process of successfully launching an entrepreneurial venture and managing a new business.
- Learn the entrepreneurial process from idea generation to implementation.
- Acquaint with special problems of starting new ventures, finding products and services, which can support new enterprises, and raising capital.
- Discuss how to start own business and also to work in or with small business or are involved with entrepreneurship.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate knowledge of the key elements of the entrepreneurial process	L2
CO2	Employ strategies to generate new ideas for startups	L2
CO3	Outline how to protect IP legally	L2
CO4	Examine different ways of generating funding	L2
CO5	Explain organizing managing people, finance and customers	L2

COURSE CONTENT:	
MODULE 1	**6Hrs**

OVERVIEW OF ENTREPRENEURSHIP: THE ENTREPRENEURIAL PERSPECTIVE : Nature and Development of Entrepreneurship. Defining Manager, Entrepreneur, Entrepreneurship and Entrepreneurship. Key Elements of Entrepreneurship. Personality Characteristics of Successful Entrepreneurs. Common Myths about Entrepreneurs. Ethics and Social Responsibility of Entrepreneurs. Types of Start-Up Firms. Process of New Venture Creation. Role of Entrepreneurship in Economic Development. Emerging Trends and Issues in Entrepreneurship. **Case Study: Successful Entrepreneurs Narayana Murthy Infosys**	
MODULE 2	**6Hrs**
THE ENTREPRENEURIAL AND ENTREPRENEURIAL MIND: The Entrepreneurial Process: Identify and Evaluate the Opportunity, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise. Managerial Versus Entrepreneurial Decision Making: Strategic Orientation, Commitment to Opportunity, Commitment of Resources, Control of Resources, Management Structure, Entrepreneurial Venturing inside a Corporation, Causes for Interest in Entrepreneurship, Climate for Entrepreneurship, Entrepreneurial Leadership Characteristics. **Case study: How to develop effective Business Plan**	
MODULE 3	**6Hrs**
CREATIVITY AND BUSINESS IDEA : Identify and Recognizing Opportunities: Observing Trends and Solving Problems. Creativity: Concept, Components and Types of Creativity, Stages of Creative Process. Sources of New Venture Ideas. Techniques for Generating Ideas. Stages of Analyzing and Selecting the Best Ideas. Protecting the Idea: Intellectual Property Rights and its Components. Linking Creativity, Innovation and Entrepreneurship. **Case study : Application of Design Thinking in New business ideas generation in particular sector (Health care, Water Saving, Energy saving)**	
MODULE 4	**6Hrs**
PREPARING THE PROPER ETHICAL AND LEGAL FOUNDATION: Initial Ethical and Legal Issues Facing a New Firm, Establishing a Strong Ethical Culture, Choosing an attorney (Lawyer), Drafting a founder's agreement, Avoiding legal disputes, Choosing a form of business organization, Obtaining business licenses and permits, Choosing a Form of Business Ownership (Sole, Proprietorship, Partnership, Corporation & Limited Liability Company) **Case study: Startup Law A to Z IP** https://techcrunch.com/2019/02/25/startup-law-a-to-z-intellectual-property/	
MODULE 5	**6Hrs**
MANAGING EARLY GROWTH AND CHALLENGES Recruiting and Selecting Key Employees. Lenders and Investors. Funding Requirements: Sources of Personal Financing. Venture Capital. Commercial Banks. Sources of Debt Financing. Key Marketing Issues for New Ventures. Why marketing is critical for Entrepreneurs. Entrepreneurs face unique Marketing Challenges. Guerrilla Marketing. Business Growth: Nature of Business Growth, Planning for Growth, Reasons for Growth. Managing Growth: Knowing and Managing the Stages of Growth, Challenges of Growing a Firm. Strategies for Firms Growth: Internal and External Growth Strategies. Implications of Growth for the Firm and Entrepreneur. Entrepreneurial Skills and Strategies to Overcome Pressures On: Financial Resources (Financial Control, Managing Inventory and Maintaining Good Records). Human Resources, Management of Employees, Time Management. **Case study: 9 ways to get startups funded** https://www.quicksprout.com/how-to-get-your-startup-funded/	

TEXT BOOKS :

1. Barringer, Ireland, “Entrepreneurship: Successfully Learning New Ventures”, Pearson, Latest Edition.
2. Hisrich, Peters, Shepherd, “Entrepreneurship”, Mc Graw Hill, Sixth Edition.

SEMESTER	III					
YEAR	II					
COURSE CODE	20CS2307					
TITLE OF THE COURSE	DATA STRUCTURES LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	2	-	30	1

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES:

- To introduce C language concepts required for data structures
- To design data structure operations to solve problems
- To introduce applications of data structures
- To implement linear data structures – stack, queue, linked list
- To implement non-linear data structures – trees and graphs

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Design and develop the programs in C to understand the different concepts of data structures.	L3
CO2	Implement stack & queue data structure and their applications, Analyse the output based on the given input data.	L3
CO3	Implement Conversions of Polish and reverse polish expressions and Record Experimental process and results	L4
CO4	Apply and implement concepts of dynamic memory allocation	L3
CO5	Use the concepts of file structures and communicate results effectively	L3

List of Laboratory/Practical Experiments activities to be conducted
Writing C programs: 1. To perform arithmetic storage/operations using arrays 2. To Implement C programs with concepts of pointers, structures 3. To implement multidimensional array Matrix Multiplication 4. To search element(s) in a multidimensional array 5. To search elements in data structure with different search methods 6. To implement stack , queue and their variations using arrays 7. To implement stack, queue and their variations using linked lists 8. To Implement Linked Lists and variations and use them to store data. 9. To implement graph & binary tree traversal techniques

10. To evaluate/convert infix/prefix/postfix expressions
11. To perform basic file operations

Open-Ended Experiments

1. A man in an automobile search for another man who is located at some point of a certain road. He starts at a given point and knows in advance the probability that the second man is at any given point of the road. Since the man being sought might be in either direction from the starting point, the searcher will, in general, must turn around many times before finding his target. How does he search to minimize the expected distance travelled? When can this minimum expectation be achieved?

2. The computing resources of a cloud are pooled and allocated according to customer demand. This has led to increased use of energy on the part of the service providers due to the need to maintain the computing infrastructure. What data structure will you use for allocating resources which addresses the issue of energy saving? Why? Design the solution.

3. Mini-Project on applying suitable data structure to a given real-world problem

Textbooks

1. A M Tannenbaum, Y Langsam, M J Augentien “Data Structures using C”, Pearson, 2013
2. R.L. Kruse, B.P. Leary, C.L. Tondo, “Data Structure and Program Design in C” PHI

Reference Books

1. Horowitz Anderson-Freed, and Sahni, “Fundamentals of Data structures in C”, 2nd Edition, Orient Longman, 2008
2. Data Structures and Algorithm analysis in C by Mark Allen Weiss, Published by Addison Wesley (3rd Indian Reprint 2000).
3. D E Knuth, The Art of Computer Programming, Volume 1, Addison-Wesley Publishing, 2013

SEMESTER	III					
YEAR	II					
COURSE CODE	20CS2308					
TITLE OF THE COURSE	DATABASE MANAGEMENT SYSTEMS LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	2	-	30	1

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	****

COURSE OBJECTIVES :

- Understand the fundamental concepts of database management. These concepts include aspects of database design, database languages, and database-system implementation.
- To provide a strong formal foundation in database concepts, recent technologies and best industry practices.
- To give systematic database design approaches covering conceptual design, logical design and an overview of physical design.
- To learn the SQL and NoSQL database system.
- To learn and understand various Database Architectures and its use for application development.
- To programme PL/SQL including stored procedures, stored functions, cursors and packages

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Install and configure database systems.	L3
CO2	Analyze database models & entity relationship models.	L3
CO3	Design and implement a database schema for a given problem-domain	L3
CO4	Understand the relational and document type database systems.	L2
CO5	Populate and query a database using SQL DML/DDL commands.	L3

List of Laboratory/Practical Experiments activities to be conducted
1. Design any database with at least 3 entities and relationships between them. Apply DCL and DDL commands. Draw suitable ER/EER diagram for the system.

2. Design and implement a database and apply at least 10 different DML queries for the following task. For a given input string display only those records which match the given pattern or a phrase in the search string. Make use of wild characters and LIKE operator for the same. Make use of Boolean and arithmetic operators wherever necessary.
3. Execute the aggregate functions like count, sum, avg etc. on the suitable database. Make use of built in functions according to the need of the database chosen. Retrieve the data from the database based on time and date functions like now (), date (), day (), time () etc. Use group by and having clauses.
4. Implement nested sub queries. Perform a test for set membership (in, not in), set comparison (<some, >=some, <all etc.) and set cardinality (unique, not unique).
5. Write and execute suitable database triggers .Consider row level and statement level triggers.
6. Write and execute PL/SQL stored procedure and function to perform a suitable task on the database. Demonstrate its use.
7. Write a PL/SQL block to implement all types of cursor.
8. Execute DDL statements which demonstrate the use of views. Try to update the base table using its corresponding view. Also consider restrictions on updatable views and perform view creation from multiple tables.
9. Mini project.

TEXT BOOKS :

1. Ramon A. Mata-Toledo, Pauline Cushman, Database management systems, TMGH, ISBN: IS978-0-07-063456-5, 5th Edition.

REFERENCES :

1. Dr. P. S. Deshpande, SQL and PL/SQL for Oracle 10g Black Book, DreamTech.
2. Ivan Bayross, SQL, PL/SQL: The Programming Language of Oracle, BPB Publication.
3. Dalton Patrik, SQL Server – Black Book, DreamTech Press.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2401**					
TITLE OF THE COURSE	**PROBABILITY AND STATISTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES :

- Understand probability, random variable and random process concepts and their importance in Computer Engineering course.
- Calculate statistics related to Random variables and process such as mean, variance, etc.
- Evaluate standard distribution functions such as Poisson's, Normal distributions
- Apply functions of random variables such as characteristic function, moment generating function to calculate statistics.
- Understand probability, random variable and random process concepts and their importance in Computer Engineering course.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Compute and interpret descriptive statistics using numerical and graphical techniques.	L4
CO2	Understand the basic concepts of random variables and find an appropriate distribution for analyzing data specific to an experiment.	L2
CO3	Extend the concepts to multiple random variables and apply them to analyze practical problems.	L2
CO4	Make appropriate decisions using statistical inference that is the central to experimental research.	L4

COURSE CONTENT:	
MODULE 1	**6 Hrs**
INTRODUCTION TO PROBABILITY THEORY : Basic Notions of Probability, Axiomatic definition, properties, Conditional Probability and Independence – Baye's Theorem.	

MODULE 2	7 Hrs
DISCRETE PROBABILITY DISTRIBUTIONS: Discrete random variables and its properties - Bernoulli trials – Binomial Distribution and its properties – Poisson Distribution and its properties.	
MODULE 3	**10 Hrs**
CONTINUOUS PROBABILITY DISTRIBUTIONS Continuous random variables and its properties - Gamma Distribution and its properties – Exponential Distribution and its properties - Normal Distribution and its properties. **BIVARIATE DISTRIBUTIONS:** Bivariate random variables – Joint – Marginal - Conditional distribution.	
MODULE 4	**9 Hrs**
RANDOM PROCESS AND QUEUING THEORY Classification – Stationary process – Markov process – Markov chain – Poisson process – Random telegraph process. Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties. Queuing Models, Methods for generating random variables and Validation of random numbers	
MODULE 5	**10 Hrs**
TESTING OF HYPOTHESIS Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis- Large sample tests- Z test for Single Proportion - Difference of Proportion, mean and difference of mean - Small sample tests- Student's t-test, F-test-chi-square test- goodness of fit - independence of attributes.	

TEXT BOOKS :

1. A First Course in Probability, S. Ross, Pearson International Edition, 9th Edition.
2. Fundamentals of Mathematical Statistics, S. C. Gupta and V. K. Kapoor, Sultan Chand & Sons, 11th Edition.

REFERENCES :

1. K. S. Trivedi, Probability and Statistics with Reliability, Queuing, and L.Computer Science Applications, 2nd Ed., Wiley, 2001.
2. Robert V. Hogg, J.W. McKean, and Allen T. Craig: Introduction to Mathematical Statistics, Seventh Edition, Pearson Education, Asia.
3. Rohatgi, V K. and Saleh , A. K. Md. Ehsanes, "An Introduction to Probability and Statistics", (John Wiley and Sons) , (2nd edition) (2000)
4. Higher Engineering Mathematics by B S Grewal, 42 nd Edition, Khanna Publishers.
5. Probability and Statistics for engineers and scientists, R.,E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
6. An Introduction to Probability Theory and its Applications, W. Feller , Vol. 1, 3rd Ed., Wiley, 1968

SEMESTER	IV					
YEAR	II					
COURSE CODE	20CS2402					
TITLE OF THE COURSE	OBJECT ORIENTED DESIGN AND PROGRAMMING					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Understand the basic concepts of object-oriented design techniques.
- Understand the fundamentals of object-oriented programming with Java.
- Draw UML diagrams for the software system.
- Impart basics of multi-threading and database connectivity.
- Develop GUI using event handling techniques in Java.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Apply the concepts of object-oriented programming in software design process.	L3
CO2	Develop Java programs using Java libraries and construct to solve real-time problems.	L3
CO3	Understand, develop and apply various object-oriented features using Java to solve computational problems	L2
CO4	Implement exception handling and JDBC connectivity in Java.	L3
CO5	Build an event-oriented GUI (graphical user interface).	L6

COURSE CONTENT:	
MODULE 1	**09 Hrs**
An Overview of Object-Oriented Systems Development: Introduction; Two Orthogonal	

Views of the Software; Object-Oriented Systems Development Methodology; Why an Object-Oriented? Overview of the Unified Approach. **Object Basics**: Introduction; An Object-Oriented Philosophy; Objects; Objects are Grouped in Classes; **Attributes**: Object State and Properties; Object behaviour and Methods; Object Respond to Messages; Encapsulation and Information Hiding; **Class Hierarchy:** Inheritance; Multiple Inheritance; **Polymorphism**; Object Relationships and Associations: Consumer-Producer Association; Aggregation and Object Containment; **Case Study** - A Payroll Program; **Object-Oriented Systems Development Life Cycle**: Introduction; Software Development Process; Building High-Quality Software; Object-Oriented Systems Development: A Use Case Driven Approach; Reusability.	
MODULE 2	**08 Hrs**
Unified Modelling Language :Introduction; Static and Dynamic models; Why Modeling? Introduction to the UML; UML Diagrams; UML Class Diagram; Use-Case Diagram. **Introduction to Java**: Java's Magic: The Bytecode; JVM; Object-Oriented Programming; Simple Java programs; Two Control Statements; Lexical Issues; **Data Types; Variables, Arrays and String constructors**; **Operators; Control Statements; Introducing Classes:** Class Fundamentals; objects; methods; constructors; this Keyword; Garbage Collection; finalize() method; Parameter Passing; Overloading; Access Control Keywords. Inheritance basics; method overriding; abstract classes; Packages and interfaces. Exception handling fundamentals; multiple catch; nested try statements.	
MODULE 3	**09 Hrs**
Multi-Threaded Programming :Multi-Threaded Programming: Java Thread Model; The main Thread; Creating a thread and multiple threads; Extending threads; Implementing Runnable; Synchronization; Inter Thread Communication; producer consumer problem. **Input/Output**: I/O Basic; Reading console input Writing Console output.	
MODULE 4	**08 Hrs**
Event and GUI Programming:Introducing Swing; The Origins of Swing; Swing Is Built on the AWT; Two Key Swing Features; The MVC Connection; Components and Containers; The Swing Packages; A Simple Swing Application; Event Handling; JLabel; JTextField; JButton	
MODULE 5	**08 Hrs**
Database Access: The Concept of JDBC; JDBC Driver Types; JDBC Packages; A Brief Overview of the JDBC process; Database Connection; Associating the JDBC/ODBC Bridge with the Database; Statement Objects; ResultSet.	

TEXT BOOK:

1. Bahrami A.; Object Oriented Systems Development using the Unified Modeling Language; McGraw Hill; 1999.
2. Schildt; Herbert. Java The Complete Reference; 8th Edition. US: McGraw-Hill Osborne Media; 2011.
3. Jim Keogh; J2EE: The Complete Reference; McGraw Hill Education in 2002.

REFERENCES:

1. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.

2. Y. Daniel Liang, Introduction to Java Programming, 7th edition, Pearson, 2013.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2403**					
TITLE OF THE COURSE	**PRINCIPLES OF MICROPROCESSORS & COMPUTER ORGANIZATION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	III	20CSXXXX	DELD

COURSE OBJECTIVES:

- To introduce the architecture of 8086
- To understand the importance and function of each pin of 8086 Microprocessor
- To familiarize with the architecture of 8086 microprocessor and its operation
- To understand the various addressing modes required for assembly language
- Programming and to calculate the physical address.
- To learn the 8086 instruction set and write 8086 Assembly level programs
- To understand the importance of different peripheral devices and their interfacing to 8086
- Understand the concepts of Hardwired control and micro programmed control.
- To explain the current state of art in memory system design
- Discuss the concept of memory organization.
- Summarize the types of memory.
- Learn about various I/O devices and the I/O interface.
- Learn the different types of serial communication techniques.
- To understand DMA technique
- To provide the knowledge on Instruction Level Parallelism
- To understand the concepts of pipelining techniques.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Identify the basic building blocks of 8086 microprocessor and use the addressing modes for executing programs efficiently	L2
CO2	Develop 8086 assembly language programs using modern assembler tools	L3
CO3	Discuss the computer arithmetic and design algorithms for various Arithmetic operations.	L2
CO4	Design data part and control part of a processor	L3
CO5	Analyze the performance of various classes of Memories	L4
CO6	Understand pipeline & parallel processing	L2

COURSE CONTENT:	
MODULE 1	**8Hrs**
Introduction to Microprocessor & its Architecture: Introduction-Evolution of Microprocessor, The Microprocessor-Based Personal Computer Systems, Internal Microprocessor Architecture, Real mode memory addressing, Memory paging, 8086 pin diagram, Internal Architecture of 8086,Registers, Addressing Modes-Immediate addressing, Register addressing, direct addressing, indirect addressing, relative addressing, Instruction formats	
MODULE 2	**12 Hrs**
Programming 8086: Assembler directives, Data Movement Instructions, String Data Transfers, Miscellaneous Data Transfer Instructions, Arithmetic and Logic Instructions, BCD and ASCII Arithmetic, Basic Logic Instructions, Shift and Rotate, String Comparisons. Program Control Instructions: The Jump Group, Assembly language programming with 8086, macros, procedures	
MODULE 3	**10 Hrs**
Processor Organization: Basic organization of computers, Block level description of the functional units as related to the execution of a program; Fetch, decode and execute cycle. Execution cycle in terms machine instructions. Information representation, Floating point representation (IEEE754), computer arithmetic and their implementation; **Data Part Design:** Fixed-Point Arithmetic-Addition, Subtraction, Multiplication and Division, Arithmetic Logic Units control and data path, data path components, design of ALU and data-path, **Control Part Design:** Control unit design; Hardwired and Micro programmed Control unit. Discussions about RISC versus CISC architectures.	
MODULE 4	**12 Hrs**
Memory Technology: Memory hierarchy, static and dynamic memory, RAM and ROM chips, Memory address map, Auxiliary Memory, Associative Memory, Cache Memory and organization. **Input/Output Organization:** Peripheral devices, Input-Output Interface; I/O Bus and Interface Modules, Isolated versus Memory-Mapped I/O, Example of an l/0 interface unit, keyboard interface, Modes of Transfer; Programmed I/O, Interrupt-initiated I/O, Direct memory access (DMA)	
MODULE 5	**10Hrs**
Pipelining: Basic Concepts, Arithmetic Pipeline, Instruction Pipeline; Four-Segment Instruction Pipeline, Pipeline hazards and their resolution, **Parallel Processing;** Flynn's classification, Multicore architectures, Introduction to Graphics Processing Units, Example: NVIDIA GPU Architecture	

TEXT BOOK:

1. Barry B Brey: The Intel Microprocessors, 8th Edition, Pearson Education, 2009
2. Mano, Morris M. Computer system architecture. Dorling Kindesley Pearson, 2005.

REFERENCES:

1. Krishna Kant, “MICROPROCESSORS AND MICROCONTROLLERS Architecture, programming and system design using 8085, 8086, 8051 and 8096”. PHI 2007.
2. Douglas V Hall, “MICROPROCESSORS AND INTERFACING, PROGRAMMING AND HARDWARE” TMH, 2006.
3. Kenneth J. Ayala, “The 8086 Microprocessor: Programming & Interfacing The PC”, Delmar Publishers, 2007
4. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Danny Causey, The x86 PC Assembly Language Design and Interfacing, 5th Edition, Pearson, 2013.
5. 5. V. Carl Hamacher, Safwat G. Zaky and Zvonko G. Vranesic , Computer Organization ,McGraw-Hill series 2002
6. Hayes, J.P , Computer Architecture and Organization, McGraw-Hill, 1998
7. Vincent P. Heuring and Harry F. Jordan , Computer Systems Design and Architecture (2nd Edition), Dec, 2003
8. David Patterson and John Hennessey , Computer Organization and Design, Elsevier. 2008
9. Comer, Douglas. Essentials of computer architecture. Chapman and Hall/CRC, 2017.
10. Hord, R. Michael. Parallel supercomputing in MIMD architectures. CRC press, 2018.
11. Tanenbaum, Andrew S. Structured computer organization. Pearson Education India, 2016.
12. William Stallings-Computer Organization and Architecture, Seventh Edition, Pearson Education

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2404**					
TITLE OF THE COURSE	**FINITE AUTOMATA AND FORMAL LANGUAGES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**2**	**50**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	*	**	***

COURSE OBJECTIVES :

- To learn general theory of automata, properties of regular sets and regular expressions.
- To understand basics of formal languages.
- To know push-down automata, context- free languages, Turing machines.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the concept of Automata	L1
CO2	Explain the concept of Regular Expression, languages and abstract machines to recognize them	L2
CO3	Know the generalized computation model and different types Computation	L2

COURSE CONTENT:	
MODULE 1	**9Hrs**
Introduction to Finite Automata: Study and Central concepts of automata theory, An informal picture of finite automata, deterministic and non-deterministic finite automata, applications of finite automata, finite automata with epsilon – transitions.	
MODULE 2	**12Hrs**
Regular expression and languages: Regular expressions, finite automata and regular expressions, algebraic laws of regular expressions. applications of regular expressions such as Grep, and Lex etc.. Properties of Regular Languages: closure properties of regular languages, Pumping Lemma, equivalence and minimization of automata .	

MODULE 3	10Hrs
Context – free Grammars and Languages: Context free grammars, Context-free languages, Parse trees, Ambiguity in grammars and languages Pushdown Automata: Pushdown automation (PDA), the language of PDA, equivalence of PDA's and CFG's, Deterministic Pushdown Automata,	
MODULE 4	**9Hrs**
Properties of Context – Free Languages: Normal forms of context free grammars, pumping lemma for context free languages, closure properties of context free languages. Applications of CFG - such as spec of programming languages, parsing techniques, and Yacc	
MODULE 5	**10Hrs**
Introduction to Turing Machine- The Turing machine, programming techniques for Turing machine, extensions to the basic Turing machine, restricted Turing Machines, Turing Machines and Computers. Chomsky hierarchy	

TEXT BOOKS :

1. Daniel I. A. Cohen, Introduction to Computer Theory, 2nd Edition, Wiley India Student Edition, 2008.
2. J.E. Hopcroft , R. Motwani, and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, 3rd Edn. Pearson Education , New Delhi 2008

REFERENCES :

1. K.L.P. Misra and N. Chandrashekaran. Theory of Computer Science- Automata, Languages and Computation, 3rd Edn. PHI, New Delhi, 2007

2. C. Martin - Introduction to Languages and the Theory of Computation 2ndEdn, TMH, New Delhi, 2000.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2405**					
TITLE OF THE COURSE	**INTRODUCTION TO NETWORKS AND CYBERSECURITY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To introduce the fundamental aspects of various types of computer networks.
- To demonstrate the TCP/IP and OSI models with merits and demerits.
- Understand the basic concepts of cyber security, how it has evolved, and some key techniques used today.
- Have an insight view of Security, Cryptography, Malware, IDS, Secure Programming etc
- Explore the subject through prescribed book, case studies, seminars and Assignments.

COURSE OUTCOMES:

CO No.	Outcomes	**Bloom's Taxonomy** Level
CO1	Understand and explore the basics of Computer Networks and working principles.	L2
CO2	Understand the concepts of Network security corresponding to various Internet Layers.	L2
CO3	Determine appropriate mechanisms for protecting the Network.	L2

COURSE CONTENT:	
MODULE 1	**9Hrs**
Overview of the Internet: Protocol, Layering Scenario, TCP/IP Protocol Suite: The OSI Model, Internet Architecture; Comparison of the OSI and TCP/IP reference model. Top-down approach **Cybersecurity:** Basics of Cyber Security-Attacks, Vulnerabilities and Threats. Need for Network Security, Data Security and physical security.	
MODULE 2	**9 Hrs**
Application Layer- Introduction, providing services, Applications layer paradigms, Client server model, Standard client-server application-HTTP, DNS, SSH. Malware Detection System, Types of Malware, Viruses & Counter Measures, Worms, Bots. **E-mail Security:** PGP, S/MIME. Secure socket programming using UDP and TCP.	
MODULE 3	**9 Hrs**

Transport Level Security: Functionality and services, TCP and UDP basics, Principles of Cryptography, Web Security Considerations, Secure Sockets Layer (SSL), Transport Layer Security, Data/Message Integrity and Digital Signatures.	
MODULE 4	**9 Hrs**
Network Layer Security: Network Security and Services, IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Internet Key Exchange. Virtual Private Network (VPN), Wireless Networks Security.	
MODULE 5	**9 Hrs**
Data Link Layer: LLC and MAC Sublayer services, Error detection and correction Techniques. **Physical Layer:** Introduction to Guided transmission media and wireless transmission media. Transmission mode, Classification of networks. Firewall, Intrusion Detection System (IDS)	

TEXT BOOK:

1. Computer Networking- A top-down approach- James F Kurose and Keith W Ross,6th Edition, Pearson Education.
2. Computer Security- Principles and Practice, William Stalling, Laurie Brown 4th Edition, Pearson

REFERENCES:

1. Behrouz A. Forouzan, Data Communications and Networking -, Fifth Edition TMH, 2013.
2. Computer Networks - Andrew S Tanenbaum, 4th Edition, Pearson Education.
3. James Graham, Richard Howard, Ryan Olson- Cyber Security Essentials CRC Press.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20DS2401**					
TITLE OF THE COURSE	**DATA SCIENCE - I**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	03	-	-	-	42	03

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES:

- To study and understand the use of High dimensional space in modelling data and the use of geometry and linear algebra to model the multi-dimensional data
- To study and understand the mathematics required for SVD applications such as centering data, PCA, clustering and ranking
- To deal with situations involving enormous amount of data and different models
- To understand randomized graph algorithms to model real life applications (WWW, internet, social networks, journal citations)

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand High dimensional space in modelling data and apply the concepts of geometry and linear algebra to model the multi-dimensional data.	L2
CO2	Design the mathematical model required for SVD applications.	L3
CO3	Analyze the applications involving enormous amount of data and different models and deal with them	L4
CO4	Understand randomized graph algorithms	L2
CO5	Apply randomized graph algorithms to model real life applications (WWW, internet, social networks, journal citations)	L3

COURSE CONTENT:	
MODULE 1	**08Hrs**

High Dimensional Space: Introduction, The Law of Large Numbers, The Geometry of High Dimensions, Properties of the Unit Ball, Volume of the Unit Ball, Volume Near the Equator, Generating Points Uniformly at Random from a Ball, Gaussians in High Dimension, Random Projection and Johnson-Lindenstrauss Lemma, Separating Gaussians, Fitting a Spherical Gaussian to Data.	
MODULE 2	**10Hrs**
Best-Fit Subspaces and Singular Value Decomposition (SVD): Introduction, Singular Vectors, Singular Value Decomposition (SVD), Best Rank-k Approximations, Left Singular Vectors, Power Method for Singular Value Decomposition, A Faster Method, Singular Vectors and Eigenvectors, Centering Data, Principal Component Analysis, Clustering a Mixture of Spherical Gaussians, Ranking Documents and Web Pages, An Application of SVD to a Discrete Optimization Problem.	
MODULE 3	**08Hrs**
Algorithms for Massive Data Problems: Streaming, Sketching, and Sampling: Introduction, Frequency Moments of Data Streams, Number of Distinct Elements in a Data Stream, Number of Occurrences of a Given Element, Frequent Elements, The Second Moment, Matrix Algorithms using Sampling, Matrix Multiplication using Sampling, Implementing Length Squared Sampling in Two Passes, Sketch of a Large Matrix, Sketches of Documents.	
MODULE 4	**08Hrs**
Random Graphs-1: The G(n, p) Model, Degree Distribution, Existence of Triangles in G(n, d/n), Phase Transitions, Giant Component, Existence of a giant component, No other large components, The case of p < 1/n, Cycles and Full Connectivity, Emergence of Cycles, Full Connectivity, Threshold for O(ln n) Diameter, Phase Transitions for Increasing Properties,	
MODULE 5	**08Hrs**
Random Graphs-2: Branching Processes, CNF-SAT, SAT-solvers in practice, Phase Transitions for CNF-SAT, Non uniform Models of Random Graphs, Giant Component in Graphs with Given Degree Distribution, Growth Models, Growth Model Without Preferential Attachment, Growth Model With Preferential Attachment, Small World Graphs, Case Studies	

TEXT BOOKS :

1. Foundations of Data Science, Avrim Blum, John Hopcroft, and Ravindran Kannan, January, 2018

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2407**					
TITLE OF THE COURSE	**OBJECT ORIENTED PROGRAMMING LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**30**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	****

COURSE OBJECTIVES :

- To learn an object oriented way of solving problems using java.
- To write Java programs using multithreading concepts and handle exceptions
- To write Java programs that connects to a database and be able to perform various operations.
- To create the Graphical User Interface using AWT Components & Swing Components.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Develop simple java programs that make use of classes and objects	L3
CO2	Write Java application programs using OOP principles and proper program structuring.	L3
CO3	Make use of inheritance and interfaces to develop java application	L3
CO4	Model exception handling, multi threading concepts in java	L3
CO5	Create the Graphical User Interface based application programs by utilizing event handling features and Swing in Java	L3
CO6	Develop Java program that connects to a database and be able to perform various operations.	L3

List of Laboratory/Practical Experiments activities to be conducted
1. Basic programs using data types, operators, and control statements in Java.
2. Basic programs using Arrays, , Strings in java
3. Object Oriented Programming Concepts: Problem on the use of constructors, inheritance, method overloading & overriding, polymorphism and garbage collection
4. Programs involving: Exception handling, Multi-threading in Java
5. Programs involving: Packages, Interfaces in Java

6. Programs involving: Input and Output in Java
7. GUI Programming in Java
8. Programs involving : Database connectivity in Java
9. Mini Project

TEXT BOOKS :

1. Bahrami A.; Object Oriented Systems Development using the Unified Modeling Language; McGraw Hill; 1999.
2. Schildt; Herbert. Java The Complete Reference; 8th Edition. US: McGraw-Hill Osborne Media; 2011.
3. Jim Keogh; J2EE: The Complete Reference; McGraw Hill Education in 2002.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20CS2408**					
TITLE OF THE COURSE	**MICROPROCESSORS LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**30**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	****

COURSE OBJECTIVES :

- To develop and execute variety of assembly language programs of Intel 8086 including arithmetic and logical, sorting, searching, and string manipulation operations
- To develop and execute the assembly language programs for interfacing Intel 8086 with peripheral devices.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Implement 8086 assembly language programs for microprocessor application using 8086 training boards	L3
CO2	Implement 8086 assembly language programs for microprocessor application using assembler and debuggers	L3
CO3	Design interfacing of various peripherals with 8086 microprocessor for simple applications	L3
CO4	Use Macros and Procedures in 8086 Programs	L3
CO5	Use assembly language and debugging tools when writing programs for a microprocessor	L3
CO6	Communicate effectively on the work done in the laboratory using formal report	L3

List of Laboratory/Practical Experiments activities to be conducted
Part-A: Software Programs Using Microprocessor Trainer Kit i) Programs involving : arithmetic operations, sorting ii) Programs on : code conversion (BCD TO HEX, Binary to ASCII, Binary to Gray) iii) Programs involving - Bit manipulation like checking: 1. Whether given data is positive or negative 2. Whether given data is odd or even

3. Logical 1‟s and 0‟s in a given data
Part- B: Software Programs Using MASM/TASM software i) Programs on : searching and sorting ii) Programs on : palindrome, string comparison iii) Programs on : current time display, Decimal up-counter display
Part-C: Hardware Programs to interface microprocessor with various peripherals Using Microprocessor Trainer Kit i) DC Motor Interface ii) Stepper Motor Interface iii) Matrix Keypad Interface iv) 7 Segment Display Interface

TEXT BOOKS :

1. Microprocessor and Interfacing - Douglas V Hall, SSSP Rao, 3^{rd} edition TMH, 2012.
2. The Intel Microprocessor, Architecture, Programming and Interfacing - Barry B. Brey, 6e, Pearson Education / PHI, 2003.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3501**					
TITLE OF THE COURSE	**COMPUTER NETWORKS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**39+26**	**4**

Perquisite Courses (if any)			
#	Sem /Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To introduce the fundamental aspects of various types of computer networks.
- To demonstrate the TCP/IP and OSI models with merits and demerits.
- To Understand the working principle of layering structure and basic network components
- To explore the features of each layer by various approach and methods

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand and explore the basics of Computer Networks and physical layer	L2
CO2	Understand about data link layer and its protocols	L2
CO3	Understand about routing mechanisms and different routing protocols	L2
CO4	Identify the issues of Transport layer to analyse the congestion control mechanism	L2
CO5	Explain principles of application layer protocols	L2

COURSE CONTENT	
MODULE 1: Overview of Networks	**9 Hrs**
Network Components- Network Physical Structure, Classification of networks (LAN-MAN-WAN), Protocols and Standards, Data representation and data flow, Layered Architecture –Comparison of the OSI and TCP/IP reference model. Physical Layer: Introduction to wired and wireless transmission media. Transmission mode (Serial/Parallel signals, Analog/Digital Signals and Periodic/Aperiodic Signals), Line coding Schemes.	
MODULE 2: Data Link Layer	9 **Hrs**
Data Link Layer – MAC (Media Access Control) and LLC (Logical Link Control) sublayer Functionalities– Design Issues: Framing – Flow control (Simplest protocol, Stop and wait, sliding	

window) – Error control (CRC, Hamming code) — Ethernet Basics-Multi Access Protocols: ALOHA, CSMA/CD, Connecting Devices: Hubs, Bridges, Switches, Routers, and Gateways	
MODULE 3: Network Layer	**8 Hrs**
Network Layer Design issues, Routing Protocol Basics, Routing Algorithm (Distance Vector Routing, Link State Routing and Hierarchical Routing). IP addressing, IP Packet format IPV4, IPV6 and IP Tunneling. Congestion control algorithms, QoS (Traffic Shaping, Packet Scheduling).	
MODULE 4: Transport Layer	7 **Hrs**
Transport Layer functions- Multiplexing and Demultiplexing. Introduction to TCP and UDP, The TCP Service Model, The TCP Segment Header, The TCP Connection Management, TCP Flow Control- Sliding Window, TCP Congestion Control, User Datagram Protocol	
MODULE 5: Application Layer	6 **Hrs**
Principles of Network Applications, WEB and HTTP, FTP, E-MAIL(SMTP, POP3), TELNET, DNS, SNMP	

List of Laboratory/Practical Experiments activities to be conducted

PART A

1. Implement three nodes point – to – point network with duplex links between them. Set the queue size, vary the bandwidth and find the number of packets dropped.
2. Implement transmission of ping messages/trace route over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
3. Implement an Ethernet LAN using n nodes and set multiple traffic nodes and plot congestion window for different source / destination.
4. Implement simple ESS and with transmitting nodes in wire-less LAN by simulation and determine the performance with respect to transmission of packets.
5. Implement and study the performance of GSM on NS2/NS3 (Using MAC layer) or equivalent Environment.
6. Implement and study the performance of CDMA on NS2/NS3 (Using stack called Call net) or equivalent environment.

PART B

Implement the following in Java:

7. Write a program for error detecting code using CRC.
8. Write a program to find the shortest path between vertices using bellman-ford algorithm.
9. Using TCP/IP sockets, write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if present. Implement the above program using as message queues or FIFOs as IPC channels.
10. Write a program on datagram socket for client/server to display the messages on client side, typed at the server side.

11. Write a program for simple RSA algorithm to encrypt and decrypt the data.
12. Write a program for congestion control using a leaky bucket algorithm.

TEXT BOOKS:

1. Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition TMH, 2013.
2. Computer Networks - Andrew S Tanenbaum, 5th Edition, Pearson Education.

REFERENCES:

1. James F. Kurose, Keith W. Ross, “Computer Networking: A Top-Down Approach”, Seventh Edition, Pearson Education, 2017.
2. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.
3. William Stallings, “Data and Computer Communications”, Tenth Edition, Pearson Education, 2014.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3502**					
TITLE OF THE COURSE	**DESIGN AND ANALYSIS OF ALGORITHMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**	***	***

COURSE OBJECTIVES:

- To introduce and implement various techniques for designing algorithms and advanced data structures
- To learn space and time complexity analysis of algorithms.
- To understand the Divide and conquer design strategy and the Greedy Technique
- To understand the concepts of Dynamic Programming Applications
- Synthesize efficient algorithms in common engineering design situations

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Outline the overview of Data structures and Algorithms	L1
CO2	Understand the different Algorithmic Design strategies	L2
CO3	Apply the Design principles and concepts to Algorithmic design	L3
CO4	Describe the DAA paradigms and when an Algorithmic Design situation calls for it.	L6
CO5	Analyse the efficiency of Algorithms using Time and Space complexity theory	L4
CO6	Implement an existing algorithm to improve the run time efficiency	L3

COURSE CONTENT:	
MODULE 1: INTRODUCTION	**8 Hrs**
The role of Algorithms in Computing, Running time analysis -- recall of asymptotic notation, big-oh, theta, big-omega, and introduce little-oh and little-omega. Worst case and average case complexity	
MODULE 2: DIVIDE AND CONQUER	**9 Hrs**
Recursive algorithms, Divide-and-Conquer recurrences, Methods for solving recurrences: substitution method, recursion tree method and the Master method. Examples-Binary search, Quick sort, Merge sort, Strassen's Matrix Multiplication. GREEDY METHOD Minimum cost spanning tree, Knapsack problem, Fractional knapsack	
MODULE 3: DYNAMIC PROGRAMMING	**9 Hrs**

Integral knapsack (contrasted with the fractional variant: 0/1 knapsack), longest increasing subsequence, All pair shortest path in graph, Matrix chain multiplication, Travelling salesman Problem	
MODULE 4: APPLICATION OF GRAPH TRAVERSAL TECHNIQUES	**7 Hrs**
Recall representation of graphs, BFS, DFS, connected components, Strongly-connected components of DAGs, Kosaraju's algorithm 1 and 2, Applications.	
MODULE 5: REASONING ABOUT ALGORITHMS	**6 Hrs**
Complexity Analysis (Polynomial vs Non-Polynomial time complexity), P, NP-hard and NP-Completeness, Reductions.	

TEXT BOOK:

1. T. H. Cormen, Leiserson, Rivest and Stein, "Introduction of Computer algorithm," , 3rd Edition, The MIT Press, 2015

REFERENCES:

1. Anany Levitin, ―Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012
2. Sara Basse, A. V. Gelder, "Computer Algorithms : Introduction Design & Analysis", 3rd Edition, Addison Wesley.
3. J.E Hopcroft, J.D Ullman, "Design and analysis of Computer algorithms", PearsonEducation, 2009.
4. Steven S. Skiena, "The Algorithm Design Manual", Second Edition, Springer, 2008

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3503**					
TITLE OF THE COURSE	**OPERATING SYSTEMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	***	***	****

COURSE OBJECTIVES:

- To understand the basic concepts and functions of operating systems.
- To understand Processes and Threads
- To analyze Scheduling algorithms.
- To understand the concept of Deadlocks.
- To analyze various Memory and Virtual memory management, File system and storage techniques.
- To discuss the goals and principles of protection in a modern computer system.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO 1	Demonstrate need for OS and different types of OS	L2
CO 2	Analyze the performance of scheduling algorithms for the given problems	L4
CO 3	Demonstrate Process Coordination and synchronization techniques.	L2
CO4	Apply the deadlock handling mechanisms to solve the given problem	L3
CO 5	Apply suitable techniques for management of different Resources	L3
CO 6	Understand the principles of protection and security Mechanisms	L2

COURSE CONTENT:	
MODULE 1: OS Overview and System Structure	**10 Hrs**
Introduction to operating systems, System structures: What operating systems do; Computer System organization; Computer System architecture; Operating System structure; Operating System operations; Process management; Memory management; Storage management; Protection and Security; Distributed system; Computing environments. Operating System Services: User - Operating System interface; System calls; Types of system calls; System programs; Operating system design and implementation; Operating System structure; Virtual machines;	

MODULE 2: Process Management	12 Hrs
Process Management: Process concept; Process scheduling; Operations on processes. Multi-threaded Programming: Overview; Multithreading models; Threading issues. Process Scheduling: Basic concepts; Scheduling Criteria; Scheduling Algorithms.	
MODULE 3: Process Coordination	**10 Hrs**
Process Synchronization: The critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors Deadlocks: Deadlocks; System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.	
MODULE 4: Memory Management	**10Hrs**
Memory Management Strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation. Virtual Memory Management: Background; Demand paging; Copy-on-write; Page replacement; Allocation of frames; Thrashing.	
MODULE 5: File System and Secondary Storage Structure	**10 Hrs**
File System, Implementation of File System**:** File system: File concept; Access methods; Directory structure; File system mounting; File sharing. Protection: Implementing File system: File system structure; File system implementation; Directory implementation; Allocation methods; Free space management. Mass storage structures; Disk structure; Disk attachment; Disk scheduling; Disk management; Swap space management. Protection and Security: Protection: Goals of protection, Principles of protection, System Security: The Security Problem, Program Threats, System and Network Threats.	

TEXT BOOKS:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 8th edition, Wiley-India, 2010

REFERENCES:

1. Operating Systems-Internals and Design Principles, William Stallings, 6th Edition, Pearson Education, 2009.
2. Operating Systems: A Modern Perspective, Gary J. Nutt, Addison-Wesley, 1997

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3504**					
TITLE OF THE COURSE	**MACHINE LEARNING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**39+26**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	****

COURSE OBJECTIVES:

- Define machine learning and understand the basic theory underlying machine learning.
- To understand the working principle of Machine Learning Algorithms
- To apply various techniques of Machine Learning Algorithms
- Perform statistical analysis of machine learning techniques.

COURSE OUTCOMES:

CO No.	Outcomes	Taxonomy Level
CO1	Describe the basic concepts and different types of Machine Learning	L2
CO2	Explore and analyse the mathematics behind Machine Learning algorithms	L2
CO3	Apply the design principles and concepts of Machine Learning Algorithms	L3
CO4	Apply effectively Unsupervised Machine Learning algorithms and various learning techniques for appropriate applications.	L3
CO5	Explore, analyse and validate the different Machine Learning algorithms	L3

COURSE CONTENT:	
MODULE 1: Introduction to Machine Learning	**7Hrs**
Well posed learning problems, Designing a Learning system. Introduction to AI, Machine learning and Deep	

learning with applications. Types of learning: supervised, unsupervised and reinforcement learning. Perspective and Issues in Machine Learning.

Classical paradigm of solving learning problems, The learning problems--classes and types of learning, fundamental of statistical learning and its framework. Introduction to feature representation and extraction.	
MODULE 2: Mathematics for Machine Learning	**8Hrs**
Introduction to Statics Probability (joint probability, conditional probability, Bayes theorem, different distributions, univariate and multivariate Gaussian distribution, PDF, MLE, Motivation, estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypothesis, Comparing learning algorithms.	
MODULE 3: Supervised Learning	**9Hrs**
Introduction to Supervised Learning, Introduction to Perceptron model and its adaptive learning algorithms (gradient Decent and Stochastic Gradient Decent), Introduction to classification, Naive Bayes classification Binary and multi class Classification, decision trees and random forest, Regression (methods of function estimation) --Linear regression and Non-linear regression, logistic regression, Introduction To Kernel Based Methods of machine learning: K-Nearest neighbourhood , kernel functions, SVM, Introduction to ensemble based learning methods	
MODULE 4: Unsupervised Learning	**8 Hrs**
Introduction to Unsupervised Learning, Clustering (hard and soft clustering) Hierarchal clustering: K-means, Fuzzy C-Means (FCM) algorithm, Gaussian mixture models (GMM), Expectation Maximization algorithm, feature Engineering in Machine Learning, Dimensionality reduction, Linear Discriminant Analysis and Principle Component Analysis.	
MODULE 5: Model Selection	**7Hrs**
Machine Learning model validation - Confusion Matrix, Accuracy, Precision, F score, Cost function, Machine Learning Optimization algorithms: Gradient descent, stochastic GD. Regularization: Normalization and Standardization overfitting, underfitting, optimal fit, bias, variance, cross-validation.	

List of Laboratory/Practical Experiments activities to be conducted
1. Implementation of linear and logistic regression 2. Implementation of SVM, KNN, Naïve Bayes ML algorithms 3. Implementation of Decision trees, Random Forest classifiers 4. Implement ensemble algorithms. 5. Implementation of different clustering algorithms and PCA Implementation of different neural networks Capstone project in specific domains (Health care, Transportation, Telecom etc.)

TEXT BOOKS;

1. Thomas M. Mitchell, Machine Learning, McGraw- Hill, Inc. New York, ISBN: 0070428077 9780070428072.
2. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press book in preparation. (2015).

REFERENCE BOOKS:

1. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning series), The MIT Press; second edition, 2009.

2. V. N. Vapnik " The Nature of statistical Learning.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3505**					
TITLE OF THE COURSE	**DESIGN AND ANALYSIS OF ALGORITHMS LABORATORY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**26**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	****	****	****

COURSE OBJECTIVES:

- To learn mathematical background for analysis of algorithm
- To understand the concept of designing an algorithm.
- To analyze the algorithms using space and time complexity.
- To learn dynamic programming and greedy method.
- To acquire knowledge of various applied algorithms.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Design and develop the Algorithms to understand the different concepts.	L3
CO2	Apply the Design principles and concepts to Algorithmic design	L3
CO3	Describe the DAA paradigms and when an Algorithmic Design situation calls for it.	L6
CO4	Analyse worst-case and best – case running times of algorithms using asymptotic analysis.	L4
CO5	Implement an existing algorithm to improve the run time efficiency	L3

List of Laboratory/Practical Experiments activities to be conducted
1. Design a C program to solve the Tower of Hanoi. Compute the time complexity.
2. Apply divide and conquer method and Design a C program to search an element in a given array and Compute the time complexity. Binary search - recursive method
3. Apply Divide and Conquer method Design a C program to sort an array using Merge sort algorithm

and compute its time complexity

4. Apply Divide and Conquer method Design a C program to sort an array using Quick sort algorithm and compute its time complexity.
5. Apply Greedy method and Design a C program to find the minimum cost spanning tree using Prim’s and Kruskal’s Algorithm and compute its complexity
6. Apply Dynamic Programming Technique and Design a C program to find the all pairs shortest path using Dijkstra’s Algorithm and computes its complexity
7. Design a C program to find the optimal solution of 0-1 knapsack problem using dynamic programming and Compute the time complexity
8. Design a C program to solve the Travelling Salesman Problem using dynamic programming and compute its time complexity.
9. Design a C program to find the longest common subsequence using dynamic programming and compute its time complexity
10. Mini project proposal should be submitted and Implementation should be done based on the problem stated in the proposal

TEXT BOOK:

1. Levitin A, “Introduction to the Design And Analysis of Algorithms”, Pearson Education, 2008.
2. T. H. Cormen, Leiserson, Rivest and Stein, “Introduction of Computer algorithm,” , 3rd Edition, The MIT Press, 2015

REFERENCES:

1. E. Horowitz, S. Sahni, and S. Rajsekaran, “Fundamentals of Computer Algorithms,” Galgotia Publication, 2015.
2. Goodrich M.T., R Tomassia, “Algorithm Design foundations Analysis and Internet Examples”, John Wiley and Sons, 2006.
3. Sara Basse, A. V. Gelder, “Computer Algorithms : Introduction Design & Analysis”, 3rd Edition, Addison Wesley.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20CS3506**					
TITLE OF THE COURSE	**OPERATING SYSTEMS LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**26**	**1**

Perquisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
*	**	***	****

COURSE OBJECTIVES:

- To learn creating process and Threads
- To implement various CPU Scheduling Algorithms
- To implement Process Creation and Inter Process Communication.
- To implement Deadlock Avoidance and Deadlock Detection Algorithms
- To implement Page Replacement Algorithms
- To implement File Organization and File Allocation Strategies

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Implement System Calls	L2
CO2	Compare the performance of various CPU Scheduling Algorithms	L3
CO3	Analyze Deadlock avoidance and Detection Algorithms	L3
CO4	Implement Semaphores	L2
CO5	Analyze the performance of the various Page Replacement Algorithms	L3
CO6	Implement File Organization and File Allocation Strategies	L2

List of Laboratory/Practical Experiments activities to be conducted		
Exp. No	Division of Experiments	List of Experiments
1	System Calls	Write a C program to create a new process that exec a new program using system calls fork(), execlp() & wait()
2		Write a C program to display PID and PPID using system calls getpid () & getppid ()
3		Write a C program using I/O system calls open(), read() & write() to copy contents of one file to another file
4	Process Management	Write a C program to implement multithreaded program using pthreads
5		Write C program to simulate the following CPU scheduling algorithms a) FCFS b) SJF c) Priority d) Round Robin
6	Process synchronization	Write a C program to simulate producer-consumer problem using semaphores
7	Deadlock	Write a C program to simulate Bankers algorithm for the purpose of deadlock avoidance.
8		Write a C program to simulate deadlock detection.
9	Memory Management	Write a C program to simulate paging technique of memory management
10		Write a C program to simulate page replacement algorithms a) FIFO b) LRU c) LFU
11	I/O System	Write a C program to simulate the following file organization techniques a) Single level directory b) Two level directory
12		Write a C program to simulate the following file allocation strategies. a) Sequential b) Indexed

TEXT BOOKS:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 8th edition, Wiley-India, 2010

REFERENCES:

1. Operating Systems-Internals and Design Principles, William Stallings, 6th Edition, Pearson Education, 2009.

2. Operating Systems: A Modern Perspective, Gary J. Nutt, Addison-Wesley, 1997

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20DS3501**					
TITLE OF THE COURSE	**DATA WAREHOUSE AND KNOWLEDGE MINING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Projects Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will emphasize the study of data warehousing.	L2
CO2	Understanding the data mining applications	L2
CO3	Apply mining techniques and algorithms to real life problems	L2
CO4	Describing Classification and Clustering algorithms for various applications	L2
CO5	Special emphasis will be given on the recent trends in mining text data, mining graphs, mining, spatio-temporal data, using Weka and R	L2

COURSE CONTENT	
MODULE 1	**9 Hrs**
Data Warehousing, Business Analysis And On-Line Analytical Processing (OLAP)-Basic Concepts - Data Warehousing Components – Building a Data Warehouse – Database Architectures for Parallel Processing – Parallel DBMS Vendors - Multidimensional Data Model – Data Warehouse Schemas for Decision Support, Concept Hierarchies -Characteristics of OLAP Systems – Typical OLAP Operations, OLAP and OLTP, Data Cube.	
MODULE 2	**8 Hrs**
Introduction to Data Mining Systems – Knowledge Discovery Process – Data Mining Techniques – Issues – applications- Data Objects and attribute types, Statistical description of data, Data Preprocessing – Cleaning, Integration, Reduction, Transformation and discretization, Data Visualization, Data similarity and dissimilarity measures.	
MODULE 3	**7 Hrs**

Data Mining - Frequent Pattern Analysis-Mining Frequent Patterns, Associations and Correlations – Mining Methods- Pattern Evaluation Method – Pattern Mining in Multilevel, Multi-Dimensional Space – Constraint Based Frequent Pattern Mining, Classification using Frequent Patterns	
MODULE 4	**8 Hrs**
Classification and Clustering- Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by BackPropagation – Support Vector Machines — Lazy Learners – Model Evaluation and Selection-Techniques to improve Classification Accuracy. Clustering Techniques – Cluster analysis- Partitioning Methods - Hierarchical Methods – Density Based Methods - Grid Based Methods – Evaluation of clustering – Clustering high dimensional data- Clustering with constraints, Outlier analysis-outlier detection methods	
MODULE 5	**7 Hrs**
Introduction to WEKA and R programming for the data mining applications: Special data mining, multimedia data mining, text mining and mining the www.	

TEXT BOOKS:

1. Jiawei Han, Micheline Kamber and Jian Pei “Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2011.
2. Amitesh Sinha, “Data Warehousing”, Thomson Learning, 2007.

REFERENCES:

1. Introduction to Data Mining – Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Pearson education
2. Data Mining: Practical Machine Learning Tools and Techniques by Ian H. Witten and Eibe Frank, Morgan Kaufmann
3. Margaret H Dunham, “Data Mining Introductory and Advanced Topics”, 2e, Pearson Education, 2006.
4. https://www.tutorialspoint.com/weka/index.htm

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**20DS3502**					
TITLE OF THE COURSE	**FULL STACK DEVELOPMENT**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	TotalHours	Credits
	3	**-**	**-**	**-**	**39**	**3**

Prerequisite Courses			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

1. Understand the major areas of web programming
2. To gain the skill into web applications and development.
3. To create website using HTML5, CSS3, JavaScript.
4. Server Side Scripting using Node.JS, Express JS and Mongo dB

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Know the fundamentals of front end web technologies using HTML 5 and CSS3	L1
CO2	Apply Cascading Style Sheets and XHTML to the idea of a web application.	L3
CO3	Comprehend the principles of client-side programming and understand how to use JavaScript to implement them in order to create dynamic web sites.	L3
CO4	Implementing the principles of server side programming using Node.js, Mongo dB	L3
CO5	Applying the Node.js framework -Express.JS to create web applications faster and smarter	L3

COURSE CONTENT:	
MODULE 1: Markup Language (HTML5)	**4 Hrs**
Introduction to HTML and HTML5 - Formatting and Fonts -Commenting Code – Anchors – Backgrounds – Images – Hyperlinks – Lists – Tables – HTML Forms, Audio ,Video Tag.	
MODULE 2: CSS3	**4 Hrs**
CSS3: Levels of style sheets; Style specification formats; Selector forms; Property value forms; Font properties; List properties; Color; Alignment of text; Background images, Conflict Resolution, CSS Box Model .CSS3 features: Box Shadow, Opacity, Rounded corners, Attribute selector.	
MODULE 3 : JavaScript	**6 Hrs**
Overview of JavaScript; Object orientation and JavaScript; General syntactic, characteristics; Primitives, operations, and expressions; Screen output and keyboard input. Control statements; Arrays; Functions, Constructors; A brief introduction on pattern matching using regular expressions, DOM Events	
MODULE 4: Node JS	**6 Hrs**
Introduction to NodeJS, Set up Dev Environment, Node JS Modules, Node Package Manager, File System, Events, Database connectivity using Mongo DB.	
MODULE 5: Express.JS	**6 Hrs**
Introducing Express: Basics of Express, Express JS Middleware: Serving Static Pages ,Listing Directory Contents, Accepting JSON Requests and HTML Form Inputs, Handling Cookies.	

TEXT BOOKS:

1. Robert W. Sebesta , ”Programming the World Wide Web”, 7th Edition, Pearson Education, 2008.
2. Basarat Ali Syed,” Beginning Node.js “,Apress ,2014

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS3601**					
TITLE OF THE COURSE	**COMPILER DESIGN AND SYSTEMS SOFTWARE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
*	**	**	***

COURSE OBJECTIVES:

1. To explain the basic system software components such as assembler, loader, linkers, compilers.
2. Provide an understanding of the fundamental principles in compiler design
3. To discuss the techniques of scanning, parsing & semantic elaboration well enough to build or modify front end.
4. To illustrate the various optimization techniques for designing various optimizing compilers.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the architecture of a hypothetical machine, structure and design of assembler.	L2
CO2	Analyse how linker and loader create an executable program from an object module created by assembler	L4
CO3	Describe the major phases of compilation and to apply the knowledge of Lex tool & YAAC tool	L2
CO4	Explain the syntax analysis phase and identify the similarities and differences among various parsing techniques and grammar transformation methods	L2
CO5	Use formal attributed grammars for specifying the syntax and semantics of programming languages.	L3
CO6	Summarize various optimization techniques used for dataflow analysis and generate machine code from the source code of a novel language.	L2

COURSE CONTENT:	
MODULE 1: Introduction to System Software,	**10Hrs**

ASSEMBLERS	
Introduction to System Software, Machine Architecture of SIC and SIC/XE. ASSEMBLERS: Basic assembler functions: A simple assembler, Assembler algorithm and data structures, Machine dependent assembler features: Instruction formats and addressing modes – Program relocation, Machine independent assembler features: Literals, Symbol-defining statements, Expressions, Program blocks	
MODULE 2 : LOADERS AND LINKERS:	**9Hrs**
Basic loader functions: Design of an Absolute Loader, A Simple Bootstrap Loader, Machine dependent loader features: Relocation, Program Linking, Algorithm and Data Structures for Linking Loader, Machine-independent loader features: Automatic Library Search, Loader Options, Loader design options: Linkage Editors, Dynamic Linking	
MODULE 3: COMPILERS	**11Hrs**
Introduction: Language Processors, Structure of compiler, The science of building a compiler, Applications of compiler technology. LEXICAL AND SYNTAX ANALYSIS: Role of lexical Analyzer, Specification of Tokens, Lexical Analyzer generator Lex. SYNTAX ANALYSIS I: Role of Parser, Syntax error handling, Error recovery strategies, Writing a grammar: Lexical vs Syntactic Analysis, Eliminating ambiguity, Left recursion, Left factoring.	
MODULE 4: SYNTAX ANALYSIS II	**12Hrs**
Top down parsing: Recursive Descent Parsing, First and follow, LL (1), –Bottom up parsing: Shift Reduce Parsing, Introduction to LR parsing Simple LR: Why LR Parsers, Items and LR0 Automaton, The LR Parsing Algorithm. SYNTAX-DIRECTED TRANSLATION: Syntax-Directed Definitions: Inherited and Synthesized Attributes, Evaluation orders for SDDs: Dependency graphs, Ordering the evaluation of Attributes, S-Attributed Definition, L-Attributed Definition, Application: Construction of Syntax Trees.	
MODULE 5: INTERMEDIATE CODE GENERATION	**10Hrs**
Three Address Code: Addresses and Instructions, Quadruples, Triples, indirect triples. CODE GENERATION: Issues in the design of code generator, Basic Blocks, Optimization of Basic Blocks, The Code Generation Algorithm, Peephole optimization. MACHINE INDEPENDENT OPTIMIZATION: The Principal Sources of Optimization	

TEXT BOOKS:

1. Leland L. Beck, “System Software – An Introduction to Systems Programming”, 3rd Edition, Pearson Education Asia, 2006.
2. Alfred V Aho, Monica S. Lam, Ravi Sethi and Jeffrey D Ullman, “Compilers – Principles, Techniques and Tools”, 2nd Edition, Pearson Education, 2007.

REFERENCES:

1. V. Raghavan, Principles of Compiler Design‖, Tata McGraw Hill Education Publishers, 2010.
2. Keith D Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann Publishers Elsevier Science, 2004.
3. D.M.Dhamdhere, Systems Programming and operating systems, Second Revised edition, Tata McGraw Hill.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20DS3601**					
TITLE OF THE COURSE	**DATA ANALYTICS WITH HADOOP**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I, II/I	20EN1103	FUNDAMENTALS OF PROGRAMMING

COURSE OBJECTIVES:

- To Learn business case studies for big data analytics
- To Understand Nosql big data management
- To manage Big data without SQL
- To understanding map-reduce analytics using Hadoop and related tools

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Describe big data and use cases from selected business domains	L1
CO2	Explain NoSQL big data management	L2
CO3	Install, configure, and run Hadoop and HDFS	L3
CO4	Perform map-reduce analytics using Hadoop	L4
CO5	Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data Analytics	L5

COURSE CONTENT:	
MODULE 1	**9 Hrs**

UNDERSTANDING BIG DATA: What is big data – why big data – Data Storage and Analysis, Comparison with Other Systems, Rational Database Management System , Grid Computing, Volunteer Computing, convergence of key trends – unstructured data – industry examples of big data –big data and healthcare – big data in medicine – advertising and big data.	
MODULE 2	**7 Hrs**
NOSQL DATA MANAGEMENT: Introduction to NoSQL – aggregate data models – aggregates – key-value and document data models – relationships –graph databases – schema less databases – materialized views – distribution models – sharding — version – Map reduce –partitioning and combining – composing map-reduce calculations	
MODULE 3	**7 Hrs**
BASICS OF HADOOP: Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression– serialization – Avro – file-based data structures.	
MODULE 4	**8 Hrs**
MAP REDUCE APPLICATIONS: MapReduce workflows – unit tests with MR Unit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution –MapReduce types – input formats – output formats	
MODULE 5	**8 Hrs**
HADOOP RELATED TOOLS: Hbase – data model and implementations – Hbase clients – Hbase examples –praxis. Cassandra – Cassandra data model –cassandra examples – cassandra clients –Hadoop integration. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation –HiveQL queries.	

TEXT BOOKS:

1. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.

REFERENCES:

1. Vignesh Prajapati, Big data analytics with R and Hadoop, SPD 2013.
2. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
3. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
4. Alan Gates, "Programming Pig", O'Reilley, 2011

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20DS3602**					
TITLE OF THE COURSE	**DATA SCIENCE-II**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

Prerequisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
***	4^{th} /2nd	20DS2401	DATA SCIENCE-1

COURSE OBJECTIVES:

- To use the statistical and computational techniques to Discover, Analyze, Visualize and Present the Data.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To Summarize the data using visual & summary analytics and common probability distributions	L2
CO2	To make inference about a sample & population using hypothesis test.	L2
CO3	To fit, interpret, and assess regression models and classification with one or more predictors.	L6
CO4	To assess the data integrity and data relevancy to a specific application	L3
CO5	To understand the significance of clustering and classification	L3

COURSE CONTENT:	
MODULE 1	**8 Hrs**
Overview of the Data Science process. Different types of data, Data Preprocessing: Data Cleaning-Missing values, Noisy data, Data cleaning as process, Data Reduction: Principal Components Analysis, Data Transformation: Strategies Overview, Data Transformation by normalization, Discretization by binning. Introducing Python Libraries (Pycharm)	
MODULE 2	**9 Hrs**
Exploratory Data Analysis: Central Tendency, Dispersions, Five number Distributions, Cross Tabulations. Data Visualization: Histogram, Box Plot, Correlation Plot, Scatter Plot, Line Chart, Bar Chart, Pie Chart, Bubble Chart, Decision Tree, Cluster Charts.Hypothesis Testing: Confidence Intervals,Constructing a hypothesis, Null Hypothesis & Alternative Hypothesis, Type I and Type II	

errors, Power Value	
MODULE 3	**8 Hrs**
Parametric test: Z test, One Sample T-TEST, Paired T-TEST, Independent Sample T-TEST, ANOVA, MANOVA, Level of significance, Power of a test. Non parametric test: Chi Square Test, Fisher's Test, Mann-Whitney U test, Kruskal-Wallis Rank Test, Wilcoxon sign rank.	
MODULE 4	**7 Hrs**
Classification Models: Logistic Regression, Discriminate Regression Analysis, Test of Associations, Chi-square strength of association, Maximum likelihood estimation, Confusion matrix, Support Vector Machines (SVM), Naive Bayes, Random Forests: Bagging & Boosting, CHAID Analysis, Decision trees, k-Nearest Neighbors, Neural Network.	
MODULE 5	**7 Hrs**
Unsupervised Learning: Principle component analysis, Reliability Test, KMO tests, Eigen Value Interpretation, Rotation and Extraction steps. Clustering Methods: K Means clustering, Agglomerative Clustering	

Textbooks:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services,Wiley
2. Jiawei Han, Micheline Kember and Jian Pei, Data Mining Concepts and Techniques, 3rd edition, Elsevier, 2012
3. Statistics for Managers Using Microsoft Excel , 8th Edition, by David M. Levine , David F. Stephan , and Kathryn A. Szabat , Publisher: Pearson

Reference Books:

1. Data Mining in excel: Lecture Notes and cases by Galit Shmueli, Publisher: Wiley
2. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd ed)., Springer, 2008.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS3604**					
TITLE OF THE COURSE	**COMPILER DESIGN AND SYSTEM SOFTWARE LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**26**	**1**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Experiment on the basic techniques of compiler construction and tools that can used to perform syntax-directed translation of a high-level programming language into an executable code.
- Know the implementation of assemblers, loaders and various parsing techniques.
- Learn how to optimize and effectively generate machine codes.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Identify patterns, tokens & regular expressions for lexical analysis.	L2
CO2	Develop LEX and YACC programs for lexical and syntax analysis phases of Compiler.	L3
CO3	Implement the pass 1 of two pass assembler and absolute loader algorithm	L3
CO4	Analyze and Implement the bottom up parsing technique	L4
CO5	Implement front end of the compiler by means of generating intermediate codes. .	L3

List of Laboratory/Practical Experiments activities to be conducted
1a. Program to count the number of characters, words, spaces and lines in a given input file.
1b. Program to recognize and count the number of identifiers in a file.
2a. Program to count the numbers of comment lines in a given C program. Also eliminate them and copy the resulting program into separate file.

2b. Program to recognize whether a given sentence is simple or compound.

3a. Program to count no of: i.+ve and –ve integers ii. +ve and –ve fractions
3b. Program to count the no of „scanf" and „printf" statements in a C program. Replace them with "readf" and "writef" statements respectively.
4.Program to evaluate arithmetic expression involving operators +,-,*,/
5. Program to recognize a valid variable which starts with a letter, followed by any number of letters or digits.
6. Program to recognize the strings using the grammar ($a^n b^n$;n>=0)
7. C Program to implement Pass1 of Assembler
8. C Program to implement Absolute Loader
9. C program to find the FIRST in context free grammar.
10.C Program to implement Shift Reduce Parser for the given grammar E →E+E E→E*E E→(E) E → id
11. C Program to implement intermediate code generation for simple expression

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20DS3603**					
TITLE OF THE COURSE	**DATA SCIENCE LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**2**	**-**	**26**	**01**

Prerequisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
***	4^{th} /2nd	20DS2401	DATA SCIENCE-1

COURSE OBJECTIVES:

- To use the statistical and computational techniques to Discover, Analyze, Visualize and Present the Data.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To Summarize the data using visual & summary analytics and common probability distributions	L2
CO2	To make inference about a sample & population using hypothesis test.	L2
CO3	To fit, interpret, and assess regression models and classification with one or more predictors.	L6
CO4	To assess the data integrity and data relevancy to a specific application	L3
CO5	To understand the significance of clustering and classification	L3

List of Experiments activities to be conducted

1. R AS CALCULATOR APPLICATION a. Using with and without Python/R objects on console b. Using Python/R mathematical functions on console
2. DESCRIPTIVE STATISTICS IN R a. Write an Python/R script to find basic descriptive statistics using summary, str, quartile function on mtcars & cars datasets. b. Write an Python/R script to find subset of dataset by using subset (), aggregate () functions on

iris dataset.
3. READING AND WRITING DIFFERENT TYPES OF DATASETS a. Reading types of data sets (.txt, .csv) from web and disk and writing in file in specific disk location. different b. Reading Excel data sheet in Python/R. c. Reading XML dataset in Python/R.
4. VISUALIZATIONS USING PYTHON/R a. Find the data distributions using box and scatter plot. b. Find the outliers using plot. c. Plot the histogram, bar chart and pie chart on sample data
5. CORRELATION AND COVARIANCE USING Python/R a. Find the correlation matrix. b. Plot the correlation plot on the dataset and visualize giving an overview of relationships among data on iris data. c. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.
6. REGRESSION MODEL using Python/R Import data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in an institute based on his or her GRE score, GPA obtained and rank of the student. Also check if the model is fit or not.
7. MULTIPLE REGRESSION MODEL Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset
8. REGRESSION MODEL FOR PREDICTION Apply regression Model techniques to predict the data on above dataset.
9. CLASSIFICATION MODEL a. Install relevant package for classification. b. Choose classifier for a classification problem. c. Evaluate the performance of classifier.
10. CLUSTERING MODEL a. Clustering algorithms for unsupervised classification. b. d. Plot the cluster data using R visualizations.

Textbooks:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services,Wiley
2. Jiawei Han, Micheline Kember and Jian Pei, Data Mining Concepts and Techniques, 3rd edition, Elsevier, 2012

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20DS3605**					
TITLE OF THE COURSE	**BUSINESS INTELLIGENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- To understand the fundamentals of Business Intelligence
- To identify the appropriateness and need Analysis the data
- To learn the preprocessing, mining and post processing of the data
- To understand various methods, techniques and algorithms in Business Intelligence

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Apply basic, intermediate and advanced techniques to analysis the data	L2
CO2	Analyze the output generated by the process of Business Intelligence	L2
CO3	Explore the hidden patterns in the data	L6
CO4	Optimize the mining process by choosing best Business Intelligence technique	L3
CO5	Applying the BI techniques in different applications	L3

COURSE CONTENT:	
Module 1	**9Hrs**
Business Intelligence: Effective and timely decisions – Data, information and knowledge – Role of mathematical models – Business intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence.	

Module 2	8 Hrs
Knowledge Delivery: The business intelligence user types, Standard reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, dimensional analysis. Visualization: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Visualization	
Module 3	**8 Hrs**
Decision Making Concepts: Concepts of Decision Making, Techniques of Decision Support System (DSS), Types of Decision Support System (DSS), Development of Decision Support System (DSS), Applications of DSS, Role of Business Intelligence in DSS	
Module 4	**7 Hrs**
Classification: Classification Problem, Classification Models, Classification Trees, Bayesian Method; Association Rule: Structure of Association Rule, Apriori Algorithm, General Association; Clustering: Clustering Methods, Partition Methods, Hierarchical Methods**.**	
Module 5	**7 Hrs**
Business Intelligence Applications: Data analytics, business analytics, ERP and Business Intelligence, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications	

Textbooks:

1. R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support,10th Edition. Pearson/Prentice Hall, 2015.ISBN-13: 978-0-13-305090-5, ISBN-10: 0-13-305090-4;
2. Business Process Automation, Sanjay Mohapatra, PHI.

Reference Books:

1. Larissa T. Moss, S. Atre, "Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making", Addison Wesley, 2003.
2. Carlo Vercellis, "Business Intelligence: Data Mining and Optimization for Decision Making", Wiley Publications, 2009.
3. David Loshin Morgan, Kaufman, "Business Intelligence: The Savvy Manager"s Guide", Second Edition, 2012.
4. Cindi Howson, "Successful Business Intelligence: Secrets to Making BI a Killer App", McGraw-Hill, 2007.
5. Ralph Kimball , Margy Ross , Warren Thornthwaite, Joy Mundy, Bob Becker, "The Data Warehouse Lifecycle Toolkit", Wiley Publication Inc.,2007.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20DS3606**					
TITLE OF THE COURSE	**PATTERN ANALYSIS FOR DATA SCIENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
***	***	***	***

COURSE OBJECTIVES:

- Numerous examples from machine vision, speech recognition and movement recognition have been discussed as applications.
- Unsupervised classification or clustering techniques have also been addressed in this course.
- Analytical aspects have been adequately stressed so that on completion of the course the students can apply the concepts learnt in real life problems

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Know feature extraction techniques and representation of patterns in feature space.	L2
CO2	Measure of similarity between two patterns. Statistical, nonparametric and neural network techniques for pattern recognition.	L2
CO3	Understand Techniques for recognition of time varying patterns.	L6
CO4	Analyzing the unsupervised learning algorithms for pattern recognition	L3
CO5	Understanding the significance of neural network in pattern analysis	L6

COURSE CONTENT:	
Module 1	**9Hrs**
Introduction: Feature extraction and Pattern Representation, Concept of Supervised and Unsupervised Classification, Introduction to Application Areas. Statistical Pattern Recognition: Bayes Decision Theory, Minimum Error and Minimum Risk Classifiers, Discriminant Function and Decision Boundary, Normal Density, Discriminant Function	

for Discrete Features, Parameter Estimation.	
Module 2	**8 Hrs**
Dimensionality Problem**:** Dimension and accuracy, Computational Complexity, Dimensionality Reduction, Fisher Linear Discriminant, Multiple Discriminant Analysis. Nonparametric Pattern Classification: Density Estimation, Nearest Neighbour Rule, Fuzzy Classification.	
Module 3	**8 Hrs**
Linear Discriminant Functions: Separability, Two Category and Multi Category Classification, Linear Discriminators, Perceptron Criterion, Relaxation Procedure, Minimum Square Error Criterion, Widrow-Hoff Procedure, Ho-Kashyap Procedure Kesler's Construction	
Module 4	**7 Hrs**
Neural Network Classifier: Single and Multilayer Perceptron, Back Propagation Learning, Hopfield Network, Fuzzy Neural Network. Time Varying Pattern Recognition: First Order Hidden Markov Model, Evaluation, Decoding, Learning.	
Module 5	**7 Hrs**
Unsupervised Classification: Clustering, Hierarchical Clustering, Graph Based Method, Sum of Squared Error Technique, Iterative Optimization	

Textbooks:

1. Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", John Wiley & Sons, 2001.
2. Earl Gose, Richard Johsonbaugh and Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall, 1999.

Reference Books:

1. Robert J.Schalkoff, Pattern Recognition Statistical, Structural and Neural Approaches, John Wiley & Sons Inc., New York, 1992.
2. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London, 1974.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20DS3606**					
TITLE OF THE COURSE	**NATURAL LANGUAGE PROCESSING TOOLS & TECHNIQUES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

Perquisite Courses(if any)			
#	Sem/Year	Course Code	Title of the Course
*	**		****

Course Objectives:

1. To understand the algorithms available for the processing of linguistic information and computational properties of natural languages
2. To conceive basic knowledge on various morphological, syntactic and semantic NLP task
3. To understand machine learning techniques used in NLP,
4. To write programs in Python to carry out natural language processing

Course Outcomes:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Analyzing information from text automatically using concepts and methods from natural language processing (NLP)	L2
CO2	Understanding the stemming and n-grams through data processing in Python programming language to carry out exercises.	L2
CO3	Apply RNNs and learning algorithms for NLP with transformer architectures.	L3
CO4	Understand existing Natural Language Processing (NLP) applications	L2
CO5	Demonstrate the Hidden Markov models in NLP	L3

COURSE CONTENT	
MODULE1	**7 Hrs**

Introduction: Past, present and future of NLP; Classical problems on text processing; Necessary Math concepts for NLP; Regular expressions in NLP; Basic text processing: lemmatization, stop word, tokenisation, stemming etc; Spelling errors corrections– Minimum edit distance, Bayesian method;	
MODULE 2	**8 Hrs**
Words & Sentences: N-grams: Simple unsmoothed n-grams; smoothing, backoff, spelling correction using N-grams, Metrics to evaluate N-grams; Parts of Speech tagging: Word classes, POST using Brill's Tagger and HMMs; Information Extraction: Introduction to Named Entity Recognition and Relation Extraction WordNet and WordNet based similarity measures, Concept Mining using Latent Semantic Analysis	
MODULE 3	**7 Hrs**
Sequence to sequence & Language Modelling : Word embedding: skip-gram model, CBOW, GloVe, BERT; Sequence to sequence theory and applications, Attention theory and teacher forcing; Language Modelling: Basic ideas, smoothing techniques, Language modelling with RNN and LSTM;	
MODULE 4	**8 Hrs**
ML for NLP : Classification- binary and multiclass, clustering, regression for text data processing; Machine translation: rule-based techniques, Statistical Machine Translation (SMT); Spam detection, consumer complaint classification.	
MODULE 5	**9 Hrs**
Hidden Markov models: Morkov chains, likelihood Computation, Semantic Analyzer, Text summarization. Self-Learn & Hands on practice: Python libraries supporting NLP; Hands on Data collection - from social network platforms, pdfs, wordfiles, json, html, Parsing text using regular expression; scraping data from web; Text processing: convert to lowercase, remove punctuation, remove stop words, standardising text, tokenising, stemming, lemmatising.	

TEXT BOOKS:

1. Daniel Jurafsky and James H. Martin. 2009. Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics. 2nd edition. PrenticeHall.
2. Christopher D. Manning and Hinrich Schütze. 1999. Foundations of Statistical Natural Language Processing. MIT Press.

REFERENCES:

1. Jurafsky and Martin, "Speech and Language Processing", 2 nd Edition, Prentice Hall, 2008. Manning and Schutze, "Statistical Natural Language Processing", MIT Press, 2001.
2. James Allen, "Natural Language Understanding", The Benajmins/Cummings Publishing Company,1998. Cover, T. M. and J. A. Thomas, "Elements of Information Theory", 2nd Edition, Wiley, 2006.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**20CS3606**					
TITLE OF THE COURSE	**SOFT COMPUTING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
1	IV	19CS2403	Design & Analysis of Algorithms

COURSE OBJECTIVES:

1. Learn the various soft computing frameworks
2. Be familiar with various neural network frameworks
3. Learn Genetic programming
4. Be exposed to hybrid systems

COURSE OUTCOMES

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Explain the principal components of soft computing that include ANN and genetic Algorithm	L2
CO2	Apply a suitable methods of soft computing to solve a particular problem	L3
CO3	Understanding the significance of neural network in soft computing	L4
CO4	Analyse the Gentic algorithms and fuzzy logic for solving the optimization problems	L2
CO5	Implementing the soft computing techniques in real life applications	L3

COURSE CONTENT:	
MODULE 1	**7 Hrs**
Introduction: Scope of soft computing, various components, description of Artificial neural networks, overview fuzzy logic, theory of genetic algorithms, theory of hybrid systems.	
MODULE 2	**8 Hrs**

Neural network: Fundamentals of neural network, basic models of ANN, learning and activation functions, basic fundamental McCulloch- Pitts neuron model	
MODULE 3	**8 Hrs**

Learning Models: Supervised learning networks, Adaline, Back propagation, Unsupervised learning network, Korhonen self-organizing feature maps networks.	
MODULE 4	**8 Hrs**
Fuzzy Logic: Introduction to fuzzy logic, classical sets and Fuzzy sets, Classical relations and Fuzzy relations, Membership functions, Fuzzy arithmetic and Fuzzy measures, fuzzy decision making.	
MODULE 5	**8 Hrs**
Genetic Algorithms: Introduction, Search space and optimization techniques, encoding, selection crossover, mutation. Application on either MATLAB environment or Python programming - Neural network algorithm, Fuzzy algorithm, Genetic algorithm	

TEXTBOOKS:

1. S.N Sivanandam and S N Deepa,"Principles of Soft Computing", Wiley India Pvt Ltd, 2011
2. J.S.R. Jang, CT Sun and E Mizutani, "Neuro Fuzzy and Soft Computing", PHI/Pearson Education 2004

REFERENCES:

1. George J Klir, Ute St Clair, Bo Yuan,"Fuzzy Set Theory: Foundations and Application" Prentice HAll, 1997
2. David E Goldberg,"Genetic Algorithm in Search Optimization and Machine Learning "Pearson Education India 2013

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20DS4702**					
TITLE OF THE COURSE	**ARTIFICIAL INTELLIGENCE**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To acquire knowledge on intelligent systems and agents, various search strategies
- Formalization of knowledge, reasoning with and without uncertainty
- To understand the concepts of Game playing and learning
- To learn an expert system with applications at a basic level

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Comprehend different types of problem-solving agents and its applications.	**L3**
CO 2	Solve problems using informed and uninformed search strategies.	**L4**
CO 3	Compare various Knowledge Representation Logic using scripts and frames.	**L3**
CO 4	Identify the need of Production system	**L4.L5**
CO 5	Use expert system tools to realize the concepts and components of the expert system.	**L5**

COURSE CONTENTS

MODULE 1	**8 HRS**
Problem Solving: Introduction to AI - Agents and Environments – Problems, problem spaces, search: Informed search strategies, uninformed search strategies Heuristic search techniques	
MODULE 2	**9 HRS**
Knowledge Representation: Knowledge representation issues - Using predicate Logic - representing simple facts in logic - representing instance and ISA relationships - computable functions and predicates - Resolution -Representing knowledge using Rules	
MODULE 3	**8 HRS**
UNCERTAINTY: Symbolic reasoning under uncertainty, statistical reasoning ,weak slot and filler structures ,strong slot and filler structures	
MODULE 4	**7 HRS**
Game Playing, Learning: Overview - Minimax search procedure - alpha-beta cutoffs - iterative deepening , Learning	
MODULE 5	**7 HRS**
Expert System & Applications: Expert System- Architecture and Roles of Expert System-Typical Expert System-MYCIN-XOON-DART- Case Study-Construction of simple reflex agent with sensor and actuator using Arduino.	

TEXTBOOKS

1. Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, 3rd Edition, Pearson Education / Prentice Hall of India, 2010.
2. Elaine Rich, Kevin Knight, Shivashankar B Nair, “Artificial Intelligence”, 3rd Edition, TMH, 2010.

REFERENCE BOOKS

1. "Artificial Intelligence: Foundations of Computational Agents" by David L. Poole and Alan K. Mackworth
2. Joseph C. Giarratano , Gary D. Riley ,”Expert Systems : Principles and Programming”,4th Edition, 2015

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20DS4703**					
TITLE OF THE COURSE	**IMAGE PROCESSING AND COMPUTER VISION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PRE REQUISTIE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	**	***	***

COURSE OBJECTIVES

- `To introduce various topics of computer vision with their applications.
- Combining the analytics with CV which helps in various Video Analytics processing

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOMS TAXONOMY LEVEL
CO 1	Apply linear algebra principles to solve computer vision problems	**L3**
CO 2	Analyze and evaluate the components and working principles of a digital camera	**L4**
CO 3	Apply segmentation algorithms to partition images into meaningful regions	**L3**
CO 4	Analyze and evaluate different parameters used in video analytics	**L4.L5**
CO 5	Evaluate different parameters used in video analytics	**L5**

COURSE CONTENTS

MODULE 1	**8 HRS**
COMPUTER VISION FOUNDATIONS: Image Processing - Colour - Linear Algebra Primer - Pixels and Filters - Edge Detection - Features and Fitting - Feature Descriptors - Image Resizing - Segmentation - Semantic Segmentation - Clustering - Object recognition - Dimensionality Reduction - Face Identification - Visual Bag of Words - Object Detection from Deformable Parts - Semantic Hierarchies and Fine Grained Recognition - Motion - Tracking - Deep	

Learning.)	
MODULE 2	**7 HRS**
IMAGE FORMATION: Geometric primitives and transformations – Photometric image formation – The digital camera – Point operators – Linear Filtering – More neighbourhood operators – Fourier transforms – Pyramids and wavelets – Geometric transformations – Global optimization..	
MODULE 3	**9 HRS**
3D VISION: Feature detection and matching – Segmentation – Edge detection - 2D and 3D feature based alignment – Pose estimation – Geometric intrinsic calibration – Triangulation Methods for 3D Vision - 3D reconstruction – Image based rendering, Image Recognition – Object Detection – Space, Instance and Category Recognition	
MODULE 4	**7 HRS**
VIDEO ANALYTICS AND ITS APPLICATIONS: Introduction to Video Analytics, Analysis Parameters-Real Time Security & User Insights, Storage analysis for Processed Video Data. Case Study: Analysis on Facial Surveillance, License Plate Recognition	
MODULE 5	**8 HRS**
APPLICATIONS OF COMPUTER VISION: Image Processing, Machine Learning – Information Retrieval – Neuroscience – Robotics – Speech Recognition – Cognitive Sciences – Graphics, Algorithms, Systems and Theory – Pattern Recognition – Computer Graphics.	

TEXTBOOKS

1. Forsyth, D. A. and Ponce, J., "Computer Vision: A Modern Approach", Prentice Hall, 2 ndEd. 2011.
2. Gonzalez, R. C. and Woods, R. E., "Digital Image Processing", Prentice Hall, 3rdEd, 2009.

REFFERENCE BOOKS

1. Trucco, E. and Verri, A., "Introductory Techniques for 3-D Computer Vision", Prentice Hall, 1998.
2. Website Link: http://www.3vr.com/

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20DS4704**					
TITLE OF THE COURSE	**EMBEDDED IOT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PRE REQUISTIE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- `To introduce various topics of computer vision with their applications.
- Combining the analytics with CV which helps in various Video Analytics processing

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOMS TAXONOMY LEVEL
CO 1	Demonstrating a foundational understanding of IoT concepts	**L2**
CO 2	Analyze the use of communication protocols in IOT and M2M technologies	**L3**
CO 3	Configure and interface Raspberry Pi with various components and demonstrating proficiency in hardware connectivity	**L3**
CO 4	Design and implement IoT solutions for specific domains	**L3**
CO 5	Explore the concepts of Industry 4.0 and technologies beyond traditional IoT	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
Introduction-Definition & Characteristics of IoT, Physical Design of IoT- Things in IoT, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies- Wireless Sensor Networks, Embedded Systems, IoT Levels & Deployment Templates.	
MODULE 2	**9 HRS**

IoT and M2M- SPI, I2C communication, Introduction toM2, Difference between IoT and M2M, SDN Network Function Virtualization IoT Platforms Design Methodology IoT Design Methodology-Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification , Service Specifications , IoT Level Specification, Functional View Specification , Operational View Specification , Device & Component Integration , Application Development, IoT Physical Devices & Endpoints	
MODULE 3	**8 HRS**
Raspberry Pi & Raspberry Pi Interfaces – Features of Raspberry Pi, Serial, , Interfacing of LED, Switch and Light Sensor (LDR) with Raspberry Pi	
MODULE 4	**7 HRS**
Domain Specific IoTs-Home Automation, Cities-Smart Parking, Environment-Weather Monitoring, Smart Grids, Smart Irrigation, Machine Diagnosis & Health & Lifestyle -Health & Fitness Monitoring, Wearable Electronics	
MODULE 5	**8 HRS**
IoT & Beyond: Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques, data- intensive IoT for continuous recognition applications, Internet of Everything	

TEXTBOOKS

1. "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry" by Maciej Kranz

REFFERENCE BOOKS

2. Internet of Things, A Hands on Approach, by Arshdeep Bahga & Vijay audisetti, UniversityPress
3. The Internet of Things, by Michael Millen,Pearson

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20DS4705**					
TITLE OF THE COURSE	**DEEP LEARNING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PRE REQUISTIE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- To understand the basic building blocks and general principles that allows one to design Deep learning algorithms
- To become familiar with specific, widely used Deep learning networks
- To introduce building blocks of Convolution neural network architecture
- To learn to use deep learning tools and framework for solving real-life problems

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOMS TAXONOMY LEVEL
CO 1	Understanding the mathematical background for building various deep learning models	**L2**
CO 2	Designing and optimizing the different deep learning algorithms which are more appropriate for various types of learning tasks in various domains	**L3**
CO 3	Implement a CNN learning algorithms and solve real-world problems deep learning tools and framework	**L3**
CO 4	Apply RNN learning algorithm for various application	**L3**
CO 5	Designing the Deep generative models for the Image and video applications and analyzing the recent advances in GANS	**L3**

COURSE CONTENTS

MODULE 1	8 HRS
Mathematical background for Deep learning- Introduction to ANN: ANN, Forward Propagation, Backward Propagation, Multilayer Perceptrons-hidden layers, activation functions, Model Selection, underfitting, overfitting, weight decay, dropout, Softmax Regression	
MODULE 2	**7 HRS**
Computational Graphs– Layers and Blocks, shallow neural network, deep neural network, Optimization for training Deep Models, self-organizing maps, . Case study	
MODULE	**9 HRS**
Foundations of Convolutional Neural Networks- Convolution operation, Convolutional Layers, Object Edge Detection in Images, Padding and Stride, Multiple Input and Multiple Output Channels, 1 × 1 Convolutional Layer, Pooling, Convolutional Neural Networks (LeNet), GoogleNet, AlexNet. Case study, Introduction to transformers.	
MODULE 4	**8 HRS**
Introduction to RNN: Basics of RNN, Rnns Computational Graph across Time, RNN's For Sequence Modeling- Language Modeling, Backpropagation Through Time, Standard RNN Gradient Flow, LSTM Network **Applications of RNN:** Music Generation, Sentiment Classification, Machine Translation, Environment Modeling, Stock Market Prediction, Next Word Prediction.	
MODULE 5	**8 HRS**
Deep Generative models: Generative Modelling, Autoencoders, Variational Autoencoders, Latent Perturbations, Image and Video Applications **GANs:** Generative Adversarial Networks – Intuition behind Gans, Training Gans, Recent Advances In Gans	

TEXTBOOKS

1. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola, "Dive into Deep Learning", Amazon, 2020
2. François Chollet, "Deep Learning Python", Manning Publications, 2018

REFFERENCE BOOKS

1. Tom Mitchell, Machine Learning, McGraw-Hill, 1997
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", O'Reilly Media; 1 edition (April 9, 2017)

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20DS4706**					
TITLE OF THE COURSE	**CLOUD COMPUTING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PRE REQUISTIE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
*	*	***	******

COURSE OBJECTIVES

- Understand various basic concepts related to cloud computing technologies
- Understand the architecture and concept of different cloud models: IaaS, PaaS, SaaS
- Understand the applications of Cloud Computing.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOMS TAXONOMY LEVEL
CO 1	Define Cloud computing and characteristics	**L3**
CO 2	Describe benefits and drawbacks of Cloud computing	**L3**
CO 3	Explain various types of virtualization and capacity planning metrics	**L3**
CO 4	Discuss various types of cloud services	**L3**
CO 5	Discuss Cloud Security and various challenges	**L3,L4**

COURSE CONTENTS

MODULE 1	**8 HRS**
Introduction: Basics of cloud computing, Cloud Computing Models (Paas, Saas, Iaas), Understanding Public Clouds, Private Clouds, Community Cloud and Hybrid Clouds, Cloud Computing Benefits and risks, Cloud Computing Challenges, Cloud Computing Architecture and Virtualization. Overview of Cloud Computing techniques (Grid Computing, Cloud Computing, Utility	

Computing, Fog Computing).	
MODULE 2	**7 HRS**
Cloud Virtualization Technology: Introduction, why virtualization, virtualization benefits, application virtualization, virtual machine, desktop virtualization, server virtualization, storage virtualization, implementing virtualization, Hypervisor.	
MODULE 3	**7 HRS**
Accessing the Cloud: Platforms, web applications framework, web hosting service, web APIs, web browsers. **Migrating to the Cloud:** Broad approaches to migrating into the cloud, the seven-step model of migration into a cloud.	
MODULE 4	**9 HRS**
CLOUD ISSUSES: Stability, quality, longevity, business continuity, service level agreements, security in the cloud, cloud authentication, cloud filtering, regulatory issues and accountability.	
MODULE 5	**8 HRS**
Cloud Platforms in Industry: Amazon Web Services, Google AppEngine, Microsoft Azure. Cloud Applications: Scientific Applications (Healthcare: ECG Analysis in the Cloud) and Business and Consumer Applications (Social Networking, Media Applications)	

TEXTBOOKS

3. Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi Mastering Cloud. Computing McGraw Hill Education

REFFERENCE BOOKS

4. Cloud Computing, Dr. Kumar Saurabh, Wiley Publications, 2012
5. Guide to Cloud Computing, Richard hill, Springer Publications, 2013

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	**20DS4707**					
TITLE OF THE COURSE	**SOCIAL NETWORK ANALYSIS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PRE REQUISTIE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE OF THEN**
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COURSE OBJECTIVES

- To understand the concept of semantic web and related applications.
- To learn knowledge representation using ontology.
- To understand human behaviour in social web and related communities.
- To learn visualization of social networks.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOMS TAXONOMY LEVEL
CO 1	Understand the foundational concepts and history of social network analysis, including network theory, sociometry, and the entry of social physicists in the field.	**L2**
CO 2	Analyze and interpret social networks using sociograms and matrices, identifying cliques and communities within the network.	**L3**
CO 3	Examine the dynamics of balance and group interactions within social networks, and explore the concepts of informal organization and community relations.	**L2**
CO 4	Apply formal models of community and kinship to analyze social networks, and recognize the role of formal methods in social network analysis.	**L2**
CO 5	Gain practical knowledge of data collection techniques for social network analysis, including observation, document analysis, and using computer programs for network analysis.	

COURSE CONTENTS

MODULE 1	8 HRS
Introduction to Social Network Analysis: The data used in social network analysis, network theory, The History of Social Network Analysis, The sociogram and sociometry, Balance and group dynamics, Informal organisation and community relations, Matrices and cliques, Formal models of community and kinship, Formal methods triumphant, Entry of the social physicists	
MODULE 2	**9 HRS**
Data Collection for Social Network Analysis: Making observations, using documents, Boundaries in relational data, Positional and reputational approaches, Organising and Analysing Network Data, Matrices and relational data, Matrix conventions, An analysis of directorship data, Direction and value in relational data, Computer programs for social network analysis	
MODULE 3	**8 HRS**
Terminology for Network Analysis: The language of network analysis, joining up the lines, The flow of information and resources, Density of connections, Density in egonets, Problems in density measures, Popularity, Mediation and Exclusion, Local and overall centrality, Mediation and betweenness, Centrality boosts centrality, Centralisation and graph centres, The absolute centre of a graph, Bank centrality in corporate networks	
MODULE 4	**7 HRS**
Groups, Factions and Social Divisions: Identifying subgraphs, the components of a network, intersecting social circles, Components and citation circles, Structural Locations, Classes and Positions, The structural equivalence of points, Clusters and similarity, Divide and CONCOR, Divisions and equivalence, Regular equivalence in roles and functions, Corporate interlocks and participations.	
MODULE 5	**7 HRS**
Social Change and Development: Structural change and unintended consequences, Small-world networks, Modelling social change, Testing explanations, Visualizing and Modelling, Taking space seriously, Using multi-dimensional scaling, Principal components and factors, Non-metric methods, How many dimensions, Worth a thousand words, Elites, communities and influence, Business elites and bank power	

TEXT BOOKS:

1. John Scott-Social Networks Analysis, 2017.

2. Borko Furht, ―Handbook of Social Network Technologies and Applications||, 1st Edition, Springer, 2010

REFFERENCE BOOKS:

1. Guandong Xu ,Yanchun Zhang and Lin Li, ―Web Mining and Social Networking – Techniques and applications||, First Edition, Springer, 2011.

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**20DS4803**					
TITLE OF THE COURSE	**DATA PRIVACY AND CYBER SECURITY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PRE REQUISTIE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
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COURSE OBJECTIVES

- Understand the basic concepts of data security, how it has evolved, and some key techniques used today.
- Have 1st depth view of Perimeter Security, Authentication and Access management, Cryptography, Malware, Secure Programming etc
- Explore the subject through prescribed book, case studies, hands on experience, extra readings for alternate view or real time application.

COURSE OUTCOMES

CO NO.	**OUTCOMES**	**BLOOMS TAXONOMY LEVEL**
CO 1	Analyze and break monoalphabetic substitution ciphers and principles and components of public-key cryptography	**L4**
CO 2	Demonstrate knowledge of basic features of data hiding in text, apply data hiding techniques such as watermarking and mimic functions	**L2,L3**
CO 3	Apply techniques such as LSB encoding, BPCS steganography, spread spectrum steganography, and robust data hiding in JPEG images to hide information in images,	**L3**
CO 4	Apply watermarking techniques to protect music scores, detect malicious tampering, and hide data in binary and fax images	**L3**
CO 5	Apply advanced data hiding techniques such as audio watermarking, echo hiding, steganographic file	**L3**

	systems	

COURSE CONTENTS

MODULE 1	8 HRS
Monoalphabetic Substitution Ciphers: Letter Distributions, Breaking a Monoalphabetic Cipher,The Pigpen Cipher. **Public-Key Cryptography**:- Diffie-HeIlman-Merkle Keys, Public-Key Cryptography, Rabin Public-Key Method, Sharing Secrets: Threshold Schemes, The Four Components, Authentication, Elliptic Curve Cryptography	
MODULE 2	**9 HRS**
Data Hiding in Text: Basic Features, Applications of Data Hiding, Watermarking, Intuitive Methods, Simple Digital Methods, Data Hiding in Text, Innocuous Text, Mimic Functions	
MODULE 3	**8 HRS**
Data Hiding in Images: LSB Encoding, BPCS Steganography, Lossless Data Hiding, Spread Spectrum Steganography, Data Hiding by Quantization, Signature Casting in Images, Robust Data Hiding in JPEG Images	
MODULE 4	**7 HRS**
INTRODUCTION TO CYBER SECURITY: Cyber Attacks, Défense Strategies, and Techniques, Guiding Principles, Authentication, Confidentiality and Integrity, Viruses, Worms, and Other Malware, Firewalls, Intrusion Prevention and Detection, DDoS Attacks Prevention/Detection, Web Service Security.	
MODULE 5	**7 HRS**
DIGITAL FORENSICS: Understanding Computer Forensics: Introduction, Historical Background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber forensics and Digital Evidence, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation.	

TEXT BOOK:

1. Data Privacy and Security, David Salomon, 2003 Springer-Verlag New York, Inc.

2. Cryptography, Network Security and Cyber Laws – Bernard Menezes, Cengage Learning, 2010 edition

3. Cyber Security: Understanding Cyber Crimes, Computer ForensicsaAnd Legal Perspectives, Sunit Belapure and Nina Godbole, Wiley India Pvt Ltd, 2013.

REFERENCES:

1. William Stallings – Cryptography and Network Security 5^{th} edition
2. Cryptography and Network Security : Atul Kahate, Mc Graw Hill Edition

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**20DS4804**					
TITLE OF THE COURSE	**BLOCKCHAIN AND CRYPTO CURRENCY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PRE REQUISTIE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
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COURSE OBJECTIVES

- Understand the basic concepts of data security, how it has evolved, and some key techniques used today.
- Have 1st depth view of Perimeter Security, Authentication and Access management, Cryptography, Malware, Secure Programming etc
- Explore the subject through prescribed book, case studies, hands on experience, extra readings for alternate view or real time application.

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOM'S TAXONOMY LEVEL
CO 1	Describe the basic concepts and technology used for blockchain	**L4**
CO 2	Explore the usage of merkle tree, cryptography and mining in Blockchain	**L2,L3**
CO 3	Usage of smart contracts in real world applications.	**L3**
CO 4	Understanding of cryptocurrency related concepts	**L2**
CO 5	Understanding Bitcoin system	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
INTRODUCTION TO BLOCKCHAIN: Distributed systems, P2P network Architecture of Blockchain, Generic elements of a blockchain: How blockchain works, Benefits, features, and limitations of blockchain How blockchain accumulates blocks, types of blockchain, Distributed ledger, Consensus mechanisms-Proof of work, Proof of Stake, Proof of Authority, CAP theorem, Decentralization, Disintermediation, Ecosystem - Storage, Communication and Computation, Dapps	

MODULE 2	9 HRS
CRYPTOGRAPHY AND SMART CONTRACTS: Symmetric cryptography (DES, AES), Asymmetric cryptography, Public and Private keys, Algorithms - RSA, Hash functions, SHA, ECDSA Smart contracts - Benefits of Smart contracts, Solidity programming-Types, Literals, Enums, Function types, Reference types, mappings, Global variables, Control structures (Events, Inheritance, Libraries, Functions), Compile, verify and Deploy.	
MODULE 3	**8 HRS**
ETHEREUM BLOCKCHAIN: The Ethereum network, Components of the Ethereum ecosystem, Ethereum Virtual Machine – Execution Environment, Opcodes and their meaning, Structure of a Block, Genesis Block, Merkle tree, Geth, Transactions, Transaction receipts, Nonce, Gas - gasPrice, gasLimit, Ether, Mining, Wallets, Ethereum network (main net, test net)	
MODULE 4	**7 HRS**
INTRODUCTION TO CRYPTOCURRENCIES: cash, digital cash, electronic payment systems, stone money of yap, bitcoin blockchain, consensus mechanism, monetary policy, Bitcoin Transactions, transaction capability, legitimacy, consensus, outlook and risks	
MODULE 5	**7 HRS**
BITCOIN: Electronic cash system, Introduction, Transactions, Timestamp server, Proof of work, network, incentive, reclaiming disk space, simplified payment verification, privacy, Introduction to Bitcoin(BTC) Mining.	

TEXT BOOK:

1. Imran Bashir, "Mastering Blockchain", Third Edition, Published by Packt Publishing Ltd, 2020.
2. A Short Introduction to the World of Cryptocurrencies Berentsen and Fabian Schä
3. Bitcoin: A Peer-to-Peer Electronic Cash System, Satoshi Nakamoto, www.bitcoin.org

REFERENCES:

1. RiteshModi" Solidity Programming Essentials, First Edition, Published by Packt Publishing Ltd, April 2018
2. E-resources : https://github.com/chaincodelabs/bitcoin-curriculum.git

SEMESTER	**VIII**					
YEAR	**IV**					
COURSE CODE	**20DS4805**					
TITLE OF THE COURSE	**HIGH PERFORMANCE COMPUTING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PRE REQUISTIE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE**
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COURSE OBJECTIVES

- Understand the fundamentals of parallel computing: Learn the principles and potential benefits of parallel computing and recognize the fundamental laws governing parallelism, including Gustafson-Barsis's Law.
- Plan for parallelization: Learn how to approach a new project for parallel computing, implement version control for code management, and use profiling to analyze the gap between system capabilities and application performance.
- Master parallel algorithms and patterns: Analyze parallel algorithms and performance models, comprehend the significance of hash functions and spatial hashing, and understand patterns like prefix sum (scan) for efficient parallel computing.
- Explore GPU architectures and concepts: Familiarize yourself with vectorization and single instruction, multiple data (SIMD) concepts, understand GPU architectures and their role in accelerated computational platforms, and explore different GPU memory spaces.
- Gain practical GPU programming skills: Learn about the GPU programming model, GPU parallelism, and data decomposition, understand how to optimize GPU resource usage, and apply these concepts to a real-world case study like D atmospheric simulation or unstructured mesh applications.

COURSE OUTCOMES

CO NO.	**OUTCOMES**	**BLOOM'S TAXONOMY LEVEL**
CO 1	Demonstrate a comprehensive understanding of parallel computing concepts, including the reasons for using parallelism and the potential benefits it offers in various computing applications.	**L2**

CO 2	Develop proficiency in planning for parallelization, including project preparation, version control implementation, and performance profiling to optimize application performance on parallel systems.	**L2,L3**
CO 3	Apply parallel algorithms and patterns to efficiently solve computing problems, analyzing algorithmic complexity, and choosing appropriate parallel approaches for specific tasks.	**L3**
CO 4	Gain practical knowledge of GPU architectures, vectorization methods, and programming models, enabling the utilization of GPU resources effectively to accelerate computational tasks.	**L2**
CO 5	Successfully implement GPU programming techniques to parallelize and optimize computational tasks, with hands-on experience working on a real-world case study, such as atmospheric simulation or unstructured mesh applications, using parallel computing methodologies.	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
Introduction to parallel computing, Why parallel computing? the potential benefits of parallel computing, Parallel computing cautions, The fundamental laws of parallel computing Breaking through the parallel limit, Gustafson-Barsis's Law, How does parallel computing work, Categorizing parallel approaches	
MODULE 2	**9 HRS**
Planning for parallelization: Approaching a new project: The preparation Version control: Creating a safety vault, Profiling: Probing the gap between system capabilities and application performance, Planning: A foundation for success Implementation: Where it all happens, Commit: Wrapping it up with quality, Performance limits and profiling Characterizing your application: Profiling, Data design and performance models	
MODULE 3	**8 HRS**
Parallel algorithms and patterns: Algorithm analysis for parallel computing applications, Performance models versus algorithmic complexity, Parallel algorithms, What is a hash function? Spatial hashing: A highly-parallel algorithm Using perfect hashing for spatial mesh operations, Prefix sum (scan) pattern and its importance in parallel computing, Parallel global sum: Addressing the problem of associativity, Future of parallel algorithm research	
MODULE 4	**7 HRS**
Vectorization: FLOPs for free, Vectorization and single instruction, multiple data (SIMD) overview, Hardware trends for vectorization, Vectorization methods. GPU architectures and concepts, The CPU-GPU system as an accelerated computational platform, Integrated GPUs: An underused option on commodity-based systems, Dedicated GPUs: The workhorse option, The GPU and the thread engine, Characteristics of GPU memory spaces, Measuring the GPU stream benchmark, The PCI bus: CPU to GPU data transfer overhead, bandwidth, Multi-GPU platforms and MPI	
MODULE 5	**7 HRS**
GPU programming model, GPU programming abstractions, GPU parallelism, Data decomposition into independent units of work: An ND Range or grid Subgroups, warps, or wavefronts execute in lockstep, Work item: The basic unit of operation, The code structure for the GPU programming model, The concept of a parallel kernel, How to address memory resources in your GPU programming model, Optimizing GPU resource usage, Reduction pattern requires synchronization across work	

groups, Asynchronous computing through queues Case study: D atmospheric simulation, Unstructured mesh application

TEXT BOOK:

1. Parallel and High Performance Computing by Robert Robey, Yuliana Zamora
2. Introduction-to-High-Performance-Computing-for-Scientists-and-Engineers/Hager-Wellein/p/book/9781439811924

REFERENCES:

1. "Introduction to High Performance Computing for Scientists and Engineers" by Georg Hager and Gerhard Wellein
2. "Parallel Programming: Concepts and Practice" by Barry Wilkinson and Michael

SEMESTER	**VII**					
YEAR	**IV**					
COURSE CODE	20OE0033					
TITLE OF THE COURSE	**BUSINESS ANALYTICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/ Project Hours	Total Hours	Credits
	03	**-**	**-**	**-**	**39**	**03**

PREREQUISITE-COURSES (IF ANY)			
#	**SEM/YEAR**	**COURSE CODE**	**TITLE OF THEN**
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COURSE OBJECTIVES

- To understand the fundamentals of Business Intelligence
- To identify the appropriateness and need Analysis the data
- To learn the preprocessing, mining and post processing of the data
- To understand various methods, techniques and algorithms in Business Intelligence

COURSE OUTCOMES

CO NO.	OUTCOMES	BLOOMS TAXONOMY LEVEL
CO 1	Understanding the influence of data in business intelligence	**L2**
CO 2	Apply basic, intermediate and advanced techniques to analysis the data	**L3**
CO 3	Analyze the output generated by the process of Business Intelligence	**L3**
CO 4	Explore the hidden patterns in the data	**L3**
CO 5	Applying the business intelligence principles to the real world problems	**L3**

COURSE CONTENTS

MODULE 1	**8 HRS**
Business Intelligence: Effective and timely decisions – Data, information and knowledge – Role of mathematical models – Business intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence.	
MODULE 2	**9 HRS**
Knowledge Delivery: The business intelligence user types, Standard reports, Interactive Analysis, Parameterized Reports and Self-Service Reporting, dimensional analysis. Visualization: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Visualization. Data Visualization idioms: Bar Chart, Vertical & Horizontal, Pie Chart and Coxcomb Plot, Line Chart, Area Chart, Reusable scatter plots.	
MODULE 3	**8 HRS**
Decision Making Concepts: Concepts of Decision Making, Techniques of Decision Support System (DSS), Types of Decision Support System (DSS), Development of Decision Support System (DSS), Applications of DSS, Role of Business Intelligence in DSS	
MODULE 4	**7 HRS**
Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers and Bad Data, Finding Duplicates. Business Intelligence Applications: Data analytics, business analytics, ERP and Business Intelligence, BI Applications in CRM, Marketing.	
MODULE 5	**8 HRS**
Real Time Applications and use cases using BI TOOLS: POWERBI, TABLEAU AND SAP	

Textbooks:

1. R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support,10th Edition. Pearson/Prentice Hall, 2015.ISBN-13: 978-0-13-305090-5, ISBN-10: 0- 13-305090-4;
2. Business Process Automation, Sanjay Mohapatra, PHI.

Reference Books:

1. Larissa T. Moss, S. Atre, "Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making", Addison Wesley, 2003.
2. Carlo Vercellis, "Business Intelligence: Data Mining and Optimization for Decision Making", Wiley Publications, 2009.