Centre for Distance and Online Education (CDOE)
Open and Distance Learning Programmes

Programme Structure

(2025-26)

Programme Name – B.Sc. Computer Science **Programme Code - ODLBSCS**

SEMESTER- I

S. No.	Course Code	Course Title	Type of Course	Credits
1	4.5 ODLCSC01	Foundation of Computer Science	CC	4
2	4.5 ODLMAT01	Differential Calculus	CC	4
	4.5 ODLSTA01	Descriptive Statistics		
	4.5 ODLECO01	Microeconomics - I		
3	4.5 ODLMAT86	Mathematics-I for Computer Science and Statistics	OE	3
4	4.5 ODLCSC02	Programming in 'C'	SEC	3
5	4.5 ODLENG81	Language and Communication Skills	AECC	2
6	4.5 ODLECO99	Indian Knowledge Systems	VAC	4
			Total Credits	**20**

SEMESTER- II

S.No.	Course Code	Course Title	Type of Course	Credits
1	4.5 ODLCSC03	Object-Oriented Modelling	CC	4
2	4.5 ODLMAT02	Integral Calculus	CC	4
	4.5 ODLSTA02	Probability and Random Variable		
	4.5 ODLECO11	Macroeconomics - I		
3	4.5 ODLCSC04	Discrete Structure	DSE	3
4	4.5 ODLCSC05	Programming in C++	SEC	3
5	4.5 ODLCSC06	ICT and Tools	AECC	2
6	4.5 ODLCSC07	Computing and Cyber Ethics	VAC	4
			Total Credits	**20**

SEMESTER- III

S.No.	Course Code	Course Title	Type of Course	Credits
1	5.0 ODLCSC01	Data Structures	CC	4
2	5.0 ODLCSC02	Digital Electronics	CC	4
3	5.0 ODLMAT01	Mathematical Programming	CC	4
4	5.0 ODLCSC03	Programming in Python	DSE	3

5	5.0 ODLMAT84	Introduction to SciLab	SEC	3
6	5.0 ODLCSC04	Web Development	AECC	2
			Total Credits	**20**

SEMESTER- IV

S.No	Course Code	Course Title	Type of Course	Credits
1	5.0 ODLCSC05	Database Management System	CC	4
2	5.0 ODLCSC06	Programming in Java	CC	4
3	5.0 ODLCSC07	Operating System	CC	4
4		MOOC Course*	CC	2 ≥
5	5.0 ODLCSC08	Graph Theory	CC	4
6	5.0 ODLECO91	Mathematical Finance	AECC	2
			Total Credits	**20**

SEMESTER- V

S.No	Course Code	Course Title	Type of Course	Credits
1	5.5 ODLCSC01	Computer Networks	CC	4
2	5.5 ODLCSC02	Theory of Computation	CC	4
3	5.5 ODLCSC03	Software Engineering	CC	4
4		MOOC Course*		2 ≥
5	5.5 ODLECO05	Fundamental of Game Theory	CC	4
6	5.5 ODLCSC04	Summer Internship (6 weeks)	VAC	2
			Total Credits	**20**

SEMESTER- VI

S.No	Course Code	Course Title	Type of Course	Credits
1	5.5 ODLCSC05	Design & Analysis of Algorithms	CC	4
2	5.5 ODLCSC06	Computer Organization	CC	4
3	5.5 ODLCSC07	Computer Graphics	CC	4
4	5.5 ODLCSC08	Project	CC	4
5	5.5 ODLCSC09	Information Security	CC	4
			Total Credits	**20**

Total Credit : 120

Abbreviation	
CC	Core Course
DSE	Departmental Specific Elective Courses offered by the Department
OE	Open Elective Courses offered by ODL Basket
AECC	Ability Enhancement Compulsory Course
VAC	Value Added Courses
SEC	Skill Enhancement Courses

Detailed Syllabus

Semester-I

Course Title: Foundation of Computer Science (4.5 ODLCSC01) **Credits :04**	
UNIT I	Introduction to Computer, Von Neumann Architecture, Generation of Computer, Storage Device-Primary Memory and Secondary Storage, Random, Direct, Sequential access methods. Concept of High- Level, Assembly and Low Level programming languages, Program Development Steps, Representing Algorithms through flow chart, pseudo code.
UNIT II	Number systems, Binary number system, Binary to decimal conversion, Decimal to binary conversion,Binary operations: addition, subtraction, complement of a number - 1's complementary subtraction, 2's complementary subtraction , binary multiplication, binary division, Representation of binary number as electrical signals, octal number system, octal to decimal conversion – decimal to octal conversion, binary to octal conversion, octal to binary conversion, advantages of octal number system, hexadecimal number system, binary to hexadecimal conversion, hexadecimal to binary conversion
UNIT III	Introduction to social media, Impact of Social Media, Types of Social Media, Social media practices, Social media platforms, Social media monitoring, Blogging, social bookmarking, Building communities-pages & Channel, Hangouts, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.
UNIT IV	Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber crimes, Remedial and mitigation measures, Legal

	perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organisations dealing with Cyber crime and Cyber security in India, Case studies.

Reference Books:

1. Sinha, P.K. "Computer Fundamentals". New Delhi: BPB Publications.
2. M. Morris Mano: Digital Logic and Computer Design, Pearson
3. Cyber Crime Impact in the New Millennium, by R. C Mishra , Auther Press. Edition 2010
4. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011)
5. Fundamentals of Network Security by E. Maiwald, McGraw Hill.

Course Title: Differential Calculus(4.5 ODLMAT01) **Credits :04**	
UNIT I	Limit of a function, Algebra of Limit, Continuous functions, Classifications of discontinuities, Differentiability of a function, Algebra of derivatives, Increasing and decreasing functions, Extreme values of functions.
UNIT II	Tangent and normal, Rolle's theorem, Mean value theorems and their geometrical interpretations, Taylor's and Maclaurin's series expansions, Taylor's theorem with Lagrange form of remainder, Indeterminate forms, L' Hospital Rule, Successive differentiation and Leibnitz theorem, Asymptotes, Convexity, concavity and point of inflexion.
UNIT III	Bhaskara II and Instantaneous Motion, Early notion of derivative, Madhava and Infinite Series, Kerala School and Yuktibhasa Proofs.
UNIT IV	Curvature of plane curves, radius of curvature in Cartesian, parametric and polar forms, center of curvature. Evolutes and involutes, envelopes. Tracing of standard Cartesian and polar curves.

Reference Books:

1. P. P. Divakaran, The Mathematics of India, Springer-Hindustan Book Agency, 2018.
2. K. Plofker, Mathematics in India: 500 BCE–1800 CE. Princeton, NJ: Princeton University Press, 2009.

Course Title: Descriptive Statistics(4.5 ODLSTA01) **Credits :04**	
UNIT I	Meaning and scope of the word 'Statistics'. Data types, measurement of scale, classification and tabulation, graphical and diagrammatic representation: Bar diagrams, multiple and stack bar diagrams, histogram, frequency polygon, frequency Curve, O- give, Pie-diagram, Boxplot, Stem and leaf diagrams. Measures of Central Tendency: Concept, requirements of a good measure. mathematical average, positional average with properties, merits and demerits. weighted average, combined mean, Graphical method of determination of Median, Mode and Quartile.
UNIT II	Measures of Dispersion: Concept, requirements of a good measure of dispersion, absolute and relative measure, Range, quartile deviation, mean deviation, variance and standard deviation with its coefficient, combined variance, interrelationship between the range, QD, MD and SD. Minimal properties of MD and mean square deviation with proof.

	Moments: Raw and central moments, relationship between raw and central moments, Sheppard correction for moments (without derivations), skewness, type and its measurement of skewness. Kurtosis, types and its measurement..
UNIT III	Bivariate Data. Scatter diagram. The concept of dependency, illustrative real-life examples. Covariance: Definition, Effect of change of origin and scale. Karl Pearson's coefficient of correlation (r): Definition, Properties, Spearman's rank correlation coefficient: Definition, Interpretation. Derivation of the formula for without ties and Modification of the formula for with-ties computation, variance of linear combination of variables. Correlation coefficient for discrete frequency distribution.
UNIT IV	Concept of regression, Lines of regression, Principal of least square and cure fitting. Fitting of lines of regression by the least square method. Regression coefficients (b_{xy}, b_{yx}) and their geometric interpretations, Properties. Derivation of the point of intersection of two regression lines and the acute angle between the two lines of regression.

Reference Books:

1. Rohatgi, V. K., & Saleh, A. M. E. (2015). An introduction to probability and statistics. John Wiley & Sons.
2. Mukhopadhyay, P. (2012), Mathematical Statistics, new Central Book Agency Pvt. Ltd., Calcutta.
3. Hoel P. G. (2016). Introduction to Mathematical Statistics, Asia Publishing House.
4. Meyer, P. L. (1965). Introductory probability and statistical applications. Oxford and IBH Publishing.
5. Roussas, G. G. (1997). A course in Mathematical Statistics. Elsevier.
6. Goon, A. M. (1987). Fundamentals of Statistics Vol. 1. The world press.

Course Title: Microeconomics - I (4.5 ODLECO01) **Credits :04**	
UNIT I	**Basic concepts** The Basic Economic Problem- Scarcity and Choice, the Basic Market Model; Interfering with the market versus working through the Market. Distinction between Microeconomics and Macroeconomics. Concepts of equilibrium- statics, dynamics, comparative statics, partial Equilibrium and General Equilibrium analysis. Positive Economics and Normative Economics.
UNIT II	**Consumer's Behavior** Utility:CardialversusOrdinal;IndifferenceCurve-AssumptionsandProperties;Consumer's Equilibrium; Price Effect-Income Effect, Substitution Effect; Engel's Curve Derivation of the Demand Curve; Giffen Paradox; Merits and Limitations of Indifference Curve Analysis; Labour leisure choice, consumer's surplus, its application and limitations. The Revealed Preference approach.
UNIT III	**Demand - Supply and market equilibrium** Law of Demand, factors explaining inverse relationship between price and quantity demand, Elasticities of demand – price, income and cross, relation between price elasticity of demand, price and marginal revenue, relation between price elasticity and total expenditure. Market supply: law of supply, role of time element in supply, Elasticity of supply.

UNIT IV	**Theory of Production-I** Organization of Production; Level of Productions and Scale of production, Production Function and its related concepts ;Total, Average and Marginal Products and the Law of Variable Proportions.
UNIT V	**Theory of Production-II** Production with two variable inputs- Isoquants; Factor Elasticity of Substitution; Returns to scale ;Least cost input combination; Expansion Path; Contract curve and the derivation of Production Possibility Curve;equilibrium of the producer - constrained output maximization and constrained cost minimization, output and substitution effects – elasticity of substitution – expansion path, returns to scale.
UNIT VI	**Theory of Cost and Revenue** Cost function: different concepts of costs, short run cost analysis and long run cost Analysis-relation between the expansion paths and cost function–total, average and Marginal cost curves –long run cost curves as envelope of short run cost curves. Optimum Size of Firm.

Reference Books:

1. G S Maddala and Ellen Miller, Micro Economic Theory and Application, Tata MacGraw Hill
2. Dominick Salvatore, Micro Economics- Theory and Applications, Oxford University Press
3. N.Y Melliwra H A. Book Co. 3. Koutsoyiannis, A., Modern Microeconomics*, London, Macmillan,(Latest. Edition).
4. James Mitchell Henderson, Richard E. Quandt, Microeconomic Theory, edition 3, McGraw-Hill, 1980
5. Karl E. Case, Ray C. Fair, Principles of Economics, Pearson Education Asia
6. Sampat Mukherjee, Modern Economic Theory, New Age International Publishers
7. Rahul A. Shastri, Micro Economic Theory, University Press (India) Limited
8. Paul A Samuelson William Nordhaus, Microeconomics 19th Edition, MacGrawhill

Course Title: Mathematics-I for Computer Science and Statistics (4.5 ODLMAT86) **Credits :03**	
UNIT I	Logic, Truth table, Conjunction, Disjunction, Implication, Bi-implication, Tautology, Contradiction, Boolean algebra of sets, Relation, Equivalence Relation,
UNIT II	Schröder-Bernstein Theorem, Division Algorithm, Representation of number in base b>1, Euclidean Algorithm, Congruence Relation, Properties of Congruence relation
UNIT III	Linear Congruences, Solvability of Linear congruence, Modular Arithmetic, Groups, Rings, Polynomial Ring, Fields, Minimal and Irreducible Polynomial, Construction of Finite Field, Primitive Element, Primitive Polynomial
UNIT IV	Vector Spaces, Basis, Dimension, Subspaces, Cosets, Linear Transformation, Rank, Nullity, Matrices of Linear Transformation, System of Linear Equations.

Reference Books:

1. Vince John, 2020, Foundation Mathematics for Computer Science: A Visual Approach, Springer International Publishing.

Course Title: Programming in 'C' (4.5 ODLCSC02) Credits :03	
UNIT I	Structure of C program, A Simple C program, identifiers, basic data types and sizes, Constants, variables, arithmetic, relational and logical operators, increment and decrement operators, conditional operator, bit-wise operators, assignment operators, expressions, type conversions, conditional expressions, precedence and order of evaluation.
UNIT II	Input-output statements, statements and blocks, if and switch statements, loops- while, do-while and for statements, break, continue, goto and labels, programming examples. Designing structured programs, Functions, basics, parameter passing, storage classes- extern, auto, register, static, scope rules, block structure, user defined functions, standard library functions, recursive functions, header files, example c programs.
UNIT III	Introduction to Arrays- concepts, declaration, definition, accessing elements, storing elements, arrays and functions, two-dimensional and multi-dimensional arrays, applications of arrays. String and String functions.
UNIT IV	Derived types- structures & Union- declaration, definition, Pointers- concepts, Character pointers and functions, pointers to pointers, pointers and multidimensional arrays, Concept of Files, File opening in various modes and closing of a file, Reading from a file, Writing onto a file, Appending to a file.

Reference Books:

1. Ritchie & Kernighan, The C Programming language, ANSI C Version 2nd Ed., PHI.
2. Ashok Kamthane, Programming in C, 2nd Ed., Pearson 2011
3. Schildt, C- The Complete Reference, 4th Ed., TMH 2000
4. E. Balaguruswamy, Programming in ANSI C, 6th Ed., TMH 2012
5. Venugopal K. R and Prasad S. R, "Mastering 'C'", Third Edition, 2008, Tata McGraw Hill.

Course Title: Language and Communication Skills (4.5 ODLENG81) Credits :02	
UNIT I	Grammar and its Usage : 1. Articles, Tenses and Modals 2. Conditional Sentences
UNIT II	Oral and Written Communication : 1. Letter Writing-Formal and Informal 2. Short Presentation, so as to get across one's perspective,
UNIT III	Forms of Writing : 1. Job Application 2. Resume Writing

Reference Books:

1. Thomson, AJ & Martinet: 4 Practical English Grammar, Oxford University Press.
2. Hyland, Ken: Second Language Writing: University of Michigan Press.
3. Gabor Don: How to start conversations and make friends; New York Fireside
4. Krishnaswamy, N: Modern English-A Book of Grammar, Usage and Composition, Macmillan India Ltd.
5. Quirk and Greenbaum: 4 University Level Grammar of English, Pearson

Course Title: Indian Knowledge Systems (4.5 ODLECO99) **Credits :04**	
UNIT I	**Introduction : Indian Knowledge Systems** Definition, Concept and Scope of IKS , Definition, Concept and Scope of IKS, IKS based approaches on Knowledge Paradigms, IKS in ancient India and in modern India Introduction to Indian Knowledge System (IKS)
UNIT II	**Indian Philosophy and Literature I** Philosophy and Literature (Maharishi Vyas, Manu, Kanad, Pingala, Parasar, Banabhatta, Nagarjuna and Panini), Mathematics and Astronomy (Aryabhatta, Mahavir acharya, Bodhayan, Bhashkaracharya, Varahamihira and Brahmgupta) Medicine and Yoga (Charak, Susruta, Maharishi Patanjali and Dhanwantri)
UNIT III	**Indian Philosophy and Literature II** Sahitya (Vedas, Upvedas, Upavedas (Ayurveda, Dhanurveda, Gandharvaveda) Puran and Upnishad) and shad darshan (Vedanta, Nyaya.Vaisheshik, Sankhya, Mimamsa, Yoga, Adhyatma and Meditation) Shastra (Nyaya, vyakarana, Krishi, Shilp, Vastu, Natya and Sangeet)
UNIT IV	**Indian Traditional communities, and their livelihood Practices** Geophysical aspects, Resources and Vulnerability, Resource availability, utilization pattern and limitations, Socio-Cultural linkages with Traditional Knowledge System Tangible and intangible cultural heritage.
UNIT V	**Indigenous Knowledge and Traditional Practices I** Myths, Rituals, Spirituals, Taboos and Belief System, Folk Stories, Songs, Proverbs, Dance, Play, Acts and Traditional Narratives, Agriculture, animal husbandry, Forest, Sacred Groves, Water Mills, Sacred Water Bodies, Land, water and Soil Conservation and management Practices, Indigenous Bio-resource Conservation,
UNIT VI	**Indigenous Knowledge and Traditional Practices II** Utilization Practices and Food Preservation Methods, Handicrafts, Wood Processing and Carving, -Fiber Extraction and Costumes, Vaidya (traditional health care system), Tantra-Mantra, Amchi Medicine System, Knowledge of dyeing, chemistry of dyes, pigments and chemicals

Reference Books:

1. Kapoor Kapil, Singh Avadhesh (2021). “Indian Knowledge Systems Vol – I & II”, Indian Institute of Advanced Study, Shimla, H.P.
2. Dasgupta,S. (1975). A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi.
3. PLofker, K. (1963). Mathematics in India, Princeton University Press, New Jeresy, USA"

Semester-II

Course Title: Object-Oriented Modelling (4.5 ODLCSC03) **Credits :04**	
UNIT I	Object orientation introduction: OO development, OO Themes; Evidence for usefulness of OO development; OO modelling history, Modelling as Design technique: Modelling; abstraction; The Three models. Class Modelling: Object and Class Concept; Link and associations concepts; Generalization and Inheritance; A sample class model; Navigation of class models; Advanced Class Modelling, Advanced object and class concepts; Association ends; N-ary associations; Aggregation; Abstract classes; Multiple inheritance; Metadata; Reification; Constraints; Derived Data; Packages.
UNIT II	UseCase Modelling and Detailed Requirements: Overview; Detailed object- oriented Requirements definitions; System Processes: A use case/Scenario view; Identifying Input and outputs-The System sequence diagram; Identifying Object Behaviour-The state chart Diagram; Integrated Object-oriented Models.
UNIT III	Process Overview, System Conception and Domain Analysis: Process Overview: Development stages; Development life Cycle; System Conception: Devising a system concept; elaborating a concept; preparing a problem statement. Domain Analysis: Overview of analysis; Domain Class model: Domain state model; Domain interaction model; Iterating the analysis.
UNIT IV	Use case Realization: Design Discipline within up iterations: Object Oriented Design-The Bridge between Requirements and Implementation; Design Classes and Design within Class Diagrams; Interaction Diagrams-Realizing Use Case and defining methods; Designing with Communication Diagrams; Updating the Design Class Diagram; Package Diagrams-Structuring the Major Components; Implementation Issues for Three- Layer Design. Design Patterns: Introduction, Describing design patterns, the catalogue of design patterns, Organizing the catalogue, solve design problems by design patterns, selecting and using a design pattern, Creational patterns: prototype and singleton (only); structural patterns adaptor and proxy (only).

Reference Books:

1. Michael Blaha, James Rumbaugh: Object Oriented Modelling and Design with UML,2nd Edition, Pearson Education, 2005.
2. Satzinger, Jackson and Burd: Object-Oriented Analysis & Design with the Unified Process, Cengage Learning ,2005.
3. Erich Gamma, Richard Helm, Ralph Johnson and john Vlissides: Design Patterns – Elements of Reusable Object-Oriented Software, Pearson Education, 2007.
4. Grady Booch et. al.: Object-Oriented Analysis and Design with Applications,Pearson Education,2007.
5. Frank Buschmann, RegineMeunier, Hans Rohnert, Peter Sommerlad, Michel Stal: Pattern –Oriented Software Architecture. A system of patterns, John Wiley and Sons.2007.
6. Booch, Jacobson, Rambaugh : Object-Oriented Analysis and Design with Applications,Pearson, 2013.

Course Title: Integral Calculus (4.5 ODLMAT02) Credits :04	
UNIT I	Integration-reduction formulae for rational and irrational functions, trigonometric functions. Exponential functions, Polynomial functions, and their composite forms.
UNIT II	Definite integrals and its application to find area under simple curve and area between two curves, Area of a curve using multiple integral, Change of order of integration.
UNIT III	Vector Differentiation and their properties, velocity, acceleration, and their radial and transversal components, directional derivative, gradient, divergence and curl and their properties.
UNIT IV	Vector integration- line, surface and volume integration, Green's theorem, Gauss divergence theorem, Stoke's theorems.

Reference Books:

1. Seymour Lipschutz, Dennis Spellman, and Murray, Spiegel, "Vector Analysis", 2nd Edition, McGraw Hill Education (India) Private Ltd., 2000.

Course Title: Probability and Random Variable (4.5 ODLSTA02) Credits :04	
UNIT I	Concepts of experiments: deterministic, probabilistic, outcomes of experiments. Sample space, Discrete (finite and countably infinite) and continuous sample space, Event, Elementary event, Compound event. Algebra of events (Union, Intersection, Complementation), De Morgan's law. Definitions of Mutually exclusive events, Exhaustive events, Venn diagram. Definition; Axiomatic definition of probability; Addition theorem (Proof of the result up to three events), Elementary properties, Classical definition of Probability as a special case, Probability as an approximation to the relative frequency, illustrative examples for computation of events based on Permutations and Combinations, with and without replacements, impossible events, certain events. Definition of conditional probability of an event, Multiplication theorem for two events, Independence of events: Pairwise and Mutual Independence of events. Partition of sample space. Statement and proof of Bayes' theorem.
UNIT II	Definition of random variable, Discrete and continuous and mixed type of random variables, Definition of distribution function, Distributions function (df) of random variable, Probability distribution of function of random variable. Probability mass function (p.m.f.) and cumulative distribution function (c.d.f.) of a discrete random variable, Probability density function (p.d.f.) and cumulative distribution function (c.d.f.) of a continuous random variable, relation between df and pmf/pdf, Median and Mode of a univariate discrete and continuous random variable.
UNIT III	Definition of expectation of a random variable, expectation of a function of a random variable, simple properties, Definitions of mean, variance of univariate distributions, Effect of change of origin and scale on mean and variance, Definition of raw, central moments, mean deviation. Pearson's coefficient of skewness, kurtosis, Definitions probability generating function (p.g.f.), moment generating function (MGF), Cumulant Generating function (CGF) and characteristic function (CF) of a random variable, Effects of change of origin and scale. p.g.f. of sum of two independent random variables is the product of p.g.f.s (statement only), Derivation of mean and variance by using p.g.f.

Reference Books:

1. Mood A. M., Grabyll R. A. and Boes D. C., Introduction to the theory of Statistics, Tata McGraw Hill
2. Mukhopadhyay, P., Mathematical Statistics, new Central Book Agency Pvt. Ltd., Calcutta.
3. AM Goon, M K Gupta and B. Das Gupta, Fundamentals of Statistics, Volume-I, World Press.
4. Ross Sheldon M., Introduction to Probability Models, Academic Press
5. Rao, B. L. S. Prakash, A first course in probability and Statistics, World Scientific.

Course Title: Macroeconomics - I (4.5 ODLECO11) Credits :04	
UNIT I	**Introduction to Macroeconomics** Origin and Roots of macroeconomics, the rationale for the distinct examination of macroeconomics, Scope of macroeconomics, Macroeconomic Variables- Stocks and Flows, Problem of Aggregation: Macroeconomic Equilibrium.
UNIT II	**Introduction to National Income** Concepts of national income, Circular flow of income in two, three and four sectors, real flow and money flow, measurement of gross domestic product; income, expenditure & output method, Difficulties in measurement of national income, nominal and real GDP, GDP and welfare, GDP deflator, the inter-relation of income and product aggregates. Inter temporal and international comparisons of National income; National income estimation in India.
UNIT III	**Determination of Income and Employment** Essential features and implications of Classical theory, self-adjustment mechanism in classical theory, Say's law in barter economy and money economy,
UNIT IV	**Keynesian Theory of Income and Employment** Keynes'objections to classical theory, Theory of Effective Demand; Simple Keynesian model of Income Determination for a closed economy, Fiscal Policy and Government Budget.
UNIT V	**Consumption function** Keynesian consumption function, Features of consumption function, Shifts/Drifts in the consumption function, Discrepancy between short run and long run consumption-income Relationship, Overview of Life Cycle Hypothesis, Permanent Income Hypothesis and Relative Income hypothesis and the economic Implications.
UNIT VI	**Saving Function** Meaning, significance, determents of savings, non-Income factors affecting households saving, Paradox of Thrift, Nexus between Saving and Economic Growth, Impact of fiscal and monetary policy on household savings.

Reference Books:

1. Shapiro, E.: Macroeconomic Analysis.
2. SurajB.Gupta : Monetary Economics, S.Chand and Company Ltd.
3. Olivier Blanchard, Macroeconomics, Pearson Education, Inc., 5th edition, 2009.
4. Errol D'Souza, Macroeconomics, Pearson Education, 2009.
5. Andrew B. Abel and Ben S. Bernanke, Macroeconomics, Pearson Education, Inc

Course Title: Discrete Structures (4.5 ODLCSC04) Credits :03	
UNIT I	Set Theory: Introduction, Combination of sets, Multisets, Ordered pairs. Proofs of some general identities on sets. Relations: Definition, Operations on relations, Properties of relations, Composite Relations, Equality of relations, Recursive definition of relation, Order of relations. Functions: Definition, Classification of functions, Operations on functions, Recursively defined functions. Growth of Functions. Natural Numbers: Introduction, Mathematical Induction, Variants of Induction, Induction with Nonzero Base cases. Proof Methods, Proof by counter – example, Proof by contradiction.
UNIT II	Algebraic Structures: Definition, Properties, types: Semi Groups, Monoid, Groups, Abelian group, properties of groups, Subgroup, cyclic groups, Cosets, factor group, Permutation groups, Normal subgroup, Homomorphism and isomorphism of Groups, example and standard results, Rings and Fields: definition and standard results
UNIT III	Lattices: Definition, Properties of lattices – Bounded, Complemented, Modular and Complete lattice. Boolean Algebra: Introduction, Axioms and Theorems of Boolean algebra, Algebraic manipulation of Boolean expressions. Simplification of Boolean Functions, Karnaugh maps, Logic gates, Digital circuits and Boolean algebra.
UNIT IV	Language of Logic: Proposition, Compound Proposition, Conjunction, Disjunction, Implication, Converse, Inverse & Contrapositive, Bi-conditional Statements, tautology, Contradiction & Contingency, Logical Equivalences, Quantifiers, Arguments Groups, Ring, fields and Lattice.

Reference Books:

1. C.L Liu and D.P. Mohapatra, Elements of Discrete Mathematics: A Computer Oriented Approach, TMH, 3rd Edition.
2. Rosen, Discrete Mathematics and its applications, 6th Edition
3. Schaum's Outlines of Discrete Mathematics, Seymour Lipschutz & Marc Lipson, 2nd Edition.

Course Title: Programming in C++ (4.5 ODLCSC05) Credits :03	
UNIT I	Introduction to programming paradigms- (Process oriented and Object oriented), Characteristics of OOP- Data hiding, Encapsulation, data security and Polymorphism. Concept of object, class, objects as variables of class data type, difference in structures and class, in terms of access to members, private and public members of a class, data & function members. Basics of C++: Structure of C++ programs, introduction to defining member functions within and outside a class, keyword *using*, declaring class, creating objects, simple programs to access & manipulate data members, *cin* and *cout* functions. Decision making constructs (if, switch), Looping (for, while, do…while)
UNIT II	Creating Classes and objects, Modifiers and Access Control, Constructors & destructor functions, Initializing member values with and without use of constructors, constant objects and members function, composition of classes, Static class members.
UNIT III	friend functions and classes, using *this* pointer, creating and destroying objects dynamically using *new* and *delete* operators. Operator overloading: Fundamentals, Restrictions, operator functions as class members v/s as friend functions. Overloading stream function, binary operators and unary operators. Converting between types.

UNIT IV	**Inheritance**: Base classes and derived classes, protected members, relationship between base class and derived classes, constructors and destructors in derived classes, public, private and protected inheritance, relationship among objects in an inheritance hierarchy, abstract classes, virtual functions and dynamic binding, virtual destructors. Multiple inheritance, virtual base classes, pointers to classes and class members, multiple class members, Templates.
UNIT V	**Exception and File Handling:** Using try, catch, throw, throws and finally; Nested try, creating user defined exceptions, File I/O Basics, File Operations.

Reference Books:

1. E. Balagurusamy, Object Oriented Programming with C++, 5th Edition, TMH Education 2011
2. Robert Lafore, Object Oriented Programming, Pearson Publication 2008
3. Rajesh Kumar Shuka, Wiley Publication, 2008
4. Bjarne Stroustrup, The C++ Programming Language, 3rd Edition, Pearson Publication 2002.

Course Title: ICT and Tools (4.5 ODLCSC06) **Credits :02**	
UNIT I	**Hardware Details:-** System Unit, Monitor, Keyboard, Mouse, Flash Memory, Cache Memory and functioning and Internal structure of Hard Disk. Evolution and Types of the latest Microprocessor. Printer, Scanner, Functionality and basic differences in printing technology.
UNIT II	**Basic Software Fundamentals:-** Basics of software, Types of Software – System software, Application software, Utility Software, Open source software, compiler, assembler, and interpreter. Operating Systems – Functions, Types, Dos, windows, Linux. Basic DOS Commands, Linux Commands.
UNIT III	**Office Processing tools** Latex: What is Latex? Latex tools , Installing LaTeX or Web Browsing software. Formatting Words, Lines, and Paragraphs, Designing Pages, Creating Lists, Creating Tables and Inserting Pictures, Create Report, resume and Slides. Understanding Word Processing: Word Processing Basics, Opening and Closing of documents, Text creation and Manipulation, Formatting of text, Table handling, Spell check, language setting and thesaurus, Printing of word document. Using Spread Sheet: Basics of Spreadsheet, Manipulation of cells, Formulas and Functions, Editing of Spread Sheet, printing of Spread Sheet. Basics of presentation software, Creating Presentation, Preparation and Presentation of Slides, Slide Show, Taking printouts of presentation/handouts.
UNIT IV	**Networking Fundamentals:-** What is Computer Network, LAN , WAN and MAN. Networking Devices such as Repeater, Hub, Switch and Router. Introduction about Layers in Computer Networks. Various kinds of addresses in Networking. Demonstration of Wireshark Tools and some of the applications using Wireshark. Introduction to Internet, WWW and Web Browsers: Concept of Internet, Applications of Internet, connecting to internet, ISP, World Wide Web, Web Browsing software, Search Engines, Understanding URL, Domain name.

Reference Books:

1. P. K. Sinha and Priti Sinha. *Computer fundamentals*. BPB publications.
2. B. Ram, *Computer fundamentals: architecture and organization*. New Age International.
3. D. H. Sanders, *Computers today,* McGraw-Hill.

4. Anita Goel, *Computer fundamentals*. Pearson Education India.
5. Computer Networks, Tanenbaum.
6. Red Hat Linux 9, Bible Chritstopher Negus.
7. LaTeX_Beginners_Guide, Stefan Kottwitz, ISBN 978-1-847199-86-7.

Course Title: Computing and Cyber Ethics (4.5 ODLCSC07) **Credits :04**	
UNIT I	**Introduction to Cyber Ethics** Evolution of Computer Technology, Emergence of Cyber Space. Definition of Ethics, Ethics in the Business World, Ethics in Information Technology, Ethical Theories: Virtue Ethics, Duty Ethics, Right Ethics, Utilitarianism, Other Ethical views, Heinz's Dilemma.
UNIT II	**Ethics in IT Societies** IT Professionals, IT workers Professional Relationships: Relationships Between IT Workers and Employers, Relationships Between IT Workers and Employers, Relationships Between IT Workers and Employers, Relationships Between IT Workers and Clients, Relationships Between IT Workers and Suppliers, Relationships Between IT Workers & Other Professionals, Professional Codes of Ethics, Certification, Government Licensing, ACM/IEEE Software Engineering Code of Ethics and Professional Practice.
UNIT III	**Computer, Internet Crime and Preventive Measures** IT security incidents, Types of Attacks: Viruses, Worms, Trojan Horses, Denial-of-Service (DoS) Attacks; Federal Laws for Prosecuting Computer Attacks, The Information Technology ACT 2000: Offences and Punishment; Implementing Trustworthy Computing: Prevention, Detection, Response, Digital Signatures, Basics of Cryptography, Public Key Cryptography, Shared Key Cryptography.
UNIT IV	**Privacy and Intellectual Property** Privacy protection and the law, Information Privacy, Classification of Privacy Laws, International Legal Standards on Privacy, Privacy laws in India, Privacy Issues, Data Encryption, Intellectual Property: Acts Regulating Intellectual Property, Copyrights, Patents, Trade Secrets, Key Intellectual Property Issues.
UNIT V	**Ethics of IT Organizations** Key Ethical Issues for Organizations, The Need for Nontraditional Workers, Contingent Workers, H-1B Workers, Outsourcing, Whistle-Blowing, Green Computing.
UNIT VI	**Ethical Challenge of Artificial Intelligence & Blockchain** Artificial Intelligence Ethics: Top Nine Ethical Issues in Artificial Intelligence, Five Core Principles to Keep AI Ethical; Blockchain Ethics: Blockchain Definition and Description, Blockchain Anonymity and Privacy, Blockchain for Voting, Blockchain for Transparent Trade Tracing.

Reference Books:

1. Stückelberger, C., & Duggal, P. (2018). *Cyber ethics 4.0*. Geneva: Globethics. net. Jonathan, R. (2003). Cyber Law [M].
2. Reynolds, G. (2019). Ethics in Information Technology–6th Edition.
3. Information Technology Act (2000), S. R. Bhansali,, University Book House Pvt. Ltd., Jaipur (2003).

Semester-III

Course Title: Data Structures (5.0 ODLCSC01) Credits :04	
UNIT I	Arrays: Array as storage element, Row major & column major form of arrays, computation of address of elements of n dimensional array. Arrays as storage elements for representing polynomials of one or more degrees for addition & multiplication, sparse matrices for transposing & multiplication.
UNIT II	Stack, queue, dequeue, circular queue for insertion and deletion with condition for over and underflow, transposition of sparse matrices with algorithms of varying complexity
UNIT III	Linear linked lists: singly, doubly and circularly connected linear linked lists insertion, deletion at/ from beginning and any point in ordered or unordered lists. Comparison of arrays and linked lists as data structures. Linked implementation of stack, queue and dequeue. Algorithms for/of insertion, deletion of stack,queue, dequeue implemented using linked structures. Polynomial representation using linked lists for addition, Concepts of Head Node in linked lists. Searching: Sequential and binary search.
UNIT IV	Non-Linear Structures: Trees definition, characteristics concept of child, sibling, parent child relationship etc, binary tree: different types of binary trees based on distribution of nodes, binary tree (threaded and unthreaded) as data structure, insertion, deletion and traversal of binary trees, constructing binary tree from traversal results. B-Trees and introduction to B+ Trees. Graph, Traversing.

Reference Books:

1. An introduction to data structures with applications By Jean-Paul Tremblay, P. G.Sorenson, TMH
2. A. Drozdek, Data Structures and Algorithms in C++, 3rd Edition, Course Technology
3. Data Structures in C & C++, Tanenbaum, PHI
4. S. Sahni, Data Structure Algorithms and Applications in C++, Wiley 2003.

Course Name: Digital Electronics (5.0 ODLCSC02) Credits :04	
UNIT I	Codes: Binary, Sum of products and product of sums, BCD, Excess 3, Gray, Alphanumeric codes, Logic Gates: OR, AND, NOT, NAND, NOR, Exclusive – OR, Exclusive – NOR, Mixed logic, Boolean Algebra: Boolean Logic Operations, Basic Law of Boolean Algebra, Demorgan's Theorem, Principle of Duality, Karnaugh map Minimization and Quine-McCluskey method of minimization, Sum of Products, Product of Sums.
UNIT II	COMBINATIONAL CIRCUIT DESIGN Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder — Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.
UNIT III	SYNCHRONOUS SEQUENTIAL CIRCUITS Flip flops — SR, JK, T, D, Master/Slave FF — operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits — Design — Moore/Mealy models, state

	minimization, state assignment, circuit implementation — Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.
UNIT IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.
UNIT V	MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS Basic memory structure — ROM -PROM — EPROM — EEPROM –EAPROM, RAM — Static and dynamic RAM — Programmable Logic Devices — Programmable Logic Array (PLA) — Programmable Array Logic (PAL) — Field Programmable Gate Arrays (FPGA) — Implementation of combinational logic circuits using PLA, PAL. Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS.

Reference Books:

1. A.S.Tannenbaum : Structured Computer Organization, Pearson
2. Thomas C. Bartee : Digital Computer Fundamentals, McGraw-Hill
3. Duglus V Hall : Microprocessors and Interfacing: programming and Hardware, McGraw-Hill, 1986.
4. Introduction to Computer Architecture, Stone S.Galgotia Publications 1996.
5. Microprocessor Architecture Programming & Applications, R. Gaonkar, Wiley Eastern-1987.
6. Computer Architecture and Organization by N.P. Carter, 4th Edition, McGraw-Hill, 2014.

Course Title: Mathematical Programming (5.0 ODLMAT01) **Credits :04**	
UNIT I	Linear Programming Problems Formulation and Solution by Graphical Method and Simplex Method, Theoretical Foundation of Simplex Method, Revised Simplex Method.
UNIT II	Duality in linear programming problem, Primal-dual method, Duality theorems, Dual simplex method; Sensitivity Analysis: Post Optimality Analysis (change in resource vector, change in cost vector, addition and deletion of a constraint, addition and deletion of a decision variable
UNIT III	Transportation Problem (TP) and its formulation, finding initial basic feasible solution of TP using North-West Corner rule, Least Cost method and Vogel's Approximation method, MODI method for finding optimal solution, Special cases in TP.
UNIT IV	Assignment Problem (AP) and its formulation, Hungarian method for solving AP, Special cases in AP, Transshipment and Travelling salesmen problem.

Reference Books:

1. Bertsimas D. and Tsitsiklis J.N., 1997, *Introduction to Linear Optimization,* Athena Scientific, Belmont, Massachusetts.
2. Bradley, H., Magnanti, 1977, *Applied Mathematical Programming*, Addison-Wesley.

Course Title: Programming in Python (5.0 ODLCSC03) **Credits :03**

UNIT I	Basics of python programming: python identifiers, indentation, comments in Python, data types, python strings.
UNIT II	Python operators: arithmetic, assignment, relational operators etc. Decision making and loop control structures.
UNIT III	Built-in functions in python, built-in string methods. User-defined functions, keyword arguments. Lambda functions.
UNIT IV	Python lists, tuples, dictionaries. Performing basic operations on lists, tuples and dictionaries.
UNIT V	Python modules, namespace and scoping. File handling, access modes, reading and writing files, renaming and deleting files.
UNIT VI	Plotting graphs in python, Introduction to Matplotlib. Developing basic GUI applications using Tkinter.

Reference Books:

1. Introduction to computation and programming using Python, John V. Guttag, MIT Press.
2. Python: The Complete Reference, by Martin C. Brown, McGraw Hill Education.
3. Learn Python Programming: An in-depth introduction to the fundamentals of Python, Third Edition, By Fabrizio Romano, Heinrich Kruger.

Course Title: Introduction to SciLab (5.0 ODLMAT84) **Credits :03**	
UNIT I	Introduction to Scilab, installation, SciNotes, files formatting, local and global variables, predefined constants, constants, common mathematical functions, variable assignment operator, data types, floating points, number formats, Boolean data strings.
UNIT II	Introduction of loops, while loop, infinite loops, for loop, if-else, arrays, vectors, operations, vector element wise operations.
UNIT III	Matrix multiplication, inverse of matrices, vector random matrix, row and columns addition and deletion, vector matrix manipulations, matrix reshaping, upper and lower triangular matrices.
UNIT IV	Introduction to 2D plotting, 3D plotting, multiple plots in same graph, multiple plots, formatting, editing of graphs.

Reference Books:

1. Mathieu, P., and Roux, P., *Scilab: I. Fundamentals,* Scilab Enterprises, 2016.
2. Affouf, M., *Scilab by Example,* Create Space Independent Pub. Platform, 2012.

Course Title: Web Development (5.0 ODLCSC04) **Credits :02**	
UNIT I	Introduction to WWW : Protocols and programs, secure connections, application and development tools, the web browser, What is server, choices, setting up UNIX and Linux web servers, Logging users, dynamic IP Web Design: Web site design principles, planning the site and navigation.
UNIT II	Introduction to HTML : The development process, Html tags and simple HTML forms, web site structure Introduction to XHTML : XML, Move to XHTML, Meta tags, Character entities, frames and frame sets, inside browser.

UNIT III	Style sheets : Need for CSS, introduction to CSS, basic syntax and structure, using CSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, CSS2.
UNIT IV	Javascript : Client side scripting, What is Javascript, How to develop Javascript, simple Javascript, variables, functions, conditions, loops and repetition.
UNIT V	DHTML : Combining HTML, CSS and Javascript, events and buttons, controlling your browser, Ajax: Introduction, advantages & disadvantages ,Purpose of it ,ajax based web application, alternatives of ajax.
UNIT VI	PHP : Starting to script on server side, Arrays, function and forms, advance PHP Databases : Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP my admin and database bugs.

Reference Books:

1. Sharma &Sharma, “Developing E-Commerce Sites”, Addison Wesley
2. Ivan Bayross, “Web Technologies Part II”, BPB Publications.
3. Steven Holzner,”HTML Black Book”, Dremtech press.
4. Web Technologies, Black Book, Dreamtech Press
5. Web Applications : Concepts and Real World Design, Knuckles, Wiley-India
6. Internet and World Wide Web How to program, P.J. Deitel & H.M. Deitel Pearson.

Semester-IV

Course Title: Database Management System (5.0 ODLCSC05) **Credits :04**	
UNIT I	Introduction to database, Overview and History of DBMS, File System vs DBMS, Purpose of Database, Overall System Structure, Entity Relationship Model, Mapping Constraints - Keys - E-R Diagrams.
UNIT II	Overview of Data Design Entities, Attributes and Entity Sets, Relationship and Relationship Sets, Features of the ER Model-Key Constraints, Participation Constraints, Weak Entities, Class Hierarchies, Aggregation. Relationship Algebra: Selection and Projection, Set Operations, Renaming, Joints, Division, Relation Calculus.
UNIT III	Relational Database Design: Pitfalls, Normalization Using Functional, Dependencies, First Normal Form, Second Normal Form, Third Normal Form and BCNF.
UNIT IV	Structured Query Language (SQL), Basic Structure, Set Operations, Aggregate, Functions, Date, Numeric, and Character Functions, Nested Sub queries, Modification of Databases, Joined Relations. Transaction Processing: ACID Properties, Concurrency Control, Recovery.

Reference Books:

1. Elmasri R and Navathe SB, Fundamentals of Database Systems, 3rd Edition, AddisonWesley, 2000.
2. Connolly T, Begg C and Strachan A, Database Systems, 2nd Edition, Addison Wesley, 1999
3. Ceri Pelagatti , Distributed Database: Principles and System - (McGraw Hill).
4. Simon AR, Strategic Database Technology: Management for the Year 2000, Morgan Kaufmann,1995.
5. A. Silversatz, H. Korth and S. Sudarsan: Database Concepts 5th edition, Mc-Graw Hills 2005.

Course Title: Programming in Java (5.0 ODLCSC06) **Credits :04**	
UNIT I	Fundamentals of object-oriented programming, Java evolution, Features of Java, Java Development Kit (JDK), Java basics, keywords, constants, variables, and data types.
UNIT II	Operators and expressions, compiling and executing java Programs, operators, control flow Statements, Switch Statement, Looping statements, break and continue.
UNIT III	Classes, objects, and methods, declaring methods in java, constructors, static members, nesting of methods, inheritance, abstract methods and classes, array, String, and vectors.
UNIT IV	Interfaces, defining interfaces, extending interfaces, implementing interfaces, Packages, creating packages, managing errors, and exception. Multithreaded programming.
UNIT V	Applets programming, Applet class, Applet and HTML, the Life cycle of an applet.
UNIT VI	Graphics programming using AWT, colors, font, Event handling, Components of an event, event classes, event listener.

Reference Books

1. Schildt Herbert, Java: The Complete Reference, 8th Edition, Tata McGraw-Hill,2011.
2. E. Balagurusamy, Programming with JAVA, a Primer, 4th Edition, 2010, TataMcGraw-Hill Publishing Company Limited, Delhi.

Course Title: Operating System (5.0 ODLCSC07) **Credits :04**	
UNIT I	Introduction to Operating Systems, Types of operating systems, Multiprogramming, Time-sharing systems, Operating system services, System calls and System programs, Storage structures.
UNIT II	Process concepts, process scheduling, operations on process, threads, Inter process communication, precedence graphs, critical section problem, semaphores, classical problems of synchronization, CPU Scheduling,
UNIT III	Deadlock: Introduction, problem, characterization, prevention, avoidance, detection,recovery from deadlock, Methods for deadlock handling.
UNIT IV	Memory Management, Single and multiple partitioned allocations, paging segmentation, Virtual Memory Management, Demand paging and Page Replacement Algorithms.
UNIT V	Device and Storage Management**:** File-System Interface, Mass-Storage Structure, Device Management: Techniques for Device Management, Dedicated Devices, Shared Devices, Buffering, Multiple Paths, Secondary- Storage Structure: Disk Structure, Disk Scheduling, Disk Management.
UNIT VI	File-System Implementation: A Simple File System, Logical & Physical File System File-System Interface: Access Methods, Directory Structure, Protection, Free-Space Management, Directory Implementation.

Reference Books:

1. Abraham Silberschatz and P. B. Galvin - Operating system concepts – Addison WesleyPublication
2. A. Tanunbaum, Modern Operating Systems, 3rd Edition, Pearson Publication.

Course Title: Graph Theory (5.0 ODLCSC08) **Credits :04**	
UNIT I	Introduction to Graph Theory – Definition, Applications, Degree of vertices, Brief History. Paths and Circuits – Isomorphism, Subgraphs, Disconnected Graphs, Euler Graph, Operation on graphs, Hamiltonian circuit, Travelling Salesman problem.
UNIT II	Tree– Properties, Center, Rooted tree, Binary trees, On counting trees, Spanning tree, Fundamental circuits, Shortest spanning tree, Prim's Algorithm, Kruskail Algorithm. Cut-sets–Properties, Finding cut-sets, Connectivity, Separability, Network flows, 1-isomorphism, 2-isomorphism
UNIT III	Planar Graph - Combinatorial Vs Geometrical graphs, Kuratowski's two graphs, Detection of planarity, dual graph, thickness and crossing. Vector Representation of Graph, Circuit and Cut-set vector subspace, Intersection, join.
UNIT IV	Matrix Representation – Incidence matrix, Circuit matrix, Cut-set matrix, Path matrix, Adjacency matrix. Coloring – Chromatic number, Chromatic partitioning, chromatic polynomial, Matching, Covering, Four color problem. Five color theorem.

UNIT V	Directed Graph – Types, Directed path, Euler diagraph, Tree with directed edges, Matrix representation, Acyclic diagraphs. Graph Enumeration – Types, Polya's counting theorem.

Reference Books

1. Narsingh & Deo, Graph Theory with Applications to Engineering and Computer Science, PHI2004 Publication.
2. V. Balkrishnan, Schaum's Outline of graph Theory, 2004.
3. Jonathan L Gross, Jay Yellen and Mark Anderson, Graph Theory and its Applications, Chapman and Hall, New York.

Course Title: Mathematical Finance (5.0 ODLECO91) **Credits :02**	
UNIT I	Review of basic mathematical tools, probability theory and random variables. Economic indicators that may affect the financial markets. Mathematics of the Time Value of Money: Simple interest, Compound interest, Annuities and amortization theory, NPV, IRR.
UNIT II	**Mathematics of Investment I** Buying and selling stocks, Common stock valuation, cost of new issues of common stock, stock value with two-stage dividend growth, Bond valuation, premium and discount prices, premium amortization, discount accumulation, estimating the yield rate.
UNIT III	**Mathematics of Investment II** Mathematics of Return and Risk: Expected rate of return, measuring the risk, risk aversion and risk premium, return and risk at the portfolio level.
UNIT IV	**Portfolio Theory I** Markowitz Portfolio Model, Two securities portfolio, N-securities portfolio, Investor Utility, Diversification and randomly selected securities. Capital market Theory: the financial beta (β), The Capital Market line, The CAPM equation,
UNIT V	**Portfolio Theory II** The Security Market Line, CAPM security risk decomposition. Portfolio Risk Measures: The Sharpe ratio, the Sortino ration, Value-at-Risk
UNIT VI	**Derivatives** Forwards, Futures and Options. Dynamics of making profits with options, Intrinsic Values of Calls and Puts, Time value of Calls and Puts, The delta ratio, determinates of option value, Option valuation. Option Pricing: The Black-Scholes-Merton (BSM) mode. The BSM model vs market data.

Reference Books:

1. A. O. Petters and X. Dong, An Introduction to Mathematical Finance with Applications (Springer, 2016)
2. S. Roman, Introduction to the Mathematics of Finance (Springer, 2004)
3. M. J. Alhabeeb, Mathematical Finance, (Wiley, 2012)
4. S. Ross, An Elementary Introduction to Mathematical Finance, Third Edition (Cambrige U. Press, Cambridge, 2011)

Semester - V

Course Title: Computer Networks (5.5 ODLCSC01) **Credits :04**	
UNIT I	Introduction to Networks and Layered Architectures (OSI, TCP/IP), Categories of Networks Network performance measures e.g. bandwidth, latency, Delay/bandwidth product. Transmission Media: Guided Media (twisted pair cable, Coaxial Cable, fibre optic cable), Unguided media (radio waves, microwaves, infrared), Topology. Hardware building Blocks of a network e.g. switches, routers, gateways etc.
UNIT II	Data Link Layer: Data Link Layer Design Issues - Error Detection and Correction. Elementary data link protocols - Sliding Window Protocols - Protocols Verification - ChannelAllocation Problem- Multiple Access Protocols
UNIT III	Network Layer: Network Layer Design Issues- Routing Algorithms-Congestion Control Algorithms- Quality of Service -Internetworking Transport Layer: Transport Services – elements of transport protocols – simple transport protocols.
UNIT IV	Application layers: Domain name system – Electronic mail – The World Wide Web. Introduction to Network security

Reference Books:

1. Computer Networks, Andrew S. Tanenbaum , Fourth edition,PHI private Ltd, New Delhi , 2008
2. Computer Networking Top Down approach 3rd editionBy Jim kurose and keithross.

Course Title: Theory of Computation (5.5 ODLCSC02) **Credits :04**	
UNIT I	Languages: Alphabets, string, language, basic operations on language, concatenation, Kleene Star.
UNIT II	Regular languages model: finite state machine (deterministic and non deterministic), regular grammars, regular expressions, equivalence of deterministic and non deterministic machine and of the three models; Properties: closure, decidability, minimality of automata.
UNIT III	Context Free Grammar, Derivation trees, Simplification of Context Free Grammar, Chomosky Normal Form, Greibach Normal Form, pushdown automata and their equivalence, Properties of Context Free Languages.
UNIT IV	Turing machines, grammars, recursive functions and their equivalence, language acceptability, decidability, halting problem.

Reference Books:

1. Hofcroft J.E., Ullman J.D., Introduction to Automata Theory, Languages and Computation,Narosa Publishing House.
2. Lewis H. R. and Papadimitriou C. H., Elements of the theory of computation, Pearson EducationAsia
3. Martin J. C., Introduction to Languages and the Theory of Computation, 2e, Tata McGraw-Hill .

4. Daniel I A Cohen, Introduction to Computer Theory, Wiley II Edition.

Course Title: Software Engineering (5.5 ODLCSC03) **Credits :04**	
UNIT I	System Analysis: Characteristics, Problems in system Development, System Level projectPlanning, System Development Life cycle (SDLC), computer system engineering & system analysis, modeling the architecture, system specification. Capability Maturity Model Integration (CMMI)
UNIT II	Requirement Analysis: Requirement analysis tasks, Analysis principles, Software prototyping and specification data dictionary finite state machine (FSM) models. Structured Analysis: Data and control flow diagrams, control and process specification behavioural modelling, extension for data intensive applications.
UNIT III	Software Design: Design fundamentals, Effective modular design: Data architectural and procedural design, design documentation, coding – Programming style, Program quality, quantifying program quality, complete programming example
UNIT IV	Testing Strategies and tactics: Testing fundamentals, strategic approach to software testing, Validation testing, system testing, Black-Box testing, white-box testing and their types, basic path testing.

Reference Books

1. R.S. Pressman, Software Engineering: A Practitioner's Approach, Mc Graw Hill.
2. P. Jalote, An Integrated Approach to Software Engineering (II Edition).
3. KK Agarwal and Y. Singh, Software Engineering, New Age International Publishers
4. I. Somerville, Software Engineering, Addison Wesle, 2006.

Course Title: Fundamental of Game Theory (5.5 ODLECO05) **Credits :04**	
UNIT I	Introduction to Game Theory; History of Game Theoretic Analysis; classifications of games; theory of rational choice.
UNIT II	Strategic Game: The Pay-off matrix; the Prisoner's dilemma.
UNIT III	Nash Equilibrium: The concept of Nash Equilibrium; dominating and dominated strategies; zero-sum game.
UNIT IV	Mixed Strategy Nash Equilibrium: concepts and examples; strategic game with randomization. Games with perfect information.
UNIT V	Games with imperfect information; Bayesian Games; Cournot's duopoly game with imperfect information; auction; other applications.
UNIT VI	Repeated, Cooperative Games and Core game using Shapely Values.

Reference Books:

1. Osborne J Martin (2004), An Introduction to Game Theory, Oxford University Press
2. Fudenberg, D. and Tirole, J. (1991), Game Theory, MIT Press
3. Gibbons, R. (1992), A Primer in Game Theory, Prentice-Hall
4. Myerson, R. (1991): Game Theory: Analysis of Conflict, Harvard University Press.

Semester - VI

Course Title: Design & Analysis of Algorithms (5.5 ODLCSC05) **Credits :04**	
UNIT I	Definition & characteristics of algorithms, structures. Difficulties in estimating exact execution time of algorithms. Concept of complexity of program. Asymptotic notations: Big-Oh, theta, Omega- Definitions and examples, Determination of time and space complexity of simple algorithms without recursion. Representing a function in asymptotic notations.
UNIT II	Divide-and-conquer, Dynamic Programming, Greedy methods, Backtracking, Branch- and Bound Technique.
UNIT III	Minimum Spanning Trees, Single-Source Shortest Paths, All-Pairs Shortest Paths,Maximum Flow. String Matching, Computational Geometry.
UNIT IV	P and NP class, NP-completeness and reducibility, NP-complete problems.

Reference Books:

1. T. Cormen, C. Leiserson, R. Rivest. Introduction to Algorithms, Indian Reprint, PHI
2. V. Aho, J. Hopcraft, J. Ulmann. The Design and Analysis of Computer Algorithms. AddisonWesley
3. S. Basse, A. V. Gelder, Computer Algorithms: Introduction to design and Analysis, 3rd., PearsonEducation Asia Pvt. Ltd.

Course Title: Computer Organization (5.5 ODLCSC06) **Credits :04**	
UNIT I	Basic architecture of computer, Computer Components and Functions, Interconnection Structures. Bus Interconnections, Von Neumann Concept, Input / Output: I/O Module, Programmed I/O, Interrupt Driven I/O, Direct Memory Access, data transfer schemes for microprocessors.
UNIT II	Classification and design parameters, Memory Hierarchy, Internal Memory: RAM, SRAM and DRAM, Interleaved and Associative Memory. Cache Memory: Design Principles, Memory mappings, Replacement Algorithms, Cache performance, Cache Coherence. Virtual Memory, External Memory : Magnetic Discs, Optical Memory, Flash Memories, RAID Levels.
UNIT III	Central Progressing Unit (CPU): General Register Organization, Control Word, Example of Micro operation, Stack Organization: Register stack, Memory Stack, Reverse Polish Notation. Instruction Formats, Three, Two, One, Zero Address Instructions, RISC Instructions, Addressing Modes, Addressing Modes Examples with Assembly Language [8085/8086 CPU], CISC Characteristics and RISC Characteristics.
UNIT IV	Parallel Processing, Concept and Block Diagram, Types (SISD, SIMD, Interconnect network, MIMD, MISD), Future Directions for Parallel Processors, Performance of Processors, Pipelining: Data Path, Time Space Diagram, Hazards. Instruction Pipelining, Arithmetic Pipelining.

Reference Books:

1. Computer System Architecture- M. Morris Mano, Pearson Publication 3rd Edition, PHI
2. Computer Organizations and Architecture - William Stallings (Pearson Education Asia),2008
3. Computer Organization and Architecture -John P. Hayes (McGraw -Hill), 1998
4. Computer Organization -V. Carl. Hamacher (McGraw-Hill), 2011

5. Nicolas Carter, Computer Architecture, Schaum's Series, TMH

Course Title: Computer Graphics (5.5 ODLCSC07) **Credits :04**	
UNIT I	**Basic of Computer Graphics:** Basic of Computer Graphics, Applications of computer graphics, Display devices, Random and Raster scan systems, Graphics input devices, Graphics software and standards.
UNIT II	**Graphics Primitives:** Points, lines, circles and ellipses as primitives, scan conversion algorithms for primitives, Fill area primitives including scanline polygon filling, inside-outside test, boundary and flood-fill, character generation, line attributes, area-fill attributes, character attributers. Aliasing, and introduction to Anti Aliasing (No anti aliasing algorithm).
UNIT III	**Two Dimensional Graphics:** Transformations (translation, rotation, scaling), matrix representation, homogeneous coordinates, composite transformations, reflection and shearing, viewing pipeline and coordinate system, window-to-viewport transformation, clipping including point clipping, line clipping (Cohen-Sutherland, liang- bersky, Mid-point), polygon clipping.
UNIT IV	**Three Dimensional Graphics:** 3D display methods, polygon surfaces, tables, equations, meshes, curved lies and surfaces, quadric surfaces, spline representation, cubic spline interpolation methods, Bezier curves and surfaces, B-spline curves and surfaces.3D scaling, rotation and translation, composite transformation, viewing pipeline and coordinates, parallel and perspective transformation, view volume and general (parallel and perspective) projection transformations.
UNIT V	**Illumination and Colour Models:** Light sources – basic illumination models – halftone patterns and dithering techniques; Properties of light 1. Standard primaries and chromaticity diagram; Intuitive colour concepts – RGB colour model – YIQ colour model – CMY colour model 2. HSV colour model – HLS colour model; Colour selection.
UNIT VI	**Animations & Realism:** Design of Animation sequences – animation function – raster animation – key frame systems – motion specification – morphing – tweening. **Fractal Graphics:** Tiling the plane, Recursively defined Curves, Koch curves, C curves, Dragons, space filling curves, turtle graphics, ray tracing.

Reference Books:

1. Computer graphics, Donald Hearn and Paulin Baker.
2. Computer graphics, Schaum's Series.
3. Computer graphics: Principles and Practice - James D Foley.
4. Principles of Interactive Computer Graphics – William M Newman
5. Mathematical Elements for Computer Graphics, David Rogers, J Alan Adams
6. Geometric Tools for Computer Graphics - Philip J Schneider, David H Eberly.

Course Title: Information Security (5.5 ODLCSC09) Credits :04	
UNIT I	Introduction to security, attacks, computer criminals, security services. Cryptography: Substitution ciphers, transposition cipher, confusion, diffusion, symmetric and asymmetric encryption. DES, odes of DES. Hash function, key exchange, digital signatures and certificates.
UNIT II	Public Key Cryptosystems: Principles of Public Key Cryptosystems, Factorization, RSA Algorithm, security analysis of RSA, Exponentiation in Modular Arithmetic. Key Management in Public Key Cryptosystems: Distribution of Public Keys, Distribution of Secret keys using Public Key Cryptosystems. Discrete Logarithms, Diffie-Hellman Key Exchange.
UNIT III	Message Authentication & Hashing: Birthday Paradox and General case of Duplications, Basic functions of Message Authentication and Hashing, Introduction to Hash & MAC algorithms. Digital Signatures: RSA Based, El Gamal Signatures, Undeniable Signatures. Authentication: Model of Authentication Systems, Impersonation, Substitution and spoofing games, Authentication schemes for mutual authentication based on shared secret, two-way public key, one-way public key, Mediated Authentication, One way Authentication
UNIT IV	Security in networks: Threats in networks, network security controls, firewalls, intrusion detection system Administrating security: Security planning, risk analysis, physical security, Ethical issues in security.

Reference Books:

1. Stalling Williams: Cryptography and Network Security: Principles and Practices, 4th Edition, Pearson Education, 2006.
2. Kaufman Charlie et.al; Network Security: Private Communication in a Public World, 2nd Ed., PHI/Pearson.
3. Pieprzyk Josef and et.al; Fundamentals of Computer Security, Springer-Verlag, 2008.
4. Trappe & Washington, Introduction to Cryptography, 2nd Ed. Pearson.