

SEMESTER I**20XD11 CALCULUS AND ITS APPLICATIONS****3 2 0 4**

LIMITS AND CONTINUITY: Standard functions – Graphs - Limit- continuity- piecewise continuity- periodic- differentiable functions - Riemann sum- integrable functions- fundamental theorem of calculus. (6+2)

SEQUENCES & SERIES: Sequences – increasing- decreasing- bounded- function limit properties - Series – convergence and divergence – alternating series test- absolute convergence – ratio test- power series- Taylor series (single variable). (8+6)

FUNCTIONS OF TWO VARIABLES: Models- partial derivative and its geometrical interpretation- Stationary points – maxima and minima- saddle points- Taylor series- Constrained maxima and minima – Lagrange multiplier method. (6+4)

MULTIPLE INTEGRALS: Evaluation of multiple integrals – Cartesian and polar forms- Change of order of integration - Applications of multiple integrals to find area and volume. (9+6)

ORDINARY DIFFERENTIAL EQUATIONS: Linear Differential Equations of first order - Exact differential equations- Integrating factors- Bernoulli equations -Linear Differential Equations of higher order with constant coefficients -Euler's equation with variable coefficients - Simultaneous equations - Method of variation of parameters. Modeling simple systems. (12+8)

VECTOR CALCULUS: Vector differentiation-gradient- divergent- curl- vector integration- Greens theorem- Stokes theorem- Gauss divergence theorem (concepts only). (6+2)

Total L: 45+T: 30=75**TEXT BOOKS:**

1. Thomas G B Jr., Maurice D Wier, Joel Hass, Frank R. Giordano, "Thomas' Calculus", Pearson Education, 2018.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley, 2014.

REFERENCES:

1. Ben Orlin, "Change Is the Only Constant: The Wisdom of Calculus in a Madcap World", Black Dog & Leventhal, New York, 2019.
2. Ray Wylie C and Raymond Wylie C, "Advanced Engineering Mathematics", McGraw Hill, 2013.
3. Ken F. Riley, Mike P. Hobson, Stephen J. Bence, "Mathematical Methods for Physics and Engineering", Cambridge University Press, 2018
4. Deborah Hughes-Hallett , Patti Frazer Lock , Andrew M. Gleason," Applied Calculus",Wiley, 2017
5. Judith A. Beecher, Judith A. Penna, Marvin L. Bittinger, "College Algebra", 5th Edition, Pearson, 2016.

20XD12 BASICS OF COMPUTATIONAL BIOLOGY**3 2 0 4**

INTRODUCTION: Evolution of Life, Cells and Tissues – types and functions, Biological Molecules – Proteins, Nucleic Acids(10)

BASICS OF GENETICS AND MOLECULAR BIOLOGY: DNA, Genes, Chromosome, Traits, Mutations, Central Dogma, Transcription, Translation, RNAs. Basic Sequence Analysis using Bioinformatics Tools. (10)

GENOMICS AND PROTEOMICS: Genomics: Genome, Human Genome Project, Sequencing, Gene Expression Studies. Proteomics : Amino acids and Proteins, Proteomics Data. (13)

BIOLOGICAL DATA: Types of Data, Sources, Data Formats, Biological databases – NCBI, ENSEMBL, GEO, Array Express, Peptide Atlas, The Human Protein Atlas, GDC, KEGG (12)

TUTORIAL PRACTICE:

CASE STUDIES: Data related to Human Diseases – Databases and data retrieval. (30)

Total L: 45+T:30=75**TEXT BOOKS:**

1. Peter H.Raven, George B.Johnson, Jonathan B. Losus, Susan R. Singer, "Biology", WBC McGraw Hill, 2017.
2. Eldon D Enger, Frederick C Ross and David B Bailey, "Concepts in Biology", Tata Mc-Graw Hill, , 2009

REFERENCES:

1. Gil Brum, Larry Mckane and Gerry Karp, "Biology fundamentals", John-Wiley & Sons, 1995.
2. Julian Sutton, "Biology- Foundations", Macmillan Company, London, 2002.

20XD13 DIGITAL ELECTRONICS**4 0 0 4**

SEMICONDUCTOR DEVICES AND CIRCUITS: (Qualitative treatment only) Fundamental aspects of semiconductors - PN junction diode - Zener diode - Rectifiers - Zener voltage regulators - Filters - Bipolar Junction Transistors - Transistor Amplifiers - Field Effect Transistor. (5)

NUMBER SYSTEM AND CODES: Binary - Octal - Hexadecimal - BCD - Excess three - Gray codes - Error correcting and detecting codes. (8)

DIGITAL CIRCUITS AND GATES: AND, OR, NOT, NAND and NOR gates - exclusive OR gates. Positive and negative logic systems - Digital integrated circuits-Characteristics -TTL and MOS logic circuits - Comparison. (8)

BOOLEAN ALGEBRA AND KARNAUGH MAPS: Boolean relations - Laws and theorems - Simplifications - Karnaugh maps and simplifications - Don't care conditions - NAND-NAND realizations. (8)

COMBINATIONAL LOGIC: Design and Implementation of Half and Full adders - Subtractors – Parallel adders - Carry look ahead addition - Encoders and decoders - Multiplexers and De-multiplexers. (8)

SEQUENTIAL LOGIC: R-S, J-K, D and T type Flip-Flops - Binary counters: Ripple and synchronous types - UP/DOWN counters - Decade counters - Shift registers - Ring counters. (8)

OPERATIONAL AMPLIFIERS: Definition of terms - Inverting and non-inverting amplifiers, inverting summing amplifier, integrators and differentiators. (7)

A/D AND D/A CONVERTORS: DACs: weighted and binary ladder types - ADCs: counter, dual slope, successive approximation types. (8)

Total L: 60**TEXT BOOKS:**

1. Leach D.P., "Digital Principles & Applications", Tata McGraw Hill, 2011.
2. Mottershed A., "Electronic Devices and Circuits", Prentice Hall, 2009.

REFERENCES:

1. Gothamann H., "Digital Electronics: An Introduction to Theory and Practice", Prentice Hall, 2000.
2. Paul Horowitz and Winfield Hill, "The Art of Electronics", Cambridge University Press, 2010.
3. Hamacher V. C., Vranesic Z. G. and Zaky S. G., "Computer Organization", McGraw Hill, 2011.

20XD14 PROBLEM SOLVING & C PROGRAMMING**4 0 0 4**

PROBLEM SOLVING: Introduction to Problem Solving- Program development- Analyzing and Defining the Problem- Algorithm-Flow Chart - Programming languages-Types of programming languages- Program Development Environment. (5)

C LANGUAGE: Introduction to C Language - C Character Set - Identifiers and Keywords - Data Types – Literal Constants - Variables – l-value-r-value - Qualifiers – Modifiers - Operators and Expressions – Type conversions - Library Functions - Data Input and Output Functions – escape sequence characters – Formatted input and output. (6)

CONTROL STATEMENTS: Making Decisions : If Statement – If/else Statement - If/else if Statement – Nested if Statements – dangling else - Switch Multiple Selection Statement– Repetition : Repetition Essentials - While Loop – do-While Loop – For Loop – Nested Loops – Breaking out of a Loop Continue statement – goto Statement. (6)

FUNCTIONS: Modular Programming – Function Prototypes - Defining and Calling Functions –Function Call Stack and Activation Records - Passing Arguments to Functions – Returning a value from a function- Recursion – Recursion vs. Iteration – Scope and lifetime of variables – Memory layout of a C program - Storage Classes - Auto - Static - Extern and Register Variables. (8)

ARRAYS: Defining Array –Array Initialization - Accessing array elements - Processing arrays - Arrays as function arguments - Multidimensional arrays – Memory address calculation of an array – Row major and column major order - String Handling. (8)

POINTERS: Pointer Variable Definitions and Initializations – Passing Arguments to Functions by address – Pointer Expressions and Pointer Arithmetic - Relationship between Pointers and Arrays - Pointers and multidimensional arrays – Constant Pointer – Pointer to Constant –NULL pointer- dangling pointers - Pointers to functions - passing functions to other functions – Introduction to Stack and Heap Memory - Dynamic Memory Allocation. (10)

STRUCTURES AND UNIONS: Structure Definitions – Initializing Structures – Accessing Structure Members - Processing a structure - typedef- Structures and pointers - Passing structures to functions – Self-Referential Structures- Bit fields - Unions – Enumeration Constants. (8)

FILES: Files and Streams - Operations on Files – Types of Files, Various Read and Write Functions for Sequential-Access and Random-Access Files -Command Line Arguments. (5)

PREPROCESSOR DIRECTIVES: #include Preprocessor Directive - #define Preprocessor Directive: Symbolic Constants - #define Preprocessor Directive: Macros - Conditional Compilation (4)

Total L: 60

TEXT BOOKS:

1. Brian W. Kernighan and Dennis Ritchie, "The C Programming Language", Pearson Education India, 2015
2. R G Dromey, "How to solve it by computer", Pearson 2008.

REFERENCES:

1. Herbert Schildt, "C The Complete Reference", McGraw Hill, 2017.
2. Gottfried B, "Programming With C", McGraw Hill, 2011.
3. Peter Prinz and Tony Crawford, "C in a Nutshell", O'Reilly, 2016.

20XD15 ENGLISH FOR PROFESSIONAL SKILLS

3 0 0 3

COMMUNICATION SKILLS USING SCIENTIFIC TEXTS: Comprehension and critical evaluation of Scientific Essays – Focus on Language Style, Word Formation, Use of Prefixes and Suffixes, Synonyms, Antonyms, Abbreviations and Acronyms and Technical Vocabulary (6)

FOCUS ON GRAMMAR: Identifying Common Errors In Articles And Prepositions, Common Errors-Misplaced Modifiers-Tenses-Redundancies And Clichés-Practice Exercises In Common Errors (6)

READING: Reading and Importance-Techniques Of Effective Reading-Improving Comprehension Skills-Techniques For Good Comprehension-Skimming And Scanning-Comprehension-Intensive And Extensive Reading-Practice In Reading Comprehension (4)

WRITING: Formal Letters-Letter of Complaint, Requisition Letter- Job Application and Resume- Report Writing- Types Of Reports- Business And Technical Reports (6)

FOCUS ON SOFT SKILLS: Intra & Interpersonal Communication-Interview Techniques-Etiquette-Body Language-Telephone Conversation (8)

PRACTICALS: Presentations-Group Discussions-Listening Exercises-Mock Interviews. (15)

Total L : 45

TEXT BOOKS:

1. N.P.Sudharshana, C. Savitha "English for Engineers", Cambridge University Press, 2018.

REFERENCES:

1. Dhanavel, S.P. , "English and Soft Skills", Orient BlackSwan, Hyderabad, 2010.
2. Lina Mukhopadhyay, et al., "English for Jobseekers", Cambridge University Press, New Delhi, 2013.

20XD16 ENGINEERING GRAPHICS AND GEOMETRIC MODELLING**0 0 4 2****INTRODUCTION:** BIS specifications - lines, lettering, and dimensioning. Projection –types. (4)**FIRST ANGLE PROJECTION:** Introduction- Projection of points, lines, planes, and solids –parallel, perpendicular and inclined to planes. (8)**ISOMETRIC PROJECTION:** Introduction- prismatic and cylindrical components. (2)**INTERACTIVE GRAPHICS:** Parametric modeling –1D, 2D and 3D geometry – transformations - display – points, lines using software. (4)**CURVES:** Types- parametric curves generation-displaying - evaluating points on curves. (4)**SURFACES:** Types- parametric surface generation-displaying - evaluating points on surfaces. (5)**SOLIDS:** Generation of part models using Computer Aided Geometric Modeling software. (3)**LABORATORY COMPONENT:****Engineering Graphics using CAD**

1. Introduction to CAD Software.
2. First angle projection of a. Points b. Lines
3. Projection of a. Planes b. Solids
4. Conversion of isometric to orthographic projection.
5. Orthographic to isometric projection.
6. Sectioning of regular solids.
7. Perspective projection of simple solids.

Geometric Modeling using a graphical programming language

8. Modeling and displaying a point and line using orthographic projection and performing simple geometric transformation.
9. Modeling and displaying of parametrically represented analytical curves
 - a. Circle b. Ellipse
10. Modeling and displaying of parametrically represented synthetic curves
 - a. Bezier Curve b. B-spline
11. Modeling and displaying of parametrically represented NURBS curve.
12. Modeling and displaying of parametrically represented synthetic surface.
 - a. Planar surface b. Ruled surface
13. Modeling and displaying of Bezier surface.
14. Modeling and displaying of B-Spline surface.

Total: P: 60**TEXT BOOKS:**

1. "A Primer on Engineering Drawing using Pro Engineer", Department of Production Engineering and CAD/CAM Centre, PSG College of Technology, 2012.
2. Michael E. Mortensen, "Geometric Modeling (Digitized)", Industrial Press, 2011.

REFERENCES:

1. David F. Rogers, Alan Adams J., "Mathematical Elements in Computer Graphics (Digitized)", McGraw Hill, 2007.
2. David Solomon, "Computer Graphics and Geometric Modeling", Springer, 2013.
3. Michael E. Mortenson, "Geometric Modeling(Digitized)", Industrial Press, 2011.
4. MarttiMantyla, "An Introduction to Solid Modeling (Digitized)", Computer Science Press, 2007.

20XD17 C PROGRAMMING LAB**0 0 4 2**

1. Simple programs to understand the concepts of data types.
2. Familiarizing conditional, control and repetition statements
3. Usage of single and double dimensional arrays including storage operation
4. Implementation of functions, recursive functions
5. Defining and handling structures, array of structures and union
6. Implementation of pointers, operation on pointers dynamic storage allocation
7. Creating and processing data files.

Total P:60

20XD18 DIGITAL ELECTRONICS LAB**0 0 2 1****DIGITAL ELECTRONICS LABORATORY**

1. Study of basic logic gates and realization of logic gates using universal gates.
2. Multiplexer and demultiplexer.
3. Half and full adder / subtractor.
4. Encoder and decoder.
5. Binary decade counter.
6. BCD to seven segment decoder.
7. Study of D/A converter.
8. Crystal Oscillator using logic gates

Total P: 30**SEMESTER II****20XD21 DISCRETE STRUCTURES****3 2 0 4****PREREQUISITES**

MATHEMATICAL LOGIC: Proposition - Logical operators - Truth tables – Laws of Logic – Equivalences – Rules of inference - Validity of arguments – Consistency of specifications – Propositional Calculus – Quantifiers and universe of discourse. (9+6)

PROOF TECHNIQUES: Introduction – Methods of proving theorems – Direct proofs, Proof by contraposition, Vacuous and trivial proofs, Proofs by contradiction – Mistakes in proofs – Mathematical induction – Strong mathematical induction and well ordering - Program correctness. (8+4)

RELATIONS AND FUNCTIONS: Definition and properties of binary relations – Representing Relations – Closures of Relations – Composition of Relations – Equivalence Relations – Partitions and Covering of Sets – Partial Orderings – n-ary Relations and their Applications -Lattices - Functions-Injective, Surjective, Bijective functions, Composition, Identity and Inverse. (8+4)

COMBINATORICS: Basics of counting – The Pigeonhole principle - Permutations and Combinations with and without repetition, Permutations with indistinguishable elements, distribution of objects - Generating permutations and combinations in lexicographic order. (8+6)

RECURRENCE RELATIONS: Some Recurrence Relation Models- Solutions of linear homogeneous recurrence relations with constant coefficients- solution of linear non-homogeneous recurrence relations by the method of characteristic roots - Divide and conquer recurrence relations. (6+5)

FORMAL LANGUAGES: Four classes of grammars (Phrase Structure, Context sensitive, Context Free, Regular) –Language of grammar (2+2)

FINITE AUTOMATA: Deterministic Finite State Automata (DFA) - Non-deterministic Finite State Automata (NFA) - Conversion of NFA to DFA (2+2)

LANGUAGES & MACHINES: Regular Expressions – Regular Sets - Equivalence of regular grammar and FA.- Context free languages: generation trees - ambiguity. (2+1)

Total L:45+T:30=75**TEXT BOOKS:**

1. Kenneth H. Rosen, "Discrete Mathematics and its Application", McGraw Hill, 2011.
2. Judith L. Gersting, "Mathematical Structures for Computer Science", W.H. Freeman and Company, 2014.
3. Tremblay J. P. and Manohar R., "Discrete Mathematical structures with application to Computer Science", Tata McGraw Hill, 2011.
4. John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education, 2014.

REFERENCES:

1. Doerr Alan and Levasseur K., "Applied Discrete Structures for Computer Science", Galgotia Publications, 2002.
2. BenardKolman, Robert C. Busby and Sharan Ross, "Discrete Mathematical Structures", Pearson Education, 2014.
3. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics – An Applied Introduction", Addison Wesley, 2009.

20XD22 ABSTRACT ALGEBRA**3 2 0 4****PREREQUISITES**

ALGEBRAIC STRUCTURES: Groups - Definition and Example, Properties of Groups, Permutation Groups, Symmetric Groups, Cyclic Groups. (8+8)

SUBGROUPS AND NORMAL SUBGROUPS: Subgroups – Definition, Cosets and Lagrange's theorem, Homomorphism, Isomorphism, Automorphism – Cayley's theorem – Normal subgroups – Factor group – Fundamental theorem of group homomorphism (8+5)

GROUPS AND CODING: Coding of Binary information and Error detection – Group codes – Decoding and Error correction. (8+3)

RINGS: Definition and Properties – Subrings, Ring of Quaternions, Integral domain - Homomorphism – Ideals and Quotient Rings – Euclidean ring - Unique factorization theorem, Domain of Gaussian Integers. Polynomials Rings – Properties, Division Algorithm, Factorization of Polynomials – Primitive polynomials. (10+8)

FIELDS: Definition – subfields - Finite fields – structure of Finite field, $GF(2^n)$. (11+6)

Total L : 45+ T:30=75**TEXT BOOKS:**

1. Herstein I. N., "Topics in Algebra", John Wiley & Sons, 2012.
2. Joseph A. Gallian, "Contemporary Abstract Algebra", Brooks/Cole, 2013.
3. Tremblay J. P. and Manohar R., "Discrete Mathematical Structures with Applications to Computer Science", Tata McGrawHill, 2017.

REFERENCES:

1. Ron M. Roth, "Introduction to Coding Theory", Cambridge University Press, 2007.
2. Ralph P. Grimaldi and Ramana B. V., "Discrete and Combinatorial Mathematics: An Applied Introduction", Pearson Education, 2014.

20XD23 DATA STRUCTURES AND ALGORITHMS**3 0 0 3****PREREQUISITES**

- 20XD14 PROBLEM SOLVING AND C PROGRAMMING

INTRODUCTION: Primitive Data Structures - Abstract Data Types - Analysis of algorithms – Best and worst case time complexities – Asymptotic notation – Growth of functions (4)

ARRAYS: Operations and Implementation– Linear search, non-recursive binary search-Sparse matrices – Operations. (3)

STACKS: Primitive operations - Sequential implementation - Applications: Recursive functions, Expression processing and Parentheses matching. (6)

QUEUES: Primitive operations - Sequential implementation – Linear queue- Circular queue- Priority queues – Double ended queue– Applications. (4)

LISTS: Primitive operations - Singly linked lists, Doubly linked lists, Circular lists, Multiply linked lists - Application: Addition of Polynomials – Linked Stacks - Linked queues. (7)

TREES: Terminologies – Binary tree - Sequential and linked representation - Traversals - Expression trees - Infix, Postfix and Prefix expressions - Heaps - Max heap, Min heap and their operations. (8)

GRAPHS: Terminologies– Representations using Adjacency matrix, adjacency list – Graph Traversal Algorithms - Breadth first and Depth first – Time complexity Analysis. (5)

HASH TABLE: Hash Function –Collision resolution techniques – Linear probing- Chaining (4)

SORTING: Insertion Sort, Selection Sort, Bubble Sort, Heap Sort, Radix Sort – Algorithms and their time complexity (4)

Total L:45

TEXT BOOKS:

- 1.Yedidyah Langsam, Moshe J Augenstein and Aaron M Tenenbaum, "Data structures using C and C++", Prentice Hall, 2016.
- 2.Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", Silicon Press, 2013
- 3.Michael T. Goodrich, Roberto Tamassia and David Mount, "Data Structures and Algorithms in C++", John Wiley, 2016.

REFERENCES:

- 1.Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Addison-Wesley, 2017.
- 2.Robert L Kruse, Bruce P Leung and Clovis L Tondo, "Data Structures and Program Design in C", Pearson Education, 2013.
- 3.Nell Dale, Chip Weems and Tim Richards, "C++ Plus Data Structures", Jones and Bartlett Learning, 2017.
- 4.Alfred V. Aho, John E Hopcraft, Jeffrey D. Ullman, "Data structures and Algorithms", Pearson Education, 2011

20XD24 OBJECT ORIENTED PROGRAMMING**3 0 0 3****PREREQUISITES**

- 20XD14 PROBLEM SOLVING AND C PROGRAMMING

PRINCIPLES OF OBJECT ORIENTED PROGRAMMING: Software crisis - Software Evolution - Procedure Oriented Programming - Object Oriented Programming Paradigm - Basic Concepts and Benefits of OOP - Object Oriented Programming Language - Application of OOP - Structure of C++ - Tokens, Expressions and Control Structures - Operators in C++ - Manipulators. (6)

FUNCTIONS IN C++: Function Prototyping - Call by Reference - Return by reference - Inline functions - Default, Const Arguments - Function - Overloading - Friend and Virtual Functions - Classes and Objects - Member functions - Nesting of Member functions - Private member functions - Memory allocation for Objects - Static data members - Static Member Functions - Array of Objects - Objects as Function Arguments - Friend Functions - Returning Objects - Const Member functions - Pointers to Members. (10)

CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors – Destructors overloading. (3)

OPERATOR OVERLOADING: Overloading Unary and Binary Operators - Overloading Binary Operators using Friend functions – Operator Type conversion. (3)

INHERITANCE: Defining Derived Classes - Single Inheritance - Making a Private Member Inheritable - Multiple Inheritance - Hierarchical Inheritance - Hybrid Inheritance –Function overriding – Virtual functions - Virtual Base Classes - Abstract Classes - Constructors in Derived Classes - Member Classes - Nesting of Classes – Composition – Aggregation. (9)

POLYMORPHISM: Basics of polymorphism – Types of polymorphism - Compile and Run Time Polymorphism - Virtual function – Object Slicing – Virtual Destructor – Dynamic binding. (5)

TEMPLATES & EXCEPTION HANDLING: Introduction to Templates, Generic Functions and Generic Classes – Exception Handling – Examples. (4)

STREAMS: String I/O -Character I/O - Object I/O - I/O with multiple Objects - File pointers - Disk I/O with member functions. (5)

Total L: 45**TEXT BOOKS:**

1. Bjarne Stroustrup, "The C++ Programming Language", Pearson Education, 2014.
2. Stanley B. Lippman, Josee Lajoie and Barbara E. Moo, "The C++ Primer", Addison Wesley, 2013.

REFERENCES:

1. Scott Meyers, "More Effective C++", Addison Wesley, 2008.
2. Bjarne Stroustrup, "The Design and Evolution of C++", Addison Wesley, 2005.
3. Stanley B Lippman, "Inside the C++ Object Model", Addison Wesley, 1996.

20XD25 THEORY OF PROBABILITY**4 0 0 4****PREREQUISITES**

- 20XD11 CALCULUS AND ITS APPLICATIONS

PROBABILITY BASIC CONCEPTS: Introduction - Sample space and events - Axiomatic approach to probability – Basic theorems. Conditional Probability - Law of multiplication - Law of total probability and Bayes' Theorem - Independence. (10)

RANDOM VARIABLES: Discrete and continuous random variables - probability mass function and density function - distribution function - Expectation and variance. (8)

THEORETICAL DISTRIBUTIONS: Discrete: Binomial, Poisson and Geometric - Continuous: Uniform, Normal, Exponential, Weibull, Erlang and Gamma. (10)

BIVARIATE DISTRIBUTIONS: Joint probability distributions - Marginal and conditional distributions - Statistical independence - Conditional expectation – Transformation of two random variables. (10)

LIMIT THEOREMS: Moments and moment generating functions- Sums of independent random variables - Limit theorems: Markov and Chebyshev inequalities, Law of Large numbers, Central Limit Theorem. (10)

RELIABILITY: Introduction - Structure Functions - Reliability of Systems of Independent Components - System Life as a Function of Component Lives - Expected System Lifetime. (12)

Total: L:60**TEXT BOOKS:**

1. SaeedGhahramani, "Fundamentals of Probability with Stochastic Processes", Pearson Education, 2018.
2. Sheldon M.Ross, "Introduction to Probability Models", Academic Press, 2014.
3. Ronald E. Walpole, Raymond H. Meyers and Sharon L. Meyers, "Probability and Statistics for Engineers and Scientists", Pearson Education, 2014.

REFERENCES:

1. Anthony J. Hayter, "Probability and Statistics for Engineers and Scientists", Cengage Learning, 2013.
2. Jay L Devore, "Probability and Statistics for Engineering and Sciences", Cengage Learning, 2015.
3. Richard A. Johnson, Irwin Miller and John Freund, "Probability and Statistics for Engineers", Pearson Education, 2014.
4. K. S. Trivedi, "Probability and Statistics with Queuing, Reliability and Computer Science Applications", John Wiley & Sons, 2016.

20XD26 OBJECT COMPUTING LAB**0 0 4 2**

Exercises pertaining to the following outlines are to be experimented using C++:

1. Arithmetic operations using array of objects and dynamic data members.
2. Creation of a class having read-only member function and processing the objects of that class.
3. Creation of a class which keeps track of the member of its instances. Usage of static data member, constructor and destructor to maintain updated information about active objects.
4. Illustration of a data structure using dynamic objects.
5. Usage of static member to count the number of instances of a class.
6. Illustration for the need of default arguments.
7. Usage of a function to perform the same operation on more than one data type.
8. Creation of a class with generic data member.
9. Overloading the operators to do arithmetic operations on objects.
10. Acquisition of the features of an existing class and creation of a new class with added features in it.
11. Implementation of run time polymorphism.
12. Overloading stream operators and creation of user manipulators.
13. Implementation of derived class which has direct access to both its own and public members of the base class.
14. Implementation of Streams to store and maintain Library system, with the features of Book Issue and Book Return.
- 15.

Total P: 60

20XD27 DATA STRUCTURES LAB**0 0 4 2**

Implementation of the following problems:

1. Time complexity based problems on arrays, matrices and strings
2. Implementation of Sparse matrix operations using arrays.
3. Implementation of Stacks and Queues using arrays.
4. Implementation of Singly linked, Doubly linked and Circular lists.
5. Implementation of Linked stacks , Linked queues and Priority queues
6. Implementation of Binary trees
7. Implementation of Graph traversal algorithms.
8. Implementation of Hash tables with collision resolution
9. Implementation of Sorting algorithms

Total P: 60**20XD28 PYTHON PROGRAMMING LAB****0 0 4 2****INTRODUCTION:** Python Interpreter – Program execution – Interactive prompt – IDLE User Interface.**TYPES AND OPERATIONS:** Python object types – Numeric types – Dynamic typing – String fundamentals – Lists – Dictionaries - Tuples – Type objects.**STATEMENTS AND SYNTAX:** Python statements - Assignments – Expressions – if Tests – while Loops - for Loops – Iterations – Comprehensions.**FUNCTIONS AND GENERATORS:**Function basics – Scopes – Arguments – Recursive functions – Anonymous functions – lambda – Generator functions -**MODULES AND PACKAGES:** Python program structure – Module Imports – Standard library modules – Packages – Namespaces.**STANDARD PACKAGES:** NumPy – Matplotlib – SciPy – SymPy – Pandas.**FILES:** Opening files – Reading and writing files – Text files – Binary files.

Implementation of the following problems using Python programming:

1. Simple programs to understand the concepts.
2. Familiarizing conditional, control and repetition statements.
3. Implementation of functions, recursive functions.
4. Defining and handling structures, array of structures and union.
5. Implementation of packages - GUI Programming
6. Creating and processing data files.
7. Plotting Probability distributions
8. Analyzing probability distributions to verify the limit theorems

TEXT BOOKS:

1. Mark Lutz, "Learning Python", O'Reilly Media, 2013.
2. Tony Gaddis, "Starting out with Python", Pearson, 2017.

REFERENCES:

1. Christian Hill, "Learning Scientific Programming with Python", Cambridge University Press, 2016.
2. Allen Downey, 'Python for Software Design", Cambridge University Press, 2009.

Total P: 60

SEMESTER III**20XD31 APPLIED STATISTICS****3 0 0 3****PREREQUISITES**

- 20XD25 THEORY OF PROBABILITY

DESCRIPTIVE STATISTICS: Frequency distribution – Bar graphs and Pie charts – Histogram- Ogive – Simpson's paradox – Measures of Location – Measures of Variability – Measures of distribution shape, relative location and detecting outliers – Exploratory Data analysis, Stem-and-leaf display – Measures of Association between two variables. (15)

STATISTICAL INFERENCE: Sampling distribution - Estimation: Point estimation, interval estimation - Criteria of a good estimator –Interval estimation of mean, proportion, and variance (single sample and two samples) - Maximum likelihood estimator. Incorporating priors with Bayesian inference, Bayesian inference for Normal distributions Hypothesis Testing: General concepts - Errors in Hypothesis testing - One-and two-tailed tests - Tests concerning mean, proportion, and variance - Tests for Goodness of fit and independence of attributes. (15)

CORRELATION AND REGRESSION: Introduction - Estimation using the regression line - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis - Inferences about population parameters – Modeling techniques. (10)

ANALYSIS OF VARIANCE: Introduction to design of experiments, Analysis of variance - Completely Randomized Design and Randomized Block Design. (5)

Total L: 45**TEXT BOOKS:**

1. Jay L. Devore, "Probability and Statistics for Engineering and Sciences", Cengage Learning, 2015.
2. David Forsyth, 'Probability and Statistics for Computer Science', Springer; 2018
3. Michael J. Evans, Jeffrey S. Rosenthal, 'Probability and Statistics - The Science of Uncertainty'. W H Freeman & Co, 2010

REFERENCES:

1. Anderson, Sweeney and Williams "Statistics for business and economics", Cengage Learning, 2014.
2. Douglas C Montgomery and George C Runge, "Applied Statistics and Probability for Engineers", John Wiley & Sons, 2014.
3. Roy D. Yates and David J. Goodman, "Probability and Stochastic Processes – A friendly Introduction for Electrical and Computer Engineers", John Wiley, 2014.
4. Trivedi K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley & Sons, 2016.

20XD32 LINEAR ALGEBRA**3 2 0 4****PREREQUISITES**

- 20XD21 DISCRETE STRUCTURES

SYSTEM OF LINEAR EQUATIONS: System of linear equations, Gauss – elimination, Gauss-Jordan method- Application of Linear systems. (5+3)

VECTOR SPACES: Vector spaces and subspaces – Span, Linear independence and dependence– Basis and dimension - Row space, Column space, and Null space– Rank and nullity- Change of basis– Similarity - Isomorphism. (10+7)

INNER PRODUCT SPACES: Inner products, Length and Angle in inner product spaces - Orthonormal bases, Gram Schmidt process - Orthogonal matrices- QR decomposition - Best Approximation and Least-squares. (10+7)

LINEAR TRANSFORMATION: Introduction to linear transformations – General Linear Transformations – Kernel and range – Matrices of general linear transformation- Geometry of linear operators. (6+4)

SPARSE MATRICES: Introduction – Storage Schemes – Basic sparse matrix operations – Sparse direct solutions – random walk problems. (4+2)

EIGEN VALUES AND EIGEN VECTORS: Introduction to Eigen values Eigen vectors, Complex Eigen values, - Diagonalization - Orthogonal diagonalization- Positive definite matrices - Quadratic forms - Quadric surfaces - Singular value decomposition. Applications to differential equations, dynamical systems. (10+7)

Total L : 45+T:30=75

TEXT BOOKS:

1. Howard Anton and Chris Rorres, "Elementary Linear Algebra", John Wiley & Sons, 2017.
2. David C. Lay, "Linear Algebra and its Applications", Pearson Education, 2016.

REFERENCES:

1. Gilbert Strang, "Linear Algebra and its Applications", Thomson Learning, 2016.
2. Steven J. Leon, "Linear Algebra with Applications", Prentice Hall, 2015.
3. Yousef Saad, "Numerical methods for Large Eigenvalue Problems", University Press, 2011.

20XD33 GRAPH THEORY**4 0 0 4****PREREQUISITES**

- 20XD21 DISCRETE STRUCTURES
- 20XD23 DATA STRUCTURES AND ALGORITHMS

BASIC CONCEPTS: Graphs - directed and undirected, subgraphs, graph models, degree of a vertex, degree sequence, Havel-Hakimi theorem, Hand-shaking lemma. Connectivity, walk, path, distance, diameter. Isomorphic graphs. Common classes of graphs – regular, complete, Petersen, cycle, path, tree, k-partite, planar, hypercube. Spanning trees – Matrix tree theorem, graph decomposition. (14)

CONNECTIVITY: Vertex and edge connectivity, Vertex and edge cuts, relationship between vertex and edge connectivity, bounds for connectivity. Harary's construction of k-connected graphs. (10)

EULERIAN AND HAMILTONIAN GRAPHS: Eulerian graphs, Route inspection problem, Hamiltonian graphs, Dirac's and Ore's theorems, Gray codes. (10)

MATCHING, VERTEX-COLORING AND DOMINATION: Matching, Berge theorem, Perfect matching - Tutte's theorem, Bipartite matching, Hall's theorem- Vertex-coloring –chromatic number, upper and lower bounds, Welsh – Powell theorem, Largest degree first and Sequential vertex coloring algorithms. Dominating set, domination number and bounds. Types – total, independent, bipartite, connected, distance dominations. Applications of the above concepts to networks. (14)

RANDOM GRAPHS: Random graph – Definitions of $G(n, p)$ and $G(n, M)$ models. Ramsey number – definition, Erdos theorem. n-existentially closed graphs, asymptotically almost surely graphs and their existence theorem. Web graph models, applications to social and biological networks. (12)

Total L:60**TEXT BOOKS:**

1. Anthony Bonato, "A Course on Web Graphs", American Mathematical Society, 2008.
2. Jonathan Gross and Jay Yellen, "Graph Theory and its Applications", CRC Press, 2006.
3. Balakrishnan R and Ranganathan, K, "A Textbook of Graph Theory", Springer-Verlag, 2019.

REFERENCES:

1. Bondy J A, Murty U S R, "Graph Theory", Springer, 2013.
2. Douglas B West, "Introduction to Graph Theory", Pearson 2018.
3. Thulasiraman K and Swamy M N S, "Graphs: Theory and Algorithms", John Wiley, 2014.
4. Albert-László Barabási, Network Science, Cambridge University Press, 2016.

20XD34 ADVANCED DATA STRUCTURES**3 0 0 3****PREREQUISITES**

- 20XD21 DISCRETE STRUCTURES
- 20XD23 DATA STRUCTURES AND ALGORITHMS

INTRODUCTION: Review of analysis of algorithms – Average case time complexity - Amortized time complexity. (4)

BINARY SEARCH TREES: Searching – Insertion and deletion of elements – randomly built binary search trees- Analysis. (4)

AVL TREES: Height – Searching – insertion and deletion of elements- AVL rotations – analysis. (5)

SPLAY TREES: Searching, Insertion and Deletion Operations - Analysis (3)

MULTIWAY SEARCH TREES: Indexed Sequential Access – M-way search trees – B-Tree – Searching, insertion and deletion - B⁺ trees, B*-trees, Tries and digital search trees, dictionary applications. (9)

MULTIDIMENSIONALSEARCH TREES: Range search–K-d trees- Quad trees (8)

PRIORITY QUEUES (HEAPS): d-Heaps- Leftist Heaps - Property and operations- Binomial heap- Fibonacci heaps. (6)

DATA STRUCTURES FOR DISJOINT SETS: Disjoint set operations-Linked list representation of disjoint sets, Disjoint Set Forests, tree representation, union by rank, find by path compression - analysis. (6)

Total L: 45

TEXT BOOKS:

1. Thomas H. Cormen, Charles E. Leiserson and Ronald L. Rivest, "Introduction to Algorithms", MIT Press, 2015.
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Addison-Wesley, 2014.

REFERENCES:

1. Michael T. Goodrich, Roberto Tamassia and David Mount, "Data Structures and Algorithms in C++", John Wiley, 2016.
2. Robert L Kruse and Clovis L Tondo, "Data Structures and Program design in C++", Pearson Education, 2013.
3. Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", Silicon Press, 2013.

20XD35 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING

3 2 0 4

PREREQUISITES

- 20XD13 DIGITAL ELECTRONICS

COMPONENTS OF A COMPUTER SYSTEM: CPU, Storage, I/O, Multimedia devices - Workstations, Servers,-Interaction among functional components-Bus organization -Data representation- Integer and floating point representation (6)

PROGRAM EXECUTION:Processing of High Level Language Code-Assembler- Code generation,-Application binary interface- - Instruction set architecture of a simple CPU– Microarchitecture of CPU, Instruction codes-The hardware-software interface - Hardware features influenced by software requirements - Specifications of the performance of a system (6)

BASIC PROCESSING UNIT:Fundamental Concepts-- Computer registers -Register transfer language -Generation and Execution of machine code- Hardware Components-Instruction Fetch and Execution Steps-Control Signals - Hardwired Control Processors (6)

MEMORY SYSTEM :-Basic Concepts- Internal Organization of Memory - Semiconductor RAM Memories - Static and Dynamic RAMs - Read-only Memories - Flash Memory - Direct Memory Access - Cache Memories - Performance Considerations - Caches on the Processor Chip – Cache coherence - Virtual Memory - Segmentation (8)

PIPELINING :-Basic Concept of pipelining - Pipeline Organization - Pipelining Issues - Data Dependencies - Operand Forwarding - Handling Data Dependencies in Software - Memory Delays- Branch Delays - Branch Prediction -Resource Limitations -Performance Evaluation (6)

PARALLEL PROCESSING AND PERFORMANCE: Flynn's taxonomy- Classification – Instruction level parallelism and its exploitation - Data Level parallelism –Thread Level parallelism- Hardware multithreading – Multicore processors - Instruction Exceptions.-CISC and RISC Processors- instruction set architecture of x86 (8)

INPUT/OUTPUT INTERFACES:Bus Structure - Operation - Synchronous and Asynchronous Bus - FireWire - PCI Bus - SCSI Bus - SATA - SAS - PCI Express - Interface Circuits- Parallel/Serial /Universal Serial Bus (USB) Program-Controlled I/O - I/O Interrupts - Handling Multiple Devices - Exception handling (7)

TUTORIAL PRACTICE:

1. Implementing the functionality of AND, OR and NOT gates.
2. Conversion of data between different number systems.
3. Arithmetic operations of binary numbers using both one's complement and two's complement arithmetic.
4. Implement parity bit generation for a n-bit binary data.
5. Practice on the DEBUGGER and 8086 Emulator Tool.
6. Conversion of BCD numbers into ASCII characters and vice versa.
7. Multiprecision addition and subtraction.

8. Packing and unpacking of BCD digits.
9. Programs on Logical and Arithmetic Instructions.
10. Implementation of Control Structures (FOR, LOOP, IF.. THEN, DO.. WHILE etc.,)
11. Programs using Arrays and Strings.
12. Programs using Special Instructions DAA, XCHG, CMPSW etc...
13. Programs using interrupt functions for input and output.

Total L:45**TEXT BOOKS:**

1. Computer Architecture and Organization Designing for Performance, William Stallings, Pearson Education series, 2014.
2. Computer Organization and Design :The Hardware/Software Interface, David A. Patterson and John L. Hennessy, Morgan Kaufmann, 2013
3. Morris Mano, "Computer Systems Architecture", Pearson Education, 2014.

REFERENCES:

1. Barry B. Brey, "The Intel Microprocessors - 8086/88, and 80186, 80286, 80386, and 80486", Pearson Education, 2009.
2. John P. Hayes, "Computer Architecture and Organization", Tata McGraw Hill, 2017.
3. Hamachar V. C., Vranesic Z. G. and Zaky S. G., "Computer Organization", McGraw Hill, 2012.
4. Douglas V. Hall, "Microprocessors and Interfacing", McGraw Hill, 2010.
5. James L. Antonakos, "An Introduction to the Intel family of Microprocessors", Pearson Education, 2007.

20XD36 APPLIED STATISTICS AND R PROGRAMMING LAB**0 0 4 2**

Implementation of the following problems using Statistical Packages:

1. Classification and tabulation of data and Graphical and diagrammatic presentation of data.
2. Perform calculations that measure the central tendency and dispersion of data and Implementation of measures of Skewness, moments and kurtosis.
3. Determination of point and interval estimates.
4. Solving linear regression, polynomial regression and non-linear regression based problems and solving multiple regression and correlation analysis based problems.
5. Solving the problems based on Time series analysis and forecasting and implementing statistical quality control charts.

Total P: 60**20XD37 ADVANCED DATA STRUCTURES LAB****0 0 4 2**

Implementation of the following problems:

1. Applications of binary search tree and its operations.
2. AVL tree including all rotations.
3. Splay tree including rotations
3. B-tree and its operations.
4. Disjoint set operations and applications.
5. Implementation of d-heap and leftist heap data structure.
6. Implementation of binomial heap

Total: P: 60**20XD38 JAVA PROGRAMMING LAB****0 0 4 2****PREREQUISITES**

- 20XD24 OBJECT ORIENTED PROGRAMMING

JAVA PROGRAMMING: Introduction - Data Types - Operators - Declarations - Control Structures - Arrays and Strings - Input/Output.-Java Classes - Fundamentals - Methods - Constructors - Scope rules - this keyword - object based vs oriented programming.- Inheritance-Reusability - Composing class - Method overriding - Abstract classes - Virtual Functions.

PACKAGES AND INTERFACES: Packages - Access protection - Importing packages – Interface - Defining and Implementing Interface - Applying Interface - Variables in Interfaces.

EXCEPTION HANDLING: Fundamentals - Exception types - Uncaught Exception - Using Try and Catch - Multiple catch clauses - Nested Try statements - Throw - Throws - Java Built-in Exception - Creating your own subclasses.

MULTI THREADED PROGRAMMING: Java thread model - Priorities - Synchronization - Messaging - Thread class and runnable Interface - Main thread - Creating the Thread - Synchronization - Interthread Communication - Deadlock.

I/O, APPLETS: I/O basics - Stream - Stream Classes - Predefined stream - Reading/Writing console input - Applet fundamentals - Native methods.- GUI Components - Applets – overview of Java Scripts – Swing.

COLLECTIONS FRAMEWORK: Generics – Autobox – Auto unboxing – Annotations – Collections Frame works – List – Set – Map

NEW FEATURES IN J2SE V5.0:Functional programming

PRACTICAL:

1. To create runtime polymorphism using abstract class, interface
2. To create callback feature using interface
3. To create a program for interface inheritance
4. To implement a user defined package
5. To implement a user defined checked exception and unchecked exceptions
6. To create inter-thread communication using shared memory, piper stream
7. To implement socket connections (UDP, TCP)

Total P:60

TEXT BOOKS:

1. Joyce Farrell , “Java Programming”, Cengage Learning, 2019
2. Herbert Schildt, "JAVA - The Complete Reference", Tata McGraw Hill, 2018.

REFERENCES:

1. Deitel and Deitel, "JAVA - How to Program", Pearson Education, 2018.
2. Douglas Lea, “Concurrent Programming in Java: Design Principles and Patterns”, Addison-Wesley, 2019.

SEMESTER IV

20XD41 OPTIMIZATION TECHNIQUES

3 2 0 4

PREREQUISITES

- 20XD32 LINEAR ALGEBRA

LINEAR PROGRAMMING: Linear programming model - Convex sets - Convex functions - Graphical solution for two dimensional problems – Transition from graphical to algebraic solution, Simplex method, Two phase simplex method, Revised Simplex (7)

DUALITY AND POST-OPTIMAL ANALYSIS: Definition of the Dual problem , Primal – Dual relationships, Economic interpretation of Duality, Dual Simplex algorithm, Post optimal analysis. (7)

TRANSPORTATION MODEL AND ITS VARIANTS:Transportation problem and its solution – Assignment problem and its solution by Hungarian method (7)

INTEGER PROGRAMMING: Gomory cutting plane methods for allinteger and mixed integer programming problems - Branch and Bound method (Land – Dolg and Dakin algorithms). (7)

DYNAMIC PROGRAMMING: Principle of Optimality – Backward and forward induction methods— Shortest path network problems – Cargo loading model. (5)

NON LINEAR PROGRAMMING :Karush-Kuhn-Tucker Conditions- Univariate and Pattern search method – Steepest descent and Conjugate gradient method (7)

CONVEX OPTIMIZATION: Convex optimization problems- linear and quadratic programs; quasi-convex optimization problems (5)

TUTORIAL PRACTICE

1. To solve linear programming problem
2. To perform sensitivity analysis
3. To solve transportation and assignment problems
4. To solve non-linear programming by gradient search methods.

Total L:45+ T:30=75

TEXT BOOK:

1. Hamdy A Taha, "Operations Research – An Introduction", Pearson India, 2017.
2. Stephen Boyd and Lieven Vandenberghe, "Convex Optimization" Cambridge University Press, 2009.

REFERENCES:

1. Hillier F and Liberman G J, "Introduction to Operations Research", McGraw Hill, 2014.
2. Kambo N S, "Mathematical Programming Techniques", East-West Press, 2012.
3. Wayne L Winston, "Operations Research: Applications and Algorithms", Thomson Brooks/Cole, 2004
4. David G Luenberger, "Linear and Nonlinear Programming", Springer, 2008.

20XD42 DATABASE DESIGN

3 0 0 3

PREREQUISITES

- 20XD21 DISCRETE STRUCTURES
- 20XD23 DATA STRUCTURES AND ALGORITHMS

BASIC CONCEPTS: Introduction to databases – Conventional file Processing – Data Modeling for a database – Three level architecture – Data Independency – Components of a Database Management System (DBMS) – Advantages and disadvantages of a DBMS – System Environment – Users of DBMS – Transaction Management. (6)

DATA MODELS: Introduction – Conceptual data modeling – Motivation - Entities, entity types, various types of attributes, relationships, relationship types - E/R Diagram(ERD) notation - Generalization – Aggregation – Conversion of ERD into relational schema – Introduction to Network data model and Hierarchical data model. (7)

RELATIONAL DATA MODEL: Introduction – Keys, relational algebra operators: selection, projection, cross product, various types of joins, division, examples, tuple relation calculus, domain relational calculus (8)

RELATIONAL DATABASE MANIPULATION: Structured Query Language (SQL) - Basic data retrieval – nested queries - correlated and uncorrelated - SQL Join – Views. (4)

DATABASE DESIGN THEORY: Functional dependencies – Normal forms - Dependency theory - Functional Dependencies(FD) – Armstrong's axioms for FDs - Closure of a set of FDs, Minimal covers – 1NF, 2NF, 3NF and BCNF - Join dependencies and definition of 5NF – Examples. (8)

DATA STORAGE AND INDEXING: Storage device Characteristics – Operations on file - Sequential files - Index Sequential files – Direct files – Indexing using Tree structures -SQL Query processing - Database tuning (8)

TRANSACTION AND SECURITY MANAGEMENT: Transaction Processing - Concurrency – Locking techniques for concurrency control - Database Recovery - Security and Integrity threats – Access Controls and Defense mechanisms (4)

Total L:45

TEXT BOOKS:

1. Elmasri R and Navathe SB, "Fundamentals of Database Systems", Pearson Education, 2016.
2. Silberschatz A, Korth H and Sudarshan S, "Database System Concepts", McGraw Hill, 2019.
3. Raghuram Ramakrishnan and Johannes Gehrke, "Database Management System", McGraw Hill, 2014.

REFERENCES:

1. Hector Garcia Molina, Jeffrey D. Ullman, Jennifer Widom, "Database Systems: The Complete Book" , Pearson Education, 2011.
2. Thomas Connolly, Carolyn Begg, "Database Systems: A Practical Approach to Design, Implementation, and Management", Pearson Education, 2014.

20XD43 PREDICTIVE ANALYTICS**3 0 0 3****PREREQUISITES**

- 20XD25 THEORY OF PROBABILITY
- 20XD31 APPLIED STATISTICS

DATA WRANGLING: DataIngest, Data Cleaning - Exploratory data analysis - Univariate data – Bivariate data, Multivariate data (5)

LINEAR REGRESSION: Coefficient of determination, Significance test, Residual analysis, Confidence and Prediction intervals. (5)

MULTIPLE LINEAR REGRESSION: Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Auto regression and Transformation of variables, Regression, Model Building. (10)

LOGISTIC AND MULTINOMIAL REGRESSION: Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test, Classification Table, Gini Co-efficient. (5)

DECISION TREES: introduction, CHI-Square Automatic Interaction Detectors (CHAID), Classification and Regression Tree (CART), Analysis of Unstructured data (5)

FORECASTING: Moving average, Exponential Smoothing, Casual Models. (5)

TIME SERIES ANALYSIS: Moving Average Models, ARMA, ARIMA models , Multivariate Models (5)

CASE STUDIES : Application of predictive analytics in retail, direct marketing, health care, financial services, insurance, supply chain, Social media analytics– Customer Analytics - Risk Analytics - Analytics for Retail and Ecommerce, etc- Working with data from different sources: spreadsheets, databases, and the cloud -Model Development- Model Validation(5)

Total L: 45**TEXT BOOKS:**

1. Daniel T. Larose, Chantal D. Larose "Data Mining and Predictive Analytics", Wiley,2015
2. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, "Introduction to Time Series Analysis and Forecasting", Wiley,2015
3. Max Kuhn, Kjell Johnson, "Applied Predictive Modeling", Springer, 2014.

REFERENCES:

1. Richard A. Johnson, Irwin Miller and John Freund, "Probability and Statistics for Engineers", Pearson Education, 2014.
2. Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, "Probability and Statistics for Engineers and Scientists", Pearson Education, 2014.
3. Thomas W. Miller, "Modeling Techniques in Predictive Analytics with Python and R: A guide to Data Science", Pearson Education, 2014.

20XD44 OPERATING SYSTEMS**3 2 0 4****PREREQUISITES**

- 20XD14 PROBLEM SOLVING AND C PROGRAMMING
- 20XD23 DATA STRUCTURES AND ALGORITHMS
- 20XD35 COMPUTER ORGANISATION AND ASSEMBLY LANGUAGE PROGRAMMING

INTRODUCTION: Abstract view of an operating system - Operating Systems Objectives and Functions – Evolution of Operating Systems - Dual-mode operation - System calls- Structure of Operating System. (3)

PROCESS DESCRIPTION AND CONTROL: Process concepts - Process Creation – Process Termination - Process states - Process Description – Process Control. (3)

PROCESS AND THREADS: Relationship between process and threads – Thread States – Thread Synchronization – Types of Thread – Multithreading model. (4)

PROCESS SCHEDULING: Scheduling basics - CPU-I/O interleaving- (non-)preemption - context switching- Types of Scheduling – Scheduling Criteria - Scheduling Algorithms – Algorithm evaluation – Real-time scheduling. (5)

PROCESS SYNCHRONIZATION: Concurrent Process – Principles of Concurrency – Race Condition - Mutual Exclusion – Critical section problems – Software support – Hardware Support – Operating System Support: Semaphore, Monitor – Classical problems of synchronization – Synchronization examples. (4)

DEADLOCK: Principles- Characterization – Methods for handling deadlock - Deadlock prevention, Avoidance, Detection, and recovery. (4)

MEMORY MANAGEMENT: Memory hierarchy –Memory Management requirements - Memory partitioning: Fixed partitioning, Dynamic partitioning, Buddy systems – Simple paging – Page table structures – Simple Segmentation – segmentation and paging. (6)

VIRTUAL MEMORY MANAGEMENT: Need for Virtual Memory management – Demand Paging –Copy on write -Page Fault handling - Page replacement - Frame allocation- Thrashing - working set model. (5)

I/O MANAGEMENT AND DISK SCHEDULING: Organization of I/O function – Evolution of I/O function – Types of I/O devices – Logical Structure of I/O functions – I/O Buffering – Disk I/O – Disk Scheduling algorithms – RAID - Disk Cache. (4)

FILE SYSTEM MANAGEMENT: Files – Access methods - File system architecture – Functions of file management –Directory and disk structure -Mounting - File sharing –File system implementation – Directory implementation - File Allocation – Free space management. (4)

VIRTUALIZATION: Requirements for Virtualization - Type 1, Type 2 Hypervisors – Paravirtualization- Memory Virtualization - I/O Virtualization - Virtual machines on Multicore CPUs–Virtualization in Multiprocessor environment. (3)

Total: L: 45+T: 30=75

Tutorial Practices:

1. Practicing UNIX Commands
2. Writing SHELL Scripts
3. Writing programs using UNIX System Calls
4. Process Creation and Execution
5. Thread Creation and Execution
6. Process / Thread Synchronization using semaphore
7. Developing Application using Inter Process communication (using sharedmemory, pipes or message queues)
8. Implementation of Memory Management Schemes
9. Implementation of file allocation technique (Linked, Indexed, Contiguous)

TEXT BOOKS:

1. Silberschatz A, Galvin, PB. and Gagne, G. "Operating System Concepts", John Wiley & Sons, Inc.,2018.
2. William Stallings, "Operating Systems: Internals and Design Principles", Pearson Education, 2017.
3. Andrew S Tanenbaum, "Modern Operating System", Prentice Hall,2018.

REFERENCES:

1. Elmasri, E., Carrick A.G. and Levine, D. "Operating Systems: A Spiral Approach", McGraw Hill, 2014.
2. McHoes, AM and Flynn, I.M. "Understanding Operating Systems", Cengage Learning, 2016.
3. Dhamdhare D M, "Operating Systems: A Concept-based Approach", McGraw-Hill, 2015.

20XD45 TRANSFORMS AND ITS APPLICATIONS

4 0 0 4

PREREQUISITES

- 20XD11 CALCULUS AND ITS APPLICATIONS

TRANSFORM METHODS: Concept of Transformation - Integral Transforms – Examples (2)

LAPLACE TRANSFORM: Definition - Transforms of Standard Functions - Transform of unit step function and Dirac delta function – Transform of derivatives and integrals -Transform of periodic functions - Inverse Laplace transform- Convolution Theorem. Method of solving ordinary linear differential equations with constant coefficient and solving integral equations by Laplace Transform technique. (15)

FOURIER SERIES: Even and odd functions, Dirichlet's conditions, statement of Fourier theorem, Fourier coefficients, change of scale, Half-range sine and cosine series, RMS value, Parseval's theorem. (13)

FOURIER TRANSFORM : Fourier integrals - Fourier Transform- Transforms of standard functions, Properties. Fourier Sine and Cosine Transform – Properties - Convolution theorem (Statement only). (10)

DISCRETE FOURIER TRANSFORMS: Discrete Convolution – Periodic sequence and circular convolution – Fast Fourier transform - Discrete Fourier Transform – decimation-in-time algorithm – Decimation-in-frequency algorithm – Computation of inverse DFT. (10)

Z-TRANSFORM: Z - Transform of standard functions, inverse Z-transform – properties of Z – Transform – Difference equations – Modeling and solution of difference equations. (10)

Total: L:60

TEXT BOOKS:

1. Ewin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 2017.
2. Ray Wylie C, Louis C Barret, "Advanced Engineering Mathematics", McGraw Hill, 2013.

REFERENCES:

1. Michael D. Greenberg, "Advanced Engineering Mathematics", Pearson Education, 2013.
2. Lokenath Debnath, Dambaru Bhatta, Integral Transforms and their Applications, CRC Press 2015.
3. Dennis G. Zill, Warren S. Wright, "Advanced Engineering Mathematics", Jones & Bartlett, 2014

20XD46 DATA ANALYTICS AND VISUALIZATION LAB

0 0 4 2

INTRODUCTION – Understanding data, Data Models, Visualization-the Medium, Representing Data, Exploring Data Visually, and Visualizing with Clarity, Designing for an Audience. The Value of Visualization - Record Information, Support Reasoning, Make a Decision, Data in Context, Find Patterns, Inspire. (8)

DATAMODELS– Taxonomy of Data Types, Nominal, Ordinal & Quantitative, Dimensions & Measures, Data Tables & Transformations, Common Data Formats. (8)

TAXONOMY – Choosing the appropriated chart type, Comparing Categories, Assessing Hierarchies, Showing changes over time, plotting connections, mapping geo-spatial data. Construction & Evaluation, Feedback. (7)

DESIGN STRUCTURES– Hierarchical, Relational, Temporal, Spatial, Spatio-Temporal, Textual Structures. Maps - Choropleth Maps, Cartograms, Flow Maps. Color - Perception of Color, Chromaticity Diagram, Color Spaces, Color Appearance, Designing Colormaps. (8)

GRAPHICAL PERCEPTION– Design Principles, Signal Detection, Magnitude Estimation, Using Multiple Visual Encodings, Pre-Attentive Processing, Gestalt Grouping, Change Blindness. (4)

EXPLORATORY DATA ANALYSIS– Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction. (5)

INTERACTION – Execution & Evaluation, Interactive Visualization, Taxonomy of Interactions, Selection, Brushing & Linking, Dynamic Queries. (3)

BIG DATA VISUALIZATION – Visualizations to present and explore big data – visualization of text data and Protein Sequences (3)

ANIMATION– Motion perception, Animated transitions in visualizations, Implementing animations. (4)

CASE STUDIES (15)

Note : Explore software like R, Python, Tableau, D3.js and Google Charts.

Total P: 60 Hrs

TEXT BOOK:

1. Nathan Yau, "Data points: visualization that means something", John Wiley & Sons, 2013.
2. Juuso Koponen, Jonatan Hildén, "Data Visualization Handbook", Aalto University publication, 2019.
3. Andy Kirk, "Data Visualisation: A Handbook for Data Driven Design", Sage Publications, 2019.

REFERENCES:

1. Colin Ware, "Information Visualization: Perception for Design", Elsevier, 2013.
2. Kieran Healy, "Data Visualization: A Practical Introduction", Princeton University Press, 2018
3. Cole Nussbaumer Knaflic, "Storytelling with Data: A Data Visualization Guide for Business Professionals", John Wiley & Sons, 2015.

4. Ware C and Kaufman M, "Visual thinking for design", Morgan Kaufmann Publishers, 2008.

20XD47 RDBMS LAB

0 0 4 2

1. Working with DDL and DML commands of SQL for creation and manipulation of single, multiple tables, Report Generation.
2. Working with PL/SQL- Triggers and stored procedures.
3. Developing Packages using a database.

Total P: 60

20XD48 SCIENTIFIC COMPUTING LAB

0 0 4 2

PREREQUISITES

- 20XD32 LINEAR ALGEBRA

SOLUTION OF ALGEBRAIC EQUATIONS: Newton Raphson method, Modified Newton Raphson method, Method of false position, Graffe's root squaring method, Bairstow's method.

SOLUTION OF ALGEBRAIC SIMULTANEOUS EQUATIONS: Gauss – Jordan elimination, Cholesky method, Crout's method, Gauss – Jacobi method, Gauss – Seidel method. Matrix Inverse by Gauss – Jordan method.

EIGENVALUES AND EIGENVECTORS: Power method for finding dominant eigenvalue and inverse power method for finding smallest eigenvalue, Jacobi method for symmetric matrices.

INTERPOLATION AND CURVE FITTING: Finite difference operators-Interpolating Polynomials, Divided Difference, Spline Curves, Bezier Curves and B-Spline Curves. Solution of linear second order difference equations with constant coefficients.

PARTIAL DIFFERENTIAL EQUATIONS: Classification of partial differential equations of second order. Liebmann's method for Laplace equation and Poisson equation, Explicit method and Crank – Nicolson method for parabolic equations. Explicit method for hyperbolic equations.

LABORATORY COMPONENT:

1. Solution of algebraic and transcendental equations
2. solving linear system of equations by direct method and iterative method
3. Computing Eigen value and Eigen vectors
4. Interpolation with unequal intervals and equal intervals
5. Numerical Differentiation and Integration
6. Taylor's series method, Euler's method, Modified Euler's method Fourth order Runge Kutta method for solving first order differential equations
7. Numerical solutions of Solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equation

Total P: 60

TEXT BOOKS:

1. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers with Software and Programming Applications", McGraw Hill, 2011.
2. Curtis F. Gerald, and Patrick O. Wheatley, "Applied Numerical Analysis" Pearson, 2011.

REFERENCES:

1. Richard L. Burden and J. Douglas Faires, "Numerical Analysis", Cengage Learning, 2011.
2. Yousef Saad. "Numerical methods for large eigenvalue problems", University Press, 2011.

SEMESTER V**20XD51 DESIGN AND ANALYSIS OF ALGORITHMS****3 0 0 3****PREREQUISITES**

- 20XD21 DISCRETE STRUCTURES
- 20XD23 DATA STRUCTURES AND ALGORITHMS
- 20XD34 ADVANCED DATA STRUCTURES
- 20XD41 OPTIMIZATION TECHNIQUES

INTRODUCTION: Fundamentals of algorithmic problem solving, deciding an appropriate data structure and algorithm design technique – Methods of specifying an algorithm – proving the correctness – Review of analysis of algorithms, analysis of recursive algorithms – Master's Theorem. (5)

DIVIDE AND CONQUER: Binary search-merge sort-quick sort-Large Integer multiplication,-Strassen's matrix multiplication-Closest pair. (7)

GREEDY METHOD: Minimum cost spanning tree (Kruskal and Prim's algorithms) - Topological sorting - Huffman codes and data compression. (6)

DYNAMIC PROGRAMMING: Principles of dynamic programming – 0/1 knapsack problem-Longest common subsequence problem -All pairs shortest problem - Travelling salesman problem. (7)

STRING MATCHING: The naïve string-matching algorithm- Rabin-Karp algorithm and analysis. (4)

NETWORK FLOW: Flow networks and Flows – Flow networks with multiple sources and sinks, -The Ford – Fulkerson method-Augmenting paths – Max flow min cut theorem-The Edmonds – Karp algorithm. (5)

NP AND COMPUTATIONAL INTRACTABILITY: Basic concepts – Polynomial time reductions- 3 SAT and Independent Set-efficient certification and NP, NP hard and NP complete problems. (5)

COPING WITH NP-COMPLETENESS: Backtracking-n queens problem, Graph coloring problem - Branch and bound - 0/1 Knap sack problem , Traveling salesman problem, Assignment problem- Approximation algorithm – Introduction – Traveling salesman problem. (6)

Total L: 45**TEXT BOOKS:**

1. Thomas H. Cormen, Charles E. Leiserson, and Ronald Rivest, "Introduction to Algorithms", MIT Press, 2015.
2. Jon Kleinberg and Eve Tardos, "Algorithm Design", Pearson Education, 2013.

REFERENCES:

1. Anany Levitin, "Introduction to Design and Analysis of Algorithms", Pearson Education, 2014.
2. Michael T. Goodrich and Roberto Tamassia, "Algorithm Design, Foundations, Analysis, and Internet Examples", Wiley, 2014.
3. Parag H Dave, Himanshu B Dave, "Design and Analysis of Algorithms", Pearson Education, 2014

20XD52 STOCHASTIC MODELS**4 0 0 4****PREREQUISITES**

- 20XD25 THEORY OF PROBABILITY
- 20XD32 LINEAR ALGEBRA

STOCHASTIC PROCESSES: Introduction – Definition- Classification of Stochastic Processes (2)

DISCRETE TIME MARKOV CHAIN: Transition Probability Matrices – Chapman Kolmogorov Equations - Classification of States – Limit Theorems – Branching Processes – Time Reversible Markov chains – Markov Decision Processes - Applications. (12)

CONTINUOUS TIME MARKOV CHAINS: Introduction – Poisson Process - Birth and Death Processes – Kolmogorov Differential Equations – Pure Birth Process - Pure Death Process - Applications. (15)

RENEWAL THEORY: Introduction – Distribution - Renewal Theorems - Residual and Excess Life Times -Alternating Renewal Process - Renewal Reward Processes – Regenerative Processes. (10)

GENERAL QUEUEING MODELS: Single and Multi server Poisson Queues - Single Server Queue with Poisson input and general service $M / G/1$ – General input and exponential service – $G/M/1$ Queueing model. (10)

BROWNIAN MOTION: First Passage time distribution – The maximum of a Brownian Motion – The Zeros of Brownian Motion – Brownian Motion with Drift - Geometric Brownian Motion. (11)

Total L:60

TEXT BOOKS:

1. Mark A Pinsky, Samuel Karlin, “An Introduction to Stochastic Modelling”, Academic Press, 2011.
2. Nicolas Privault, “ Understanding Markov Chains”, Springer, 2018.
3. Roy D.Yates and David J. Goodman, “Probability and Stochastic Processes – A friendly Introduction for Electrical and Computer Engineers”, John Wiley & Sons, 2014.

REFERENCES:

1. SaeedGhahramani, “Fundamentals of Probability with Stochastic Processes”, Pearson, 2018.
2. Sheldon M. Ross, “Introduction to Probability Models”, Academic Press, 2014.
3. Medhi J., “Stochastic Processes”, New Age International Publishers, 2014.
4. Samuel Karlin and Howard E.Taylor, “A First course in Stochastic Processes”, Academic Press, 2011.
5. Gross.D and Harris C.M, “Fundamentals of Queueing theory”, John Wiley & Sons, 2013.

20XD53 COMPUTER NETWORKS

3 2 0 4

PREREQUISITES

- 20XD35 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING

INTRODUCTION: Network goals - Applications of Networks - Design issues for the layers - OSI Reference Model - Types of Network - Network Topologies- Analog and Digital data transmission- Data encoding- Bandwidth and data rate-.Bit Rate, Baud Rate- Sampling Rate. (5+5)

DATA COMMUNICATION:Multiplexing - Synchronous and Asynchronous TDM – FDM –CDM - Switching, Circuit Switching, Packet Switching. (3+5)

TRANSMISSION OF DIGITAL DATA: Transmission Impairments - Single and Multiple bit error correction-Error Detection and Correction - Cyclic Redundancy Check Code -.Hamming Code. (4+3)

DATA LINK CONTROL AND PROTOCOLS: Line Discipline - Flow Control - Sliding Window Protocol - Error Control - Automatic Repeat Request – Stop and wait - ARQ - Go back by n ARQ - Selective Reject ARQ. (5+2)

LOCAL AREA NETWORKS: Random Access protocols- Ethernet – Fast Ethernet – Gigabit Ethernet – Wireless LANs- Internetworking- LAN -LAN Connections – Repeaters- Hubs - Bridge – Spanning tree-Switches – Routers. (5+5)

IP: TCP/IP Protocol Structure - Internet Protocol – IP addressing-ICMP-ARP-BOOTP-DHCP (9+3)

ROUTING:Distance vector routing _ Link state Routing – RIP – OSPF (4+2)

TRANSPORT LAYER- TCP concepts - Port number - UDP – TCP-UDP Vs TCP. (5+2)

APPLICATIONS: SMTP - MIME Format, DNS, HTTP. (5+3)

TUTORIAL PRACTICE

1. Familiarize with the layered approach of the protocol stack
2. Familiarize with packet capturing tools in Java and Wireshark
3. Familiarize with IP addressing and subnetting concepts
4. Analyse the existing routing protocols and implement any one of them
5. Implement client server programs using sockets which has multiple clients.
6. Implement a simple firewall system

Total L:45+ T:30=75

TEXT BOOKS

1. Behrouz A Forouzan, "Data Communications and Networking", Tata McGraw Hill, 2013.
2. Behrouz A Forouzan, "TCP/ IP Protocol Suite", Tata McGraw Hill, 2017.
3. Peterson, Larry L., and Bruce S. Davie. Computer networks: a systems approach. Elsevier, 2012.

REFERENCES

1. Kevin Fall R and Richard Stevens W, "TCP/IP Illustrated, Volume 1: The Protocols", Addison-Wesley, Ann Arbor, 2011.
2. James F. Kurose, Keith Ross, "Computer Networking: A Top-Down Approach", Addison-Wesley, 2017.
3. Douglas Comer, "Internetworking with TCP/IP", Prentice Hall, 2013.
4. William Stallings, "Data and Computer Communications", Prentice Hall, 2007.

20XD54 MACHINE LEARNING**3 0 0 3****PREREQUISITES:**

20XD25 THEORY OF PROBABILITY
 20XD31 APPLIED STATISTICS
 20XD32 LINEAR ALGEBRA
 20XD41 OPTIMIZATION TECHNIQUES

TYPES OF MACHINE LEARNING – Supervised learning, unsupervised, Reinforcement learning, semi supervised learning – Generative, Discriminative models- Parametric, Non parametric approaches - Optimization – Convex set - Convex functions – Loss functions in machine learning - Gradient descent – variants (10)

SUPERVISED LEARNING: Classification – Linear classification – Logistic regression –linear discriminant analysis –Neural networks – Perceptron - Multilayer perceptron - Back propagation – Training - Support Vector Machines – Linear, Soft margin, Linearly non separable data - Kernel functions (10)

Bayesian Classifier – Decision theory – Maximum A Posteriori estimate – maximum likelihood estimate - K nearest neighbour - Model selection – Bootstrapping and cross validation – Model evaluation – Performance Measures – Receiver operating characteristic curve (ROC) – AUC - Bias –variance – over fitting – under fitting - Regularization (10)

UNSUPERVISED LEARNING: Clustering –Types - K-means – Mixture of Gaussians –Spectral clustering - Cluster validity measures – dimensionality reduction- extraction –Factor Analysis- PCA (Principal components analysis) - ICA (Independent components analysis) - Applications : image segmentation – Image compression –Outlier analysis (10)

SEMI SUPERVISED LEARNING: Self training – Transductive SVM – Graph based learning - Active learning – online learning (5)

Total L: 45**TEXT BOOKS:**

1. Christopher M Bishop, "Pattern Recognition and Machine Learning", Springer, 2016.
2. Richard O Duda, Peter E Hart and David G Stork, "Pattern Classification (Digitized)", John Wiley, 2012.
3. Oliver Chapelle, Bernhard Scholkopf, Alexander Zian, "Semi-supervised Learning" The MIT Press, 2010

REFERENCES:

1. David Barber, "Machine Learning: A Probabilistic Approach", <http://www.idiap.ch/~barber>, 2006.
2. Alpaydin Ethem, "Introduction to Machine Learning", Massachusetts Institute of Technology Press, 2020.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, "The Elements of Statistical Learning", Springer, 2013.

20XD56 DESIGN AND ANALYSIS OF ALGORITHM LAB**0 0 42**

To implement the following

1. Problem using closest pair algorithm
2. Prims minimum cost spanning tree
3. Kruskal's minimum cost spanning tree using min heap data structure, union and find operation
4. Problem related to topological sorting
5. Application of all pairs shortest path problem , longest common subsequence
6. Application of N QUEENS using back tracking
7. TSP, Assignment Problem using branch – and - bound
- 8.

Total P:60

20XD57 MACHINE LEARNING LAB

1. Download the datasets from UCI machine learning repository / www.kaggle.com for classification and clustering.
 - a. Mail spam
 - b. Breast cancer data
 - c. Iris data
 - d. MNIST dataset
2. Implement the following Classification algorithms on the above suitable datasets.
 - a. Naïve Bayes
 - b. LDA / QDA
 - c. SVM
 - d. K nearest neighbor
 - e. Multi layer Perceptron
3. Do tenfold cross validation experiments and statistical validation using t-test and ANOVA.
4. Apply clustering for image segmentation and image compression.
5. Apply Spectral clustering on data sets and visualization through plots
6. Apply PCA / LDA / Factor analysis on Iris data set, reduce the dimension and visualize the data .
7. Apply semi supervised learning techniques on data sets for the following tasks: to fill missing values / classification

20XD58 CAPSTONE PROJECT**0 0 4 2****SEMESTER VI****20XD61 PARALLEL AND DISTRIBUTED COMPUTING****3 0 03****PREREQUISITES**

- 20XD44 OPERATING SYSTEMS
- 20XD53 COMPUTER NETWORKS

CONCEPTS AND TERMINOLOGY: Generic Processor / ASIC Processor Architecture – Pipeline Architecture – Instruction Set Architecture - Types of Parallelism - Flynn's Classical Taxonomy – Terminology. (6)

PARALLEL COMPUTER MEMORY ARCHITECTURES: Shared Memory - Distributed Memory -Hybrid Distributed-Shared Memory Multiprocessors: Communication and Memory issues - Message Passing Architectures - Vector Processing and SIMD Architectures. (5)

PARALLEL PROGRAMMING MODELS: Overview -Shared Memory Model - Threads Model - Message Passing Model - Data Parallel Model - Other Models. (5)

DESIGNING PARALLEL PROGRAMS: Automatic vs. Manual Parallelization - Understand the Problem and the Program - Partitioning -Communications - Synchronization -Data Dependencies - Load Balancing -Granularity -I/O -Limits and Costs of Parallel Programming - Performance Analysis and Tuning - Parallel Examples -Array Processing – Compiler Transformation techniques for High performance computing: - Transformations for parallel Machines. (6)

PRAM ALGORITHMS& BSP: PRAM model of computation- Work-Time formalism and Brent's Theorem; algorithm design techniques-parallel prefix, pointer jumping, Euler tours, divide and conquer, symmetry breaking; survey of data-parallel algorithms; relative power of PRAM models - Bulk synchronous parallel model. (6)

HIGH PERFORMANCE COMPUTING ARCHITECTURES - Latency Hiding Architectures -Multithreading Architectures - Dataflow Architectures - **GPGPU Architecture**- Overview of basic Accelerators /GPU / GPGPU and its programming model – CUDA - OpenCL. (6)

DISTRIBUTED COMPUTING: Introduction -- Definitions, motivation - Communication Mechanisms - Communication protocols,-RPC- RMI- Distributed Algorithms – snapshots - leader election – Synchronization -Traditional synchronization - lock free - clocks. Replication and Coherence - Consistency models and protocols –overview of Fault Tolerance. (6)

DENSE LINEAR ALGEBRA: Matrix transposition - Matrix product - Gaussian elimination - Data distribution - Parallel linear algebra libraries. (5)

Total L: 45**TEXT BOOKS**

1. Andrew S. Tanenbaum and Maarten van Steen, "Distributed Systems, Principles and Paradigm" Prentice Hall, 2013.
2. Michael J Quinn, "Parallel Computing : Theory And Practice" , Tata Mcgraw-Hill,2004
3. Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General-Purpose GPU Programming", Pearson Education, 2011

REFERENCES

1. Vijay K Garg, "Principles of Distributed Computing", Kluwer Academic Publisher, 2014.
2. Joel M. Crichlow, "Distributed And Parallel Computing" , Prentice Hall Of India, 2007
3. Shane Cook , "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs (Applications of Gpu Computing)", Elsevier Inc., 2013
4. Srinath Perera, Thilina Gunarathne, Mapreduce Cook book, Packy Publishing, 2013
5. David F. Bacon, Susan L. Graham and Oliver J. Sharp, "Compiler Transformations for High Performance Computing" Technical report, 1994

20XD62 DEEP LEARNING**3 0 0 3****PREREQUISITES**

- 20XD54 MACHINE LEARNING

INTRODUCTION – Basic concepts – Convex sets, convex functions – loss functions – Gradient descent – Variants - Perceptron – Activation functions - Geometric representation – Perceptron Convergence theorem (3)

FEED FORWARD NETWORKS- Multi layer Perceptron – back propagation - Learning XOR – Auto encoder - Deep neural networks (7)

TRAINING NEURAL NETWORKS: Optimization methods for neural networks - Adagrad, Adadelata, rmsprop, adam, NAG - second order methods for training, Saddle point problem in neural networks, Regularization methods - dropout, batch normalization, Ridge and Lasso (10)

CONVOLUTIONAL NETWORKS–structure – properties – Region based CNN - LeNet – Alex net (5)

RECURRENT NETWORKS– Recurrent neural networks(RNN) – Gated Recurrent unit – Long Short Term Memory - Bidirectional RNNs - Deep recurrent network – Methodology – Applications (8)

DEEP LEARNING RESEARCH : Linear Factor Models, variants of Autoencoders, Representational Learning, Structured probabilistic models for deep learning, Monte Carlo Methods, Generative adversarial networks - Deepgenerative models (9)

APPLICATIONS : Natural language processing, Big Data, Brain Computer Interface, Vision, IoT (3)

Total L:45**TEXT BOOKS:**

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville , "Deep Learning" , The MIT Press, 2016,
2. Yoshua Bengio, " Learning Deep Architectures for AI, Foundations & Trends in Machine Learning", Now Publishers, 2009

REFERENCES

1. Li Deng, Dong Yu, "Deep Learning: Methods and Applications", Now Publishers 2014.
2. Jon Krohn, "Deep Learning for Natural Language Processing: Applications of Deep Neural Networks to Machine Learning Tasks", Addison-Wesley, 2017.

20XD63 BIG DATA AND MODERN DATABASE SYSTEMS**3 0 0 3****PREREQUISITES**

- 20XD42 DATA BASE DESIGN
- 20XD34 ADVANCED DATA STRUCTURES

OBJECT AND SPATIAL DATABASES: Object Oriented Databases - Complex data types - Structured types and Inheritance - Query Processing in Object databases - Spatial Databases : Geometric Information System - Spatial Data Types – Spatial Queries - Spatial indexing techniques (6)

PARALLEL AND DISTRIBUTED DATABASES: Architecture of parallel databases – Parallel query evaluation, Parallel query optimization – Distributed DBMS Architecture, Distributed Database Design, Distributed Query Processing (5)

DATA MODELING FOR BIG DATA: Big Data and Challenges, Big Data models, NoSQL data models, Basic principles of NoSQL models, BASE properties, CAP Theorem, SQL databases Vs NoSQL databases - **MAP-REDUCE:** Apache Hadoop and HDFS, SPARK (10)

NOSQL DATABASES (PART 1): Key - Value Stores: Amazon DynamoDB, Key -Value Stores (in-memory) : Redis , Column Oriented Store: Google BigTable , Apache Cassandra - Hbase. (10)

NOSQL DATABASES (PART 2): Document Oriented Stores – MongoDB - Apache CouchDB - Graph databases: Neo4J - OrientDB (9)

DATABASE INTEGRATION: Data warehousing, Virtual Data Integration - Schema directed data integration - Schema mapping and information preservation (5)

Total L:45

TEXT BOOKS

1. Pramod J. Sadalage and Martin Fowler, "NoSQL Distilled - Brief Guide to the Emerging World of Polyglot Persistence", Pearson Education, 2013.
2. Guy Harrison, "Next generation Databases: NoSQL and BigData", Apress, 2015.
3. Kristina Chodorow, Shannon Bradshaw, Eoin Brazil "MongoDB: The Definitive Guide", O'Reilly Media, 2019

REFERENCES

1. Ramez Elmasri and Shamkrant Navathe, "Fundamentals of Database Systems", Pearson Education, 2016.
2. M.Tamer Ozsu, Patrick Valduriez, "Principles of Distributed Database Systems", Springer, 2020.
3. Anhai Doan, Alon Halevy, Zachary Ives, "Principles of data integration", Morgan Kaufmann, 2012.
4. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, "Learning Spark: Lightning-Fast Big Data Analysis", O'Reilly Media, 2015

20XD64 ARTIFICIAL INTELLIGENCE

3 2 0 4

PREREQUISITES

- 20XD21 DISCRETE STRUCTURES
- 20XD23 DATA STRUCTURES AND ALGORITHMS
- 20XD25 THEORY OF PROBABILITY
- 20XD33 GRAPH THEORY

INTRODUCTION: The foundations of AI - The History of AI - Intelligent agents - Agent based system. (2)

PROBLEM SOLVING: State Space models - Searching for solution - Uninformed/Blind search - Informed/ Heuristic search - A* search - Hill-climbing search - Meta Heuristic: Genetic Algorithm - Adversary based search : Minimax – Expectimax – Alpha Beta pruning – Constraint satisfaction problem - Backtracking search (11)

KNOWLEDGE REPRESENTATION AND REASONING: Knowledge representation - Logics - bivalent logic - inference - Fuzzy logic: membership - Fuzzy rules and reasoning - Fuzzy inference (10)

UNCERTAIN KNOWLEDGE AND PROBABILISTIC REASONING: Uncertainty - Probabilistic reasoning - Semantics of Bayesian network - Exact inference in Bayesian network- Approximate inference in Bayesian network - Probabilistic reasoning over time – Inference in temporal models - Hidden Markov Models – Dynamic Bayesian Networks (11)

DECISION-MAKING: Basics of utility theory, Utility functions - Sequential decision problems - Markov decision process - Value iteration - Policy iteration - Decisions in Multi agent system: Multi agent decision theory - Group decision making (11)

TUTORIAL PRACTICE:

1. Search Techniques: A* algorithm for 8 – puzzle and Missionaries and Cannibals problem, Hill climbing, genetic algorithm and Constraint satisfaction techniques
2. Simple games – minimax and expectimax
3. Logic based exercises, Fuzzy Inference System.
4. Decision making: Implementing HMM models, sequential and multi agent decision making

Total: L: 45+T: 30 = 75

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 2020.
2. David Poole and Alan Mackworth, "Artificial Intelligence: Foundations of Computational agents", Cambridge University Press, 2017.
3. Timothy Ross, "Fuzzy Logic with Engineering Applications", John Wiley and sons, 2016.

REFERENCES:

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2013.
2. Nils J. Nilsson, "The Quest for Artificial Intelligence: A History of Ideas and achievements", Cambridge University Press, 2010.
3. Daphne Koller and N Friedman, "Probabilistic Graphical Models - Principles and Techniques", MIT press, 2009.

20XD66 PARALLEL AND DISTRIBUTED COMPUTING LAB**0 0 4 2**

1. Basic Master – Worker program and send messages.
2. Write a program to find the summation of largest number in a very larger array of integers. (The contents of the array should be equally distributed to all processes).
3. Write a parallel program in SPMD to calculate the PI value using integral approximation method.
4. Matrix multiplication, Transpose, using parallel algorithm.
5. Select your own choice of very dense computational problem having divide and conquer method and implement it in parallel algorithm. And produce the performance chart with 2, 4, 6 and 8 nodes.
6. Implement data parallelization algorithm using CUDA and OpenCL
7. Hadoop setup – Map reduce – Programming models – Text mining.

Total P: 60**20XD67 BIGDATA AND MODERN DATABASE SYSTEMS LAB****0 0 4 2**

1. Creating and querying of Object Relational databases and Spatial databases
2. Implementation of No-SQL databases :
3. DynamoDB, MongoDB, HBASE, Neo4J, Redis
4. Big data processing using Hadoop and Spark
5. Map Reduce with Spark and Hadoop
6. Data Integration from heterogeneous Databases.

Total P:60**20XD68 DEEP LEARNING LAB****0 0 4 2**

1. Collect data sets from the url : <http://deeplearning.net/datasets/>
2. Use TensorFlow library for visualization of data sets in different domains and analysis:
 - a. Given a set of images of handwritten digits from MNIST, classify the images into digits
 - b. Do image captioning using RCNN
 - c. Text classification using CNN
 - d. Language modeling using RNN
 - e. Speech processing
 - f. Optical character recognition using CNN and RNN
 - g. Sentiment analysis and classification using LSTM
 - h. Document classification / Radiology reports classification
 - i. Visualization of CNN and RNN parameters
 - j. POS tagging using RNN
 - k. Dimensionality reduction and visualization using Auto encoders and its variants

Total P:60

SEMESTER VII
20XDP1PROJECT WORK I

0 0 0 12

SEMESTER VIII
20XD81 REINFORCEMENT LEARNING

3 0 0 3

PREREQUISITES

- 20XD54 MACHINE LEARNING
- 20XD64 ARTIFICIAL INTELLIGENCE

REINFORCEMENT PROBLEM: Introduction - Elements of RL, History of RL- Evaluative feedback -Goals and rewards – Returns -Bandit learning: Upper-confidence - bound algorithms - Thompson sampling, online learning - Multi agent reinforcement learning (6)

MARKOV DECISION PROCESS (MDP) – Value functions - Optimality Criterion in MDPs.- Partially Observed Markov Decision Process (4)

DYNAMIC PROGRAMMING (DP): Policy Evaluation- Policy Improvement - Value Iteration, asynchronous DP- Efficiency of DP- Stochastic DP. (5)

MONTE CARLO METHODS: Policy Evaluation- Policy Improvement- On-policy and off- policy Monte Carlo controls- Incremental implementation. (8)

TEMPORAL DIFFERENCE LEARNING (TD): TD-prediction- Optimality of TD - Sarsa- Q-Learning – R- Learning-Actor-Critic Model- Unifying Monte Carlo and TD-Traces- Games. (8)

FUNCTION APPROXIMATION- Value prediction and control – Gradient Descent methods-Linear methods – Artificial Neural Network based approximation- lazy learning - Policy Gradient methods- REINFORCE algorithm, exact gradient methods, estimating gradients, approximate policy gradient algorithms, actor-critic methods - Deep Q Learning - Inverse RL (9)

PLANNING AND LEARNING: Model based learning and planning - prioritized sweeping-Heuristic search. (5)

TUTORIAL PRACTICE:

1. Ranking of nodes of a graph using Q-Learning (Page Rank, Trust Rank, Distance Rank).
2. Implementing n-armed Bandit problem.
3. Finding shortest paths in graphs using RL.
4. Solving GridWorld problems.
5. RL for Stochastic grid world.
6. Automated Chess player.
7. Multi-agent system.
8. Distributed RL.
9. Policy search algorithm.

Total L: 45+T:30 = 75

TEXT BOOKS

1. Sutton R. S. and Barto A. G., "Reinforcement Learning: An Introduction", MIT Press, 2018.
2. Dimitri P. Bertsekas, "Reinforcement Learning and Optimal Control", Athena Scientific, 2019
3. Csaba Szepesvári, "Algorithms for Reinforcement Learning", Morgan & Claypool, 2010.

REFERENCES

1. Lattimore, T. and Szepesvári, C." Bandit Algorithms", Cambridge University Press, 2018.
2. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, 2020.
3. Masashi Sugiyama, "Statistical Reinforcement Learning : Modern Machine Learning Approaches", CRC Press, Taylor & Francis Group, 2015

20XD82 NATURAL LANGUAGE PROCESSING**3 0 0 3****PREREQUISITES**

- 20XD54 MACHINE LEARNING
- 20XD64 ARTIFICIAL INTELLIGENCE

INTRODUCTION: Natural language processing techniques - analysis in NLP: morphological – syntactic, semantic - pragmatic - Applications (3)

WORDS : Regular expressions – Automata – Morphology – Finite state Transducers – Finite state morphological parsing – Combining FST lexicon and rules – Porter Stemmer Algorithm – Probabilistic models for Spelling – Bayes method, Minimum edit distance - N-Grams – Counting words in Corpora – Simple n-grams – Smoothing – Evaluating language models : Entropy, Perplexity- Part of Speech Tagging (POS) – Rule based tagging – Stochastic based tagging – Transformation based tagging - Context Free Grammars - Top down parser – Earley Algorithm – Bottom-up parsing – CYK parser – Probabilistic parsing. (15)

SEMANTICS & PRAGMATICS: First order predicate calculus – Syntax driven semantic analysis – Attachments for a fragment of English – Word Sense Disambiguation – Machine learning approaches – Dictionary based approaches – Pragmatics : Discourse –Textcoherence. (10)

NATURAL LANGUAGE GENERATION : Architecture of NLG Systems- Generation Tasks and Representations- Application of NLG. Machine Translation: Language similarities and differences – The transfer metaphor – Direct translation – Statistical translation - Translation involving Indian Languages. (12)

CASE STUDIES : Mail spam, web spam detection, Fake news detection - Sentiment Analysis - Information extraction - Automatic summarization - Question answering - Named entity recognition and relation extraction - IE using sequence labeling - Open problems (5)

Total: L:45**TEXT BOOKS:**

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall,2014.
2. Philipp Koehn , "Statistical Machine Translation", Cambridge University Press, 2010.

REFERENCES:

1. Christopher Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing", MIT Press,2008.
2. James Allen, "Natural Language Understanding", Addison Wesley,1995.

20XD83 DATA MINING**3 0 0 3****PREREQUISITES**

- 20XD42 DATABASE DESIGN
- 20XD54 MACHINE LEARNING

DATA WAREHOUSE and OLAP TECHNOLOGY: Overview- Need for Data Warehouse- multidimensional data model-Data Warehouse architecture -Data warehousing Schemas - Data Warehousing to Data mining (7)

MINING FREQUENT PATTERNS, ASSOCIATIONS AND CORRELATIONS: Basic concepts – Efficient and Scalable Frequent Itemset Mining methods – Apriori, FP Tree. **CLASSIFICATION AND PREDICTION:** Overview of Classification techniques – Ensemble Learning-bagging, boosting, cascading, stacking. **CLUSTERING:** Hierarchical – Density based (10)

INCREMENTAL & STREAM DATA MINING: Incremental Algorithms for Data Mining, Characteristics of Streaming Data, Issues and Challenges, Streaming Data Mining Algorithms, Any time stream Mining (10)

SEQUENCE MINING: Characteristics of Sequence Data, Problem Modeling, Sequential Pattern Discovery, Timing Constraints, Applications in Bioinformatics **Multivariate Time Series (MVTS) Mining:** Importance of MVTS data - Sources of MVTS data - Mining MVTS data (10)

APPLICATIONS AND TRENDS IN DATA MINING: Spatial Data Mining –Graph Mining- Web Mining –Text Mining. (8)

Total L:45**TEXT BOOKS:**

1. Jiawei Han and Micheline Kamber, "Data Mining – Concepts and Techniques", Morgan Kaufmann Publishers, 2012.
2. Tan, Steinbach and Kumar, "Introduction to Data Mining", Pearson Education, 2014.

REFERENCES:

1. Anand Rajaraman, Jeffrey Ullman, "Mining Massive Data sets", Cambridge University Press, 2014.
2. Trevor Hastie, Robert Tibshirani and Jerome Freidman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer Series in Statistics, 2011.
3. Ian Witten, Frank Eibe and Mark A Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Elsevier, 2011.

20XD86 REINFORCEMENT LEARNING LAB**0 0 4 2**

1. Ranking of nodes of a graph using Q-Learning (PageRank, TrustRank, DistanceRank).
2. Implementing n-armed Bandit problem.
3. Finding shortest paths in graphs using RL.
4. Solving GridWorld problems.
5. RL for Stochastic grid world.
6. Automated Chess player.
7. Multi-agent system.
8. Distributed RL.
9. Policy search algorithm.
10. Feed forward neural network.

Total P: 60**20XD87 –NATURAL LANGUAGE PROCESSING LAB****0 0 4 2****Sample lab assignments**

1. Sentiment analysis and classification using n gram models, RNN and LSTM
2. Document classification / Radiology reports classification using RNN and LSTM
3. Visualization of text data
4. POS tagging on text data using HMM
5. Language modeling using n gram models
6. Machine translation using Deep learning and HMM
7. Optical character recognition using
8. Word sense disambiguation

Total P: 60**20XD88 DATA MINING LAB****0 0 4 2**

Implement the following problems

1. FP Tree for finding frequent item sets
2. Ensemble of classifiers
3. Wrapper and filter methods for feature selection
4. Data mart and different operations
5. Mining stream data

Total P: 60

SEMESTER IX**20XD91 DATA PRIVACY AND SECURITY****3 0 0 3****PREREQUISITES**

- 20XD53 COMPUTER NETWORKS
- 20XD54 MACHINE LEARNING

INTRODUCTION: Security Problems in computing – security goals – threats and attacks. – Services and mechanisms. (2)

CRYPTOSYSTEMS: Introduction – symmetric key cryptography – substitution cipher – transposition cipher – stream ciphers and block ciphers – Advanced Encryption Standard (AES) – cryptanalysis of symmetric key cryptosystems. Public key cryptography – Introduction – RSA cryptosystem – attacks on RSA – Elliptic curve cryptosystem. (10)

MESSAGE INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT: Message digest – Message authentication code – Cryptographic hash function – Digital signatures – Anonymous protocols – Challenge response system – zero knowledge protocol – secure two party computation – DSS. Symmetric key distribution – Kerberos – Diffie – Hellman key agreement – Public key distribution – Certificates. (10)

NETWORK SECURITY: Application Layer Security – PGP and S/MIME, Transport Layer security – SSL – Network layer security – IPsec. (4)

PROGRAM SECURITY : Secure Coding – Malicious and non-Malicious program errors – OWASP/SANS Top Vulnerabilities – Malwares – types – Buffer Overflows – defense mechanisms – Incomplete mediation – XSS – Redirection – Inference – Application Controls – Evaluation of Security Systems. (4)

DATA BASE SECURITY : Security Requirements – database administration security – SQL injection and exploitation and defense methods – database roles and permissions – Object level security – Sensitive data – Multilevel Databases – Multi level security. (5)

DATA PRIVACY : Introduction – Foundations of privacy – Logical methods for specification and enforcement of privacy policies – Privacy preserving data publication – An introduction to Differential privacy: Definitions and early uses – Noiseless differential privacy – Applications of Differential privacy – Synthetic datasets and network trace analysis – Differential privacy for large data – Differentially private social network analysis – Web privacy: online tracking and advertisement – Privacy and machine learning – case study: HIPAA privacy rule (10)

Total L:45**TEXT BOOKS:**

1. John R. Vacca, "Network and Systems Security" Syngress Imprint of Elsevier, 2014.
2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", Tata McGraw Hill, 2011.
3. Mark Stamp, "Information Security: Principles and Practice", John Wiley & Sons, 2011.

REFERENCES:

1. Basta, Alfred, and Melissa Zgola. "Database Security". Cengage Learning, 2011.
2. Cynthia Dwork and Aaron Roth, "The Algorithmic Foundations of Differential Privacy," Nova publishers Inc, 2014.

20XD92 NETWORK SCIENCE**3 0 0 3****PREREQUISITES**

- 20XD33 GRAPH THEORY
- 20XD52 STOCHASTIC MODELS

RANDOM NETWORKS: Basics of networks and graphs, random network model – degree distribution, evolution, small world property, six degrees of separation, Watts-Strogatz model, local clustering coefficient, random networks and network science. (5)

BARABÁSI-ALBERT MODEL: Growth and preferential attachment, Barabási-Albert model, degree dynamics, degree distribution, diameter and the clustering coefficient, preferential attachment – absence of growth, measure, non-linearity, the origins. (8)

SCALE-FREE PROPERTY: Power laws and scale-free networks, Hubs, Universality, Ultra-small property, role of the degree exponent, Generating networks with a pre-defined degree distribution. (10)

EVOLVING NETWORKS: Bianconi-Barabási model, measuring fitness, Bose-Einstein condensation, evolving networks. (6)

DEGREE CORRELATIONS: Assortativity and disassortativity, Measuring degree correlations, Structural cutoffs, Degree correlations in real networks, Generating correlated networks, impact of degree correlations. (8)

NETWORK ROBUSTNESS: Percolation theory, robustness of scale-free networks, attack tolerance, cascading failures, modeling cascading failures, building robustness. (8)

Total: L:45

TEXT BOOK:

1. Albert-László Barabási, Network Science, Cambridge University Press, 2020
2. Filippo Menczer, Santo Fortunato, Clayton A. Davis, "A First Course in Network Science", Cambridge University Press, 2020.

REFERENCES:

1. Estrada, E., Fox, M., Higham, D.J. and Oppo, G.L., "Network Science - Complexity in Nature and Technology", Springer, 2010.
2. Ted G. Lewis, "Network Science: Theory and Practice", John Wiley & Sons, 2013.
3. Guido Caldarelli, Alessandro Chessa, "Data Science and Complex Networks: Real Case Studies with Python", Oxford University Press, 2016.

20XD93 INFORMATION RETRIEVAL AND WEB SEARCH

3 0 0 3

PREREQUISITES

- 20XD31 APPLIED STATISTICS
- 20XD32 LINEAR ALGEBRA
- 20XD34 ADVANCED DATA STRUCTURES

INTRODUCTION: Overview of IR Systems - Historical Perspectives - Goals of IR - The impact of the web on IR - The role of artificial intelligence (AI) in IR. (3)

TEXT REPRESENTATION: Statistical Characteristics of Text: Zipf's law; Porter stemmer; morphology; index term selection; using thesauri. **Basic Tokenizing, Indexing:** Simple tokenizing, stop-word removal, and stemming; inverted indices; Data Structure and File Organization for IR - efficient processing with sparse vectors. (6)

RETRIEVAL MODELS: Similarity Measures and Ranking - Boolean Matching – Extended Boolean models - Ranked retrieval - Vector Space Models -, text-similarity metrics - TF-IDF (term frequency/inverse document frequency) weighting - cosine similarity, Probabilistic Models, Evaluations on benchmark text collections. (8)

QUERY PROCESSING: Query Operations and Languages- Query expansion; Experimental Evaluation of IR: Performance metrics: recall, precision, and F-measure. (5)

TEXT CATEGORIZATION AND CLUSTERING: Categorization: Rocchio; Naive Bayes, kNN; Clustering: Agglomerative clustering; k-means; Expectation Maximization (EM); Dimension Reduction: LSI, PCA. (6)

WEB SEARCH: IR Systems and the WWW - Search Engines: Spidering, Meta Crawlers and near duplicate pages, Question answering,; Link analysis: Hubs and Authorities, Google PageRank, Duplicate Detection. (5)

INFORMATION FILTERING TECHNIQUES: introduction to Information Filtering, Relevance Feedback - Applications of Information Filtering; **RECOMMENDER SYSTEMS:** Collaborative filtering and Content-Based recommendation of documents and products. (6)

INFORMATION EXTRACTION AND INTEGRATION: Extracting data from text; Basic Techniques: Named Entity Recognition, Co-reference Resolution, Relation Extraction, Event Extraction; Extracting and Integrating specialized information on the Web, Web Mining and Its Applications. (6)

Total L: 45

TEXT BOOKS:

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2012.
2. Stefan Büttcher, Charles L. A. Clarke, Gordon V. Cormack, " Information Retrieval – Implementing and Evaluating Search Engines ", The MIT Press, 2016

3. B.Croft, D. Metzler, T. Strohman, "Search Engines: Information Retrieval in Practice", Pearson Education, 2015.

REFERENCES:

1. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, "Modern Information Retrieval", Pearson Education, 2010.
2. Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor, "Recommender Systems – Handbook", Springer, 2015.

20XD96 INFORMATION RETRIEVAL AND WEB SEARCH LAB**0 0 4 2**

1. Different retrieval models - Boolean, Vector space and Probability based retrieval.
2. Query refinement techniques
3. Evaluation of the set based and ranked retrieval algorithms.
4. Dimension Reduction techniques
5. Classification and Clustering techniques
6. Web based retrieval - Link based retrieval, combining content and link information
7. Recommender systems- Collaborative and Content Based Filtering
8. Information Extraction techniques

Total P: 60**20XD97 DATA PRIVACY AND SECURITY LAB****0 0 4 2**

1. Design of a Client server application for a basic cryptosystem.
2. Performing a frequency analysis attack on a cipher text enciphered with Affine cipher.
3. Detection of a Buffer overflow attack.
4. Packet Sniffing using Wireshark Tool to perform the traffic analysis attack.
5. Implementation of RSA cryptosystem.
6. Key distribution using RSA(KDC) – Key hacking.
7. Key exchange using Diffie-Hellman technique – MITM attack.
8. Authentication of File transfer using Hashing / Message digest.
9. Digital signature, generation and verification.
10. Password authentication.
11. Securing transaction by defending SQL Injection attacks.
12. Cross - Site scripting.
13. Implementation of security techniques to safeguard the database against accidental or deliberate breaches.
14. Security testing for applications.
15. Analysis and removal of vulnerabilities from a web application.

Total P: 60**20XD98 NETWORK SCIENCE LAB****0 0 4 2**

1. Implementation of Barabási-Albert model.
2. Implementation of Watts-Strogatz model.
3. Implementation of Bianconi-Barabási model.
4. Obtaining Degree correlations in real networks.
5. Case studies of the theory concepts on real networks.

Total P: 60**SEMESTER X****20XDP2 PROJECT WORK II****0 0 0 12**

PROFESSIONAL ELECTIVES**20XDA1 DATA COMPRESSION****3 2 0 4****PREREQUISITES**

- 20XD23 DATA STRUCTURES
- 20XD25 THEORY OF PROBABILITY
- 20XD45 TRANSFORMS AND ITS APPLICATIONS

DATA COMPRESSION LEXICON: Introduction to Data Compression - Dawn Age - Coding - Lossy Compression. (4)

MINIMUM REDUNDANCY CODING (THE DAWN AGE): The Shannon - Fano Algorithm, The Huffman Algorithm - Into the Huffman Code : Counting the Symbols, Building the tree (5)

ADAPTIVE HUFFMAN CODING: Adaptive Coding - Updating the Huffman Tree - Escape code. (5)

ARITHMETIC HUFFMAN CODING: Arithmetic Coding with floating point data type – Arithmetic coding with integral data type. (6)

STATISTICAL MODELING: Higher-order Modeling - Finite Context Modeling – Order one modeling – Order two Modeling (5)

SPEECH COMPRESSION: Digital Audio Concepts - Lossless Compression of Sound. (5)

VIDEO COMPRESSION: JPEG Compression - Implementing DCT - Complete Code Listing. (5)

DICTIONARY-BASED COMPRESSION: LZ77 Compression and Decompression - LZSS Compression and Decompression - LZ78 Compression and Decompression - LZW Compression and Decompression – LZMW Compression and Decompression - LZAP Compression and Decompression – LZJ Compression and Decompression. (10)

TUTORIAL PRACTICE:

1. Implement Shannon Fano algorithm and Huffman algorithm.
2. Design compression and decompression program using adaptive Huffman coding.
3. Implement arithmetic coding algorithm.
4. Design compression program using statistical modeling upto 3 order.
5. Design compression and decompression program using LZ77 algorithm.

Total: L: 45+T: 30 = 75**TEXT BOOK:**

1. Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann, 2013.
2. David Salomon, "Data Compression: The Complete Reference", Springer, 2014

REFERENCES:

1. Charles K. Chui, Qingtang Jiang, "Applied Mathematics: Data Compression, Spectral Methods, Fourier Analysis, Wavelets and Applications", Atlantic Press, 2013

20XDA2 MOBILE COMPUTING**3 2 0 4****PREREQUISITES**

- 20XD53 COMPUTER NETWORKS

OVERVIEW OF MOBILE COMMUNICATIONS: Introduction to mobile and wireless devices - wireless networking, Advantages and disadvantages of wireless networking, Evolution of mobile communication generations- Challenges in mobile computing – Vertical and horizontal mobile applications - Wireless LAN and Wireless WAN. (5)

CELLULAR CONCEPT: Wireless transmission - Frequencies for radio transmission - Regulations - Signals, Antennas, Signal propagation, Path loss of radio signals, Additional signal propagation effects - Multi-path propagation - Multiplexing -

Space division multiplexing - Frequency division multiplexing - Time division multiplexing - Code division multiplexing - Spread spectrum - Direct sequence spread spectrum - Frequency hopping spread spectrum. (10)

CELLULAR NETWORK : Cellular Concepts – Factors determining cell size and shape - GSM-Mobile services - System architecture -- Handover – GPRS – Mobile services – System architecture – Location Management strategies – Eager caching Vs lazy caching - LTE Network architecture and interfaces (10)

MOBILE APPLICATIONS ARCHITECTURE: Smart Client – Smart Client Architecture – Messaging Architecture – The Model-View-Controller Model- Delegate Pattern- Building Smart Client Applications-Design, Development, implementation, testing and deployment phase- MVVM mobile architecture design. (6)

MOBILE APPLICATION DEVELOPMENT: Introduction to Android Platform – Android architecture overview - Application life cycle - UI design for Android - Different types of layouts – Widgets – List view and Adapters - Dialogs and Toasts – Intent filters - Files and database – SQLite on Android - Security model – Comparison with IOS application development -Building cross-platform applications using React Native. (14)

TUTORIAL PRACTICE:

1. Android SDK installation and study
2. Defining Layouts
3. Single Activity Application, Application with multiple activities, using intents to Launch Activities
4. Application using GUI Widgets
5. Application with Notifications
6. Creating and Saving Shared Preferences and Retrieving Shared Preferences
7. Usage of SQLite Databases for storage
8. Working with Retrofit library in Android Applications
9. Android Automated Testing Frameworks
10. Case Study : Dagger Framework for Android

Total L:45+T:30=75

TEXT BOOKS:

1. Bill Philips, Kristin Marsicano and Chris Stewart, "Android Programming : The big Nerd Ranch guide", O'Reilly, 2017.
2. Jochen Schiller, "Mobile Communications", Pearson Education, 2012.
3. Martyn Mallick, "Mobile and Wireless Design Essentials", Wiley, 2003

REFERENCES:

1. Ronan Schwarz, Phil Dutton, James Steele and Nelson To, "The Android Developer's Cookbook -Building Applications with the Android SDK", Addison Wesley, 2013.
2. Andreas F.Mohisch, "Wireless Communications", John Wiley & Sons, 2010.
3. David Taniar, "Mobile computing concepts, methodologies, tools and applications", IGI Global, 2009.

20XDA3 DIGITAL IMAGE PROCESSING

3 2 0 4

PREREQUISITES

- 20XD11 CALCULUS AND ITS APPLICATIONS
- 20XD21 DISCRETE STRUCTURES
- 20XD25 THEORY OF PROBABILITY
- 20XD32 LINEAR ALGEBRA

DIGITAL IMAGE PROCESSING: Elements of a Digital image processing system – Structure of the Human eye – Image formation and contrast sensitivity – Sampling and Quantization – Neighbours of a pixel – Distance measures – Photographic film structure and exposure – Film characteristics – Linear scanner – Video camera – Image processing applications. (6)

IMAGE TRANSFORMS: Introduction to Fourier transform – DFT – Properties of two dimensional FT – Separability, Translation, Periodicity, Rotation, Average value – FFT algorithm – Walsh transform – Hadamard transform – Discrete Cosine transform. (5)

IMAGE ENHANCEMENT: Definition – Spatial domain methods – Frequency domain methods – Histogram modification technique – Neighborhood averaging – Media filtering – Lowpass filtering – Averaging of multiple images – Image sharpening by differentiation and high pass filtering. (8)

IMAGE RESTORATION: Definition – Degradation model – Discrete formulation – Circulant matrices – Block circulant matrices – Effect of diagonalization of circulant and block circulant matrices – Unconstrained and constrained restorations – Inverse filtering – Wiener filter – Restoration in spatial domain. (8)

IMAGE ENCODING: Objective and fidelity criteria – Basic encoding process – The mapping – The quantizer – The coder – Differential encoding – Contour encoding – Runlength encoding – Image encoding relative to fidelity criterion – Differential pulse code modulation. (8)

IMAGE ANALYSIS AND COMPUTER VISION: Typical computer vision system – Image analysis techniques – Spatial feature extraction – Amplitude and Histogram features. Transform features – Edge detection – Gradient operators – Boundary extraction – Edge linking – Boundary representation – Boundary matching – Shape representation. (10)

TUTORIAL PRACTICE:

1. Implementation of Viewing digital images, bits and bytes, sampling and quantization.
2. Apply scaling, translation and rotation, sums and differences with the grayscale and color images.
3. Implementation of Histograms and stretches, convolutional filters.
4. Construct edge detection algorithms using Operators.
5. Implement Fourier transforms and the frequency domain, non-linear filters.
6. Implement the image restoration techniques.
7. Apply various image encoding methods with grayscale images.
8. Implement the conversion between color spaces.
9. Extract the Spatial, Histogram, and Transform features.
10. Implement the boundary and shape representation of digital images.

Total: L: 45+T: 30 = 75

TEXT BOOKS:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Prentice Hall, 2011.
2. Kenneth R. Castleman, "Digital Image Processing", Pearson Education, 2007.

REFERENCES:

1. Maria Petrou , Costas Petrou, "Image Processing: The Fundamentals", John Wiley& Sons, 2010.

20XDA4 MULTIMEDIA ANALYTICS

3 2 0 4

PREREQUISITES

- 20XDA3 DIGITAL IMAGE PROCESSING
- 20XD54 MACHINE LEARNING

MULTIMEDIA DATABASES: Architectures - Schema, Functional, System, Distributed, Interoperability, Hypermedia. Metadata for Multimedia Databases. (5)

DEALING WITH MULTIMEDIA DATABASES: Text Databases - Querying Character Data Using SQL, Statistical Methods for Text Analysis, Querying Multimedia Text, Content-dependent Metadata, Indexing Technologies for Text. Image Databases - Technologies for Image Processing, Role of Feature Extraction, Retrieval Methods, Developing Image Media Databases. Video Databases - Video Analysis and Segmentation, Storage of Video Objects, Dealing with Moving Images, Metadata for Speech and Video, Manipulating Video Data, Video Query Process. (10)

MULTIMEDIA DATA MINING: Technologies, Architectural Support, Process of Multimedia Data Mining, Outcomes, Approaches and Techniques. (5)

TEXT MINING - Overview, From Textural Information to Numerical Vectors - Collection Documents, Document Standardization, Tokenization, Lemmatization, Vector Generation for Prediction, Sentence Boundary Determination, Part-Of-Speech Tagging, Word Sense Disambiguation, Phrase Recognition, Named Entity Recognition, Parsing, Feature Generation. Using Text for Prediction - Recognizing that Documents Fit a Pattern, Document Classification, Learning to Predict from Text, Evaluation of Performance, Applications. (10)

DESIGNING A CONTENT-BASED IMAGE RETRIEVAL SYSTEM: Feature Extraction and Representation, Similarity Measurements, Dimension Reduction and High-dimensional Indexing, Clustering, The Semantic Gap, Learning, Relevance Feedback, Benchmarking Solutions. (7)

DESIGNING A CONTENT-BASED VIDEO RETRIEVAL SYSTEM: Video Parsing, Video Abstraction and Summarization, Video Content Representation, Indexing and Retrieval, Video Browsing Schemes, Samples of Video Retrieval Systems. (6)

AUDIO MINING: Overview, Audio Retrieval, Audio Mining, Taxonomy for Audio Mining. (2)

TUTORIAL PRACTICE:

1. Construct the following multimedia databases and manipulate them.
 - a. Text Databases
 - b. Image Databases
 - c. Audio Databases
 - d. Video Databases
2. Implement the various phases of text mining algorithm.
3. Construct a document classification system and analyze its performance.
4. Develop a CBIR system for a benchmark database with semantic and relevance feedback.
5. Construct an index based video retrieval system.
6. Develop an audio retrieval system.

Total: L: 45+T: 30 = 75**TEXT BOOKS:**

1. Sholom M. Weiss, NitinIndurkha, Tong Zhang and Fred Damerau, "Text Mining: Predictive Methods for Analyzing Unstructured", Springer, 2010.
2. Oge Marques andBorkoFurht, "Content-Based Image and Video Retrieval", 2012.
3. Robertson, L. Methods and innovations for multimedia database content management/current trends and future practices for digital literacy and competence, Information Science Reference, 2013.

REFERENCES:

1. Djeraba, C. Multimedia mining: a highway to intelligent multimedia documents (Vol. 22). Springer Science & Business Media, 2012.
2. Dunckley Lynne, Multimedia Databases: An Object Relational Approach, Pearson Education, 2003.

20XDA5 COMPUTATIONAL NEUROSCIENCE**3 2 0 4****PREREQUISITES**

- 20XD12 BASICS OF COMPUTATIONAL BIOLOGY
- 20XD32 LINEAR ALGEBRA
- 20XD54 MACHINE LEARNING

INTRODUCTION: Introduction and history of Computational Neuroscience - Tools and specialization in neuroscience – Levels of organization in the brain – Levels of analysis and Computational Theory of the brain. (3)

MATHEMATICAL BACKGROUND: Linear systems - eigenvalues, eigenvectors for symmetric matrices – quadratic forms, solving a system of linear equations - Dynamic systems, bifurcation map in terms of trace and determinant - Phase plane analysis: null clines - Hopf bifurcation and limit cycles (11)

HODGKIN HUXLEY MODEL: Neuron - Membrane potential, action potential, Electrophysiology - Goldman-Hodgkin-Katz voltage equation - Hodgkin-Huxley model. (9)

COMPONENTS OF NEURAL SIGNALING – Neurotransmission - Models of Sensory Systems: Vision – Touch –Hearing - Motor Systems (4)

REVIEW OF ARTIFICIAL NEURAL NETWORKS: McCulloch-Pitts Neuron, Perceptron, MLP, Self-organizing map, Hopfield network. Neural Network: Perception – MLP: Back Propagation – case studies - Past tense learning, NetTalk, biological plausibility of backpropagation algorithm – Hebbian Learning and PCA - Linsker's model of the visual system - Reinforcement Learning - Spiking neuron networks. (7)

INTRODUCTION TO INFORMATION THEORY: Communication channel and information gain – Information measure and Entropy – Properties of Joint and Conditional Information Measures and A Markov Source – Non-linear correlation measures. (5)

CASE STUDIES: Complex network analysis- Structural and functional brain networks. (6)

TUTORIAL PRACTICE:

1. Familiarity with tools such as EEGLab, UCINET.
2. Implementation of signal processing concepts – Frequency Component Analysis of signals etc.
3. Implementation of various Artificial Neural Network algorithms using real time neuroscience datasets.
4. Implementation of complex network metrics using UCI Net / PAJEK.
5. Statistical Analysis on Neuroscience data.

Total: L: 45+T: 30 = 75

TEXT BOOKS:

1. Eric Kandel, James Thomas Schwartz and Jessel, "Principles of Neural Science", McGraw-Hill, 2013.
2. Feng J., "Computational Neuro Science: A Comprehensive Approach", Chapman and Hall / CRC, 2004.
3. Randall C. O'Reilly and Yuko Munakata, "Computational Explorations incognitive Neuroscience: Understanding the Mind", MIT Press, 2000.

REFERENCES:

1. Thomas P. Trappenberg, "Fundamental of Computational Neuroscience", Oxford University press, 2010.
2. Raymond W. Yeung, "Information Theory and Network Coding", Springer, 2011.
3. Cover T. M. and Thomas J. A., "Elements of Information Theory", John Wiley & Sons, 2006.
4. Claude Elwood Shannon and Warren Weaver, "The Mathematical Theory of Communication", University of Illinois Press, 1999.

20XDA6 PERVASIVE COMPUTING**3 2 0 4****PREREQUISITES**

- 20XD35 COMPUTER ORGANIZATION
- 20XD53 COMPUTER NETWORKS

INTRODUCTION: Pervasive computing, m-Business, challenges and future of pervasive computing - modelling key for pervasive computing - pervasive system environment interaction - IOT - architectural design - application examples: Healthcare, Tracking, emergency information systems, home networking appliances and entertainment. (3)

DEVICE TECHNOLOGY FOR PERVASIVE COMPUTING: Hardware computing devices - pervasive information access devices-smart identification, smart card, labels, tokens - embedded controls, smart sensors, actuators -Human-machine interfaces, Biometrics - Various operating systems for pervasive devices. (6)

COMMUNICATION TECHNOLOGIES FOR PERVASIVE COMPUTING: Connecting the world – WWAN, SRWC, DECT, Bluetooth, IrDA – mobile internet – internet protocols. Audio networks - wireless data networks - pervasive networks - service oriented networks - network design issues - Managing smart devices in virtual environments, user-centered and physical environments - pervasive computing issues. (7)

APPROACHES FOR DEVELOPING PERVASIVE APPLICATIONS: Categorization - smart services for pervasive application development - developing mobile applications – presentation transcoding – device independent view component – heterogeneity of device platforms - Context Awareness and Mobility to build pervasive applications. (8)

CONTEXT AWARE SYSTEMS: Modelling - mobility awareness - spatial awareness - temporal awareness - ICT system awareness - Intelligent Systems - basic concepts- autonomous systems - reflective and self-aware systems - self management and autonomic computing - complex systems. (8)

LOCATION AWARE SYSTEMS: Basic concepts - DNS Server, server process, client process – location modelling – location update- location inquiry - location management– cost- network topology – mobility pattern, memory less movement Model, Markovian Model, Shortest distance model, Gauss-Markov model, Activity Based Model, Mobility Trace, Fluid-flow Model, Gravity Model. (7)

Location dependent information system - location dependent data – location aware queries – location dependent queries – moving object database queries - query transition steps in LDQ processing. (6)

TUTORIAL PRACTICE:

1. Create application with onClick, onKeyDown, onFocusChanged Event Handlers.
2. Create application with Toast Notifications.
3. Create application with Android's Advanced User Interface Functions.
4. Create Android Audio/Video Application.
5. Create application to Create, Modify and Query an SQLite Database.
6. Create application that Works with an Android Content Provider.
7. Create application that performs Data Storage and Retrieval from Android External Storage.
8. Create Location-Aware application that uses Proximity Alerts and Google Maps API.
9. Implementation of small packages to demonstrate all APIs.

Note: Implementations in android platform.

Total L:45+T:30=75**TEXT BOOKS:**

1. Stefan Poslad, "Ubiquitous Computing - Smart Devices, Environment and Interactions", John Wiley & Sons, 2011.

2. Adelstein F and Gupta S K S, "Fundamentals of Mobile and Pervasive Computing", Tata McGraw Hill, 2008.

REFERENCES:

1. Syed Ijlal Ali Shah, Mohammad Ilyas, Hussein T. Mouftah, "Pervasive Communications Handbook", CRC Press, 2015.
2. GuruduthBanavar, Norman Cohen, Chandra Narayanaswami, "Pervasive Computing: An Application-Based Approach", John Wiley & Sons, 2012.
3. Mohammed Ilyas and ImadMahgoub, "Mobile Computing Handbook", Auerbach Publications, 2009.
4. Burkhardt, Henn, Hepper and Rintdorff, Schaeck. "Pervasive Computing", Pearson Education, 2009.
5. AshokeTalukdar and RoopaYavagal, "Mobile Computing", Tata McGraw Hill, 2010.
6. A. Genco, S. Sorce: Pervasive Systems and Ubiquitous Computing, WIT Press, 2012.

20XDA7 MARKETING ANALYTICS**3 2 0 4****PREREQUISITES**

- 20XD43 PREDICTIVE ANALYTICS
- 20XD54 MACHINE LEARNING

MODELS AND METRICS: Marketing Analytics, Models and metrics- Market Insight – Market data sources, sizing, PESTLE trend analysis, and porter five forces analysis – Market segment identification and positioning. (8)

COMPETITIVE ANALYSIS AND BUSINESS STRATEGY: Competitor identification, Intelligence gathering, analysis and strategy- Analytics based strategy selection, with strategic models and metrics , Forecasting, balanced scorecard, and critical success factors. (8)

PRODUCT, SERVICE AND PRICE ANALYTICS: Conjoint analysis model, decision tree model, portfolio resource allocation, Pricing techniques, pricing assessment, pricing for business markets, price discrimination (12)

DISTRIBUTION AND PROMOTION ANALYTICS: Retail location selection, distribution channel evaluation, and multi-channel distribution, Promotion budget estimation and allocation, promotion metrics for traditional media and social media. (8)

SALES ANALYTICS: E Commerce sales mode, sales metrics, profitability metrics and support metrics. (9)

TUTORIAL PRACTICE:

1. Implementation of different metrics in marketing analytics.
2. Implementation of forecasting techniques for sales data.
3. Implementation of portfolio analysis.

Total: L: 45+T: 30 = 75**TEXT BOOK:**

1. Stephan Sorger, "Marketing Analytics – Strategic Models and Metrics", Admiral Press, 2013.
2. Simon Kingsnorth, "Digital Marketing Strategy: An Integrated Approach to Online Marketing", Kogan Page, 2019

REFERENCES:

1. Wayne L. Winston, "Marketing Analytics: Data-Driven Techniques with Microsoft Excel", Wiley, 2014
2. Simon Kingsnorth, "Digital Marketing Strategy: An Integrated Approach to Online Marketing", Kogan Page, 2019

20XDA8 WEB ANALYTICS**3 2 0 4****PREREQUISITES**

- 20XD54 MACHINE LEARNING

INTRODUCTION: Understanding web analytics – The foundations of Web analytics: Techniques and Technologies – Present and Future of Web analytics. (3)

DATA COLLECTION: Importance and Options –Web server log files: Click stream data – User submitted information – Web server performance data – Page tags –First and third party tracking. (12)

WEB ANALYTICS STRATEGY: Key performance indicators – Web analytics process – Heuristics evaluations – Site visits – Surveys – Measuring reach – Measuring acquisition – Measuring conversion – Measuring retention – Security and privacy implications of Web analytics. (13)

WEB ANALYTICS TOOLS: Content organization tools – Process measurement tools – Visitor segmentation tools – Campaign analysis tools – Commerce measurement tools – Google analytics – Omniture – Web trends – Yahoo! Web analytics. (12)

GOOGLE ANALYTICS: Key features and capabilities – Quantitative and qualitative data - Working of Google analytics – Privacy - Tracking visitor clicks, Outbound links and Non HTML files. (5)

TUTORIAL PRACTICE:

1. Data collection using different analytics tools.
2. Web log analysis.
3. Identifying reach.
4. Measuring acquisition.
5. Calculating the conversion from search to purchase.
6. Retain ratio computation.
7. Report generation.
8. Implementing the working of Google analytics.
9. Implementing the working of Yahoo! Analytics.
10. Implementing the working of Omniture.

Total L: 45+T:30=75

TEXT BOOKS:

1. Bernard J. Jansen, "Understanding User-Web Interactions via Web analytics", Morgan and Claypool, 2009.
2. Avinash Kaushik, "Web Analytics2.0", John Wiley & Sons, 2010.

REFERENCES:

1. Brian Clifton, "Advanced web metrics with Google analytics", John Wiley & Sons, 2012.
2. Jerri L. Ledford, Joe Teixeira and Mary E. Tyler, "Google Analytics", John Wiley & Sons, 2013.

20XDA9 COMPUTER GRAPHICS

3 2 0 4

PREREQUISITES

- 20XD23 DATA STRUCTURES
- 20XD32 LINEAR ALGEBRA

GRAPHICS INPUT - OUTPUT DEVICES: Raster scan Displays - Random scan displays - Direct view storage tubes - Flat panel displays - Joy Stick - Digitizers - Touch panels - LCD. **GRAPHICAL USER INTERFACE AND INTERACTIVE INPUT METHODS:** The user dialog - Input of graphical data - Input function - Interactive picture construction techniques - Virtual reality environments. (3)

OPENGL: Architecture, The OpenGL API, Primitives and Attributes, Color, Viewing, Control Functions, Programming Event-Driven Input, Transformations, OpenGL Extensions. (4)

TWO DIMENSIONAL GRAPHICS: Basic transformations - Matrix representation and homogeneous coordinates - Composite transformations - Line drawing algorithms: DDA and Bresenham's algorithms - Circle generation algorithms: Midpoint circle algorithm - Point clipping - Line clipping: Cohen Sutherland algorithm - Polygon clipping: Sutherland Hodgeman algorithm - Line covering. (8)

RASTER GRAPHICS: Fundamentals: generating a raster image, representing a raster image, scan converting a line drawing, displaying characters, speed of scan conversion, natural images - Solid area scan conversion: Scan conversion of polygons, Y-X algorithm, properties of scan conversion algorithms - Interactive raster graphics: painting model, moving parts of an image, feed back images. (8)

CURVES AND SURFACES: Parametric representation of curves - Bezier curves – B-Spline curves - Parametric representation of surfaces - Bezier surfaces - Curved surfaces - Ruled surfaces - Quadric surfaces – Concatenation of two curve segments – Order of Continuity. (5)

IMAGE PROCESSING FUNDAMENTALS: Sampling and Quantization, Image Enhancement - Histogram Processing, Filtering, Edge Detection, Image Transforms. (7)

THREE DIMENSIONAL GRAPHICS: 3D transformations - Viewing 3D graphical data - Orthographic, oblique, perspective projections - Hidden lines and hidden surface removal. (5)

FRACTAL-GEOMETRY METHODS: Tiling the plane - Recursively defined curves - Koch curves - C curves - Dragons - Space filling curves - Fractals - Grammar based models - Graftals - Turtle graphics - Ray tracing. (5)

TUTORIAL PRACTICE:

1. Drawing a line, circle using algorithms.
2. Implementation of 2D Transformations (translation, scaling, rotation).
3. Window – viewport simulation with various aspect ratios.
4. Polygon clipping and line clipping using algorithms.
5. Drawing a 2D curve using Bezier generation.
6. Drawing a 2D curve using B-Spline generation.
7. Model a primitive (car / Aircraft) with OpenGL API.
8. Simulate the primitive.
9. Animate the primitive.

Note: Algorithms in the Computer Graphics have to be implemented by the student using C++/ OpenGL. (Wherever applicable).

Total: L: 45+T: 30 = 75

TEXT BOOKS:

1. Donald Hearn and Pauline Baker M, "Computer Graphics Using OpenGL", Pearson Education, 2014.
2. William M. Newmann, Robert F.Sproull, "Principles of Interactive Computer Graphics", Tata McGraw Hill, 2014.
3. Foley James D., VandamAndries and Hughes John F., "Computer Graphics: Principles and Practice", Addison Wesley, 2013.

REFERENCES:

1. Rafael C. Gonzalez., and Richard Eugene Woods, "Digital Image Processing", Pearson Education, 2013.
2. Anil K. Jain., "Fundamentals of DigitalImage Processing", Pearson Education, 2016.
3. Angel, "Interactive Computer Graphics- A top down approach with OpenGL", Pearson Education, 2014.
4. HillF. S., "Computer Graphics Using OpenGL", PHI Learning Pvt. Ltd., 2012.

20XDAA ALGORITHMS FOR BIOINFORMATICS

3 2 0 4

PREREQUISITES

- 20XD12 BASICS OF COMPUTATIONAL BIOLOGY
- 20XD33 GRAPH THEORY
- 20XD52 STOCHASTIC MODELS
- 20XD54 MACHINE LEARNING

BIOLOGICAL DATA: DNA, RNA, Amino acids, Protein, Structural databases, genomes, Central dogma – Molecular Biology, Prediction of molecular function and structure. (7)

SEQUENCE COMPARISON ALGORITHMS: Dynamic Programming Algorithms, Edit Distance and Alignments, Alignment with Gap Penalties, Spliced Alignment, Similarity-Based Approaches to Gene Prediction, Multiple Alignment, HMM, Profile HMM Alignment, Viterbi Algorithm, Randomized Algorithms-Gibbs sampling, Genetic, Expectation Maximization Algorithm. (10)

EXHAUSTIVE SEARCH ALGORITHMS: Repeat finding Hash tables, Exact, approximate, combinatorial pattern matching, profile search, Motifs, Motif finding using Greedy algorithm, Dynamic Programming Algorithms, Divide-and-Conquer Algorithms, Keyword Trees, Suffix Trees, Heuristic Similarity Search Algorithms, BLAST: Sequence against a Database. (10)

GRAPH BASED ALGORITHMS: Shortest superstring problem – sequencing by hybridization – SBH as a Hamiltonian path problem – SBH as an Eulerian Path problem – Fragment assembly in DNA sequencing – Protein sequencing and Identification. (8)

CLUSTERING ALGORITHMS: Support Vector Machine, Ant Colony Algorithm, Clustering and Trees, Hierarchical Clustering, k- Means Clustering, Evolutionary Trees, Distance-Based, Additive Matrices, parsimony Tree Reconstruction. (10)

TUTORIAL PRACTICE:

1. Motif Finding.
2. Sequence Comparison.
3. Searching biological databases.

4. Applications of HMM.
5. Finding SBH using Hamilton cycle / Eulerian Path.
6. Implementation of some clustering algorithms.

Total: L: 45+T: 30 = 75

TEXT BOOKS:

1. Neil Jones and Pavel Pevzner, "An Introduction to Bioinformatics Algorithms", MIT Press, 2009.
2. Jonathan Pevsner, "Bioinformatics and Functional Genomics", John Wiley & Sons, 2009.

REFERENCE:

1. Mount, "Bioinformatics: Sequence and Genome Analysis", Cold Spring Harbor Laboratory Press, 2006.

20XDAB MATHEMATICAL MODELLING

3 2 0 4

PREREQUISITES

- 20XD41 OPTIMIZATION TECHNIQUES
- 20XD43 PREDICTIVE ANALYTICS
- 20XD52 STOCHASTIC MODELS

INTRODUCTION TO MODELING: Modeling process, Overview of different kinds of model. (3)

EMPIRICAL MODELING WITH DATA FITTING: Error function, least squares method; fitting data with polynomials and splines. (6)

CAUSAL MODELING AND FORECASTING: Introduction, Modelling the causal time series, forecasting by regression analysis, predictions by regression. Planning, development and maintenance of linear models, trend analysis, modelling seasonality and trend, trend removal and cyclical analysis, decomposition analysis. Modelling financial time series. Econometrics and time series models. Non seasonal models: ARIMA process for univariate and multivariate (10)

PORTFOLIO MANAGEMENT: Simple market models, risk-free assets, risky assets, discrete time market model. Portfolio - Introduction, risk and return of a portfolio. Portfolio with two-securities- Risk and expected return, risk-reward analysis, asset pricing models, portfolio optimization, Markowitz model and efficient frontier method, Capital Asset Pricing Models (CAPM). (11)

MODELING WITH BIOINFORMATICS: Introduction, Biological data- types, mode of collection, documentation and submission. Sequence alignment- Definition, significance, dot matrix method, dynamic programming- Global and local alignment tools, scoring matrices and gap penalties. Multiple sequence alignment: Iterative methods. Genetic algorithm, Hidden Markovian models, statistical methods, position specific scoring matrices. (15)

TUTORIAL PRACTICE:

1. Implementing curve fitting techniques for data and error analysis
2. Causal models for financial time series data- trend analysis, seasonality indices identification, cyclical analysis
3. Implementing Portfolio optimization models- Risk award analysis,
4. Markowitz model and efficient frontier method for determining optimal portfolios.
5. Implementation of capital asset pricing model
6. Multiple sequence alignment using Hidden Markovian models.

Total: L: 45+T: 30 = 75

TEXT BOOKS:

1. Giordano F R, Weir M D and Fox W P, "A First Course in Mathematical Modeling", Brooks/Cole, 2013.
2. Mount, DW, "Bioinformatics Sequence and genome analysis", Cold Spring Harbor Laboratory, 2004.
3. Capinski M. and Zastawniak T, "Mathematics for Finance: An Introduction to Financial Engineering", Springer, 2010

REFERENCES:

1. Hamdy A Taha, "Operation Research- An Introduction", Pearson Education, 2014.
2. Christoffersen P, "Elements of Financial Risk Management", Academic Press, 2012.
3. Alexander Isaev, Introduction to Mathematical Methods in Bioinformatics, Springer, 2006

20XDAC SOFTWARE ENGINEERING

3 2 0 4

PREREQUISITES

- 20XD24 OBJECT ORIENTED PROGRAMMING

SYSTEM METHODOLOGIES: System - System Development - Types of systems – People involved in the systems development - The project life cycle models - Need for Software Engineering - Objectives and Benefits of Software Engineering - Factors that influence Quality & Productivity – Quality attributes of a software product -Software Development Models (5)

SOFTWARE PLANNING: Software Project Estimation - Different techniques of Project cost estimation Decomposition techniques - COCOMO & PUTNAM models- **SOFTWARE ANALYSIS:** Functional and non-functional requirements- Requirements engineering process – Elicitation – validation and management – Principles of Analysis - Analysis tools - Analysis Models (8)

DESIGN CONCEPTS AND PRINCIPLES: Design process and concepts – Levels of Design - Coupling – Cohesion -Design Tools - Software Design Methods – Design Techniques - Design of Input and control - Design of Output. (8)

SOFTWARE QUALITY and TESTING :Quality Assurance versus Quality Control-The Cost of Quality-Software Quality Factors - Importance –Testing Types -Testing Techniques- Test Design-Test Scenarios-Test Cases Design-types-Test Scenario-Test cases for sample case studies - Smoke Testing-Sanity Testing-Regression Testing, Re-Testing, Ad-Hoc Testing-Gorilla Testing. Test Management-Test Policy-Test Strategy-Test Plan-Test Process-Levels of Testing-Testing Metrics-Review-Walk through Inspection-Desk Checking - Testing Tools- Software Metric -Software quality - SEI CMM and ISO-9001 -Software Risk and Reliability (10)

OBJECT ORIENTED SYSTEMS DEVELOPMENT: Object Oriented Systems Development life Cycle - Object oriented methodologies -Rational Unified Process – Unified Modeling Language –Process workflows – Importance of Modeling – Types of Modeling-Software Design patterns- Business Aspects of Software Engineering. (8)

AGILE SOFTWARE DEVELOPMENT- Traditional Model vs. Agile Model- Agile Fundamentals- Generating User Stories - Agile software development methods –Agile management (6)

TUTORIAL PRACTICE:

Case Studies –Software project Management- Model selection- Agile Frameworks- Scrum- Kanban- Lean Startup –Defect tracking and testing tools

Total L: 45+T:30=75

TEXT BOOKS:

1. Roger S Pressman, Bruce R Maxim “Software Engineering – A Practitioner’s Approach”, McGraw Hill, 2019.
2. John Hunt, “The Unified Process for Practitioners”, Springer, 2014.

REFERENCES:

1. Boriz Beizer, “Software System Testing & Quality Assurance”, Thomson Publishing group, 2016.
2. Shari Lawrence Pfleeger, “Software Engineering Theory and Practice”, Pearson Education, 2017.
3. Grady Booch, James Rumbaugh and Ivar Jacobson, “The Unified Modeling Language User Guide”, Addison Wesley,2011.

20XDAD SOFTWARE PATTERNS

3 2 0 4

PREREQUISITES

- 20XDAC SOFTWARE ENGINEERING

REUSABLE PATTERNS: Reusable object oriented software – Motivation - Best design practices of object oriented software - Benefits of patterns – Definition – Types - Pattern description - How design patterns solve design problems - Pattern Language - IDIOMS. (10)

DESIGN PATTERNS: Creational pattern: Abstract factory – Builder - Factory method – Prototype – Singleton, Structural patterns: Adapter – Bridge – Composite – Decorator – Façade – Flyweight - Proxy, Behavioral patterns: Command – Interpreter - Iterator, Mediator - Memento – Observer - State – Strategy - Template method – Visitor - Chain of Responsibility, Case Studies. (15)

ARCHITECTURAL PATTERNS: From Mud to Structure: Layers - Pipes and Filters - Blackboard, Interactive Systems: Model View Controller (MVC),Presentation Abstraction Control, Adaptable Systems – Reflection, Microkernel. Anti-Patterns.Case studies. (10)

REFACTORING: What is refactoring, Principles in refactoring, Bad smells in code, Refactoring Techniques - Composing methods, Moving features between objects, Organizing data, Simplifying conditional expressions, Making method calls simpler,

Dealing with generalization. Design Refactoring – Technical Debt, Design Smells, Abstraction Smells, Encapsulation Smells, Modularization Smells, Hierarchy Smells, Architectural Refactoring. Refactoring Tools. (10)

TUTORIAL PRACTICE:

1. ATM Simulation – Singleton pattern.
2. Image Viewer Application – Bridge pattern.
3. Address Book Maintenance – Prototype pattern.
4. US, Canada Tax and Freight charges – Factory Method pattern.
5. The Fast Food Franchise – Builder pattern.
6. Computer Models with different architectures – Abstract Factory pattern.
7. An Evaluation Application – Decorator pattern.

Total: L:45+T:30 = 75

TEXT BOOKS:

1. Erich Gamma, Richard Helm, Ralph Johnsons and John Vlissides, "Design Patterns: Elements of Reusable Object-Oriented Software", Pearson Education, 2004.
2. Frank Buschman, RegineMeunier, Hans Rohnert, Peter Sommerland and Michael Stal, "Pattern-Oriented SoftwareArchitecture: A System of Patterns", John Wiley& Sons, 2011.
3. Martin Fowler, Kent Beck, William Opdyke and Don Roberts, "Refactoring: Improving the Design of Existing Code", Addison-Wesley Longman, 2012.

REFERENCES:

1. Girish Suryanarayana, Ganesh Samarthyam, and Tushar Sharma, "Refactoring for Software Design Smells: Managing Technical Debt", Morgan Kaufmann Publishers, 2014.
2. Len Bass, Paul Clements, and Rick Kazman, "Software Architecture in Practice", Addison Wesley, 2013.

20XDAE APPLIED GRAPH ALGORITHMS

3 2 0 4

PREREQUISITES

- 20XD25 THEORY OF PROBABILITY
- 20XD33 GRAPH THEORY
- 20XD34 ADVANCED DATA STRUCTURES

BASIC CONCEPTS: Graphs – representations, Planar graphs- Euler's formula, crossing number, doubly connected edge list data structure, Algorithm complexity – time and space. (4)

GEOMETRIC GRAPHS: Planar straight line graph, Euclidean minimum spanning tree algorithm, Art gallery problem, visibility graphs, Computing point visibility for polygons with and without holes. (10)

VLSI PHYSICAL DESIGN: Manhattan distance, overlap graph, containment graph, interval graph, neighborhood graph, hypergraphs, Rectilinear minimum spanning tree, Rectilinear Steiner minimum tree, Kernighan-Lin partitioning algorithm, Partitioning based algorithms for floor planning and placement, Lee's algorithm for routing, Shadow propagation algorithm for compaction. (11)

VERTEX-PURSUIT GAME: Graph homomorphism, retracts, cops and robbers - cop number (k), bounds, cop-win graphs. Polynomial algorithm for fixed k, NP-hard with k not fixed. (10)

VORONOI DIAGRAMS: plane sweep algorithm, Voronoi Diagram – definition and properties, Fortune's algorithm. Delaunay triangulation. (10)

TUTORIAL PRACTICE:

1. Storing planar graphs using doubly connected edge list.
2. Borůvka's Euclidean minimum spanning tree algorithm.
3. Computing point visibility for polygons with and without holes.
4. Polynomial time approximation algorithms for vertex guarding.
5. Vertex guard algorithm using set cover.
6. Kernighan-Lin partitioning algorithm.
7. Partitioning based algorithms for floorplanning and placement.
8. Lee's algorithm for routing.
9. Shadow propagation algorithm for compaction.
10. Polynomial algorithm for fixed cop number.
11. Plane sweep algorithm.
12. Fortune's algorithm for Voronoi diagram.
13. Divide and conquer Delaunay triangulation.

Total: L: 45+T: 30 = 75

TEXT BOOKS:

1. Thomas H. Cormen, Charles E. Leiserson and Ronald L. Rivest, "Introduction to Algorithms", PHI Learning, 2013.
2. Ghosh S. K., "Visibility Algorithms in the Plane", Cambridge University Press, 2007.
3. Naveed A. Sherwani, "Algorithms for VLSI Physical Design Automation", Springer, 2013

REFERENCES:

1. Anthony Bonato, "The Game of Cops and Robbers on Graphs", American Mathematical Society, 2011.
2. Mark de Berg, Otfried Cheong, Marc van Kreveld, "Computational Geometry - Algorithms and Applications", Springer Verlag, 2011.

20XDAF GAME THEORY**3 2 0 4****PREREQUISITES**

- 20XD41 OPTIMIZATION TECHNIQUES

INTRODUCTION: Game theory the theory of rational choice – Interacting decision makers. (2)

NASHEQUILIBRIUM: Strategic games – Best response – Dominance – Examples from economics, business, environment, military - Symmetric games and symmetric equilibria. Illustrations: Cournot's model of oligopoly, Electoral competition. (7)

MIXED STRATEGIES: Dominance – Equilibrium – Illustrations: Expert diagnosis, Reporting a crime – Formation of players' beliefs. (4)

EXTENSIVE GAMES WITH PERFECT INFORMATION: Strategies and outcomes – Nash equilibrium – Subgame perfect equilibrium - Stackelberg's model of duopoly, Buying votes – Illustrations: Entry into a monopolized industry, Electoral competition with strategic voters, Committee decision making. (7)

GAMES WITH IMPERFECT INFORMATION: Bayesian games – Examples – Strategic information – Transmission – Agenda Control with imperfect Information – Signaling games - Education as a signal of ability. (6)

REPEATED GAMES: The prisoner's dilemma – Finitely repeated and infinitely repeated – Strategies – Nash equilibrium – Subgame – Perfect equilibria and the one – deviation – Property – General results – Finitely replaced games – Variation on a theme: Imperfect observability. (6)

INTRODUCTION TO ALGORITHMIC GAME THEORY: Auction and mechanism design basics - the Vickrey auction - Sponsored Search Auction - Social choice theory - VCG mechanism. Algorithmic Aspects of Equilibria: Existence and computational complexity equilibria - Market Equilibrium - Correlated Equilibrium. Quantifying the inefficiency of equilibria: Routing Games and Congestion Games - Network Formation - Price of Anarchy and Price of Stability - Bandwidth Sharing. (13)

TUTORIAL PRACTICE:

Implement the following using GAMBIT Software.

1. Display the Normal Form game.
2. Find all strongly dominant strategies.
3. Find all weakly dominant strategies.
4. Find all very weakly dominant strategies.
5. Find Strongly dominant strategy equilibrium, if one exists.
6. Find Weakly dominant strategy equilibrium, if one exists.
7. Find Very Weakly dominant strategy equilibrium, if one exists.
8. Find all pure strategy Nash Equilibria, if they exist.
9. Displaying and solving the Extensive Form games.

Total: L: 45+T: 30 = 75

TEXT BOOKS:

1. Martin J. Osborne, "An Introduction to game theory", Oxford University Press, 2004.
2. Nisan N., Roughgarden T., Tardos E., Vazirani V., "Algorithmic Game Theory", Cambridge University Press, Cambridge, 2007.

REFERENCES:

1. Ken Binmore, "Playing for Real: A Text on Game Theory", Oxford University Press, 2007.
2. David Easley, Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.

3. Matthew O. Jackson, "Social and Economic Networks", Princeton University Press, 2008.
4. Yoav Shoham, Kevin Leyton-Brown, "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations", Cambridge University Press, 2008.

20XDAG SOCIAL NETWORK DATA ANALYTICS

3 2 0 4

PREREQUISITES

- 20XD33 GRAPH THEORY
- 20XD34 ADVANCED DATA STRUCTURES

INTRODUCTION: On line Social Networks – Terminologies - Research topics. (3)

STATISTICAL PROPERTIES OF SOCIAL NETWORKS: Static properties – Dynamic properties. (5)

RANDOM WALKS IN SOCIAL NETWORKS – Random walks on graphs – Algorithms – Applications. (7)

COMMUNITY DISCOVERY IN SOCIAL NETWORKS: Communities – Core methods – Applications. (8)

NODE CLASSIFICATION IN SOCIAL NETWORKS: Methods using local classifiers – Random walk based methods – Algorithms - Applications - Node classification to large scale social networks. (10)

MODELS AND ALGORITHMS: Social influence analysis – Expert location in social networks – link prediction. (12)

TUTORIAL PRACTICE:

Do the following on Twitter, Facebook or any social network data set.

1. Study of the different metrics of social network.
2. Visualization of social network.
3. Power law distribution of social data.
4. Node classification using iterative method.
5. Node classification using label propagation.
6. Usage of Graph Laplacian.

Total: L: 45+T: 30 = 75

TEXT BOOK:

1. Charu C. Aggarwal, "Social Network Data Analytics", Springer Publications, 2011.
2. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.

REFERENCES:

1. Marshall Sponder "Social Media Analytics Effective tools for building, interpreting, and using metrics", McGrawHill, 2011.
2. Stanley Wasserman, Katherine Faust, "Social network analysis: Methods and applications", Cambridge University Press, 1995.
3. Stephen Borgatti, Martin Everett, Jeffrey Johnson, "Analysing Social Networks", SAGE Publications Ltd., 2013.

20XDAH HEALTH CARE ANALYTICS

3 2 0 4

PREREQUISITES

- 20XD54 MACHINE LEARNING
- 20XD82 NATURAL LANGUAGE PROGRAMMING

HEALTHCARE DATA: Data Sources and Basic Analytics – Applications and Practical Systems for Healthcare (12)

IMAGE ANALYSIS AND OBJECT DETECTION – Electronic Health Records - Components, Benefits, Challenges, Biomedical Image Analysis- Biomedical imaging modalities, Object Detection – Image Segmentation – Feature Extraction (12)

MINING OF SENSOR DATA – Biomedical Signal Analysis – Genome Data Analysis for Personalized Medicine (10)

NLP FOR CLINICAL TEXT – Social Media Analytics for Healthcare (Disease outbreak) - Temporal Data Mining (Disease Progression Modelling) (11)

TUTORIAL PRACTICE:

APPLICATIONS / CASE STUDIES- Data Analytics for Pervasive Health, Data Analytics for Pharmaceutical Discoveries, Clinical Decision Support Systems, Medical Imaging Case Studies (30)

Total L: 45+T:30 = 75

TEXT BOOK:

1. Chandan K. Reddy, Charu C. Aggarwal Healthcare Data Analytics Chapman and Hall/CRC,2015
2. Trevor L. Strome, Healthcare Analytics for Quality and Performance Improvement, 2013

REFERENCES:

1. Hui Yang, Eva K. Lee, Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, John Wiley & Sons, 2016.
2. Christo El Morr and Hossam Ali-Hassan, "Analytics in Healthcare-A practical Introduction", Springer, 2019.

20XDAI CYBER SECURITY ANALYTICS

3 2 0 4

PREREQUISITES

- 20XD54 MACHINE LEARNING
- 20XD82 NATURAL LANGUAGE PROGRAMMING

INTRODUCTION - Cybersecurity -Data Mining- Machine Learning - Review on Cybersecurity Solutions - Proactive Security Solutions - Reactive Security Solutions - Successful ML applications in Cyber security (3)

SUPERVISED LEARNING FOR MISUSE/SIGNATURE DETECTION -Misuse/Signature Detection -Machine Learning in Misuse/Signature Detection -Machine-Learning Applications in Misuse Detection – Malware Analysis - Static – Dynamic – Smartphone security (9)

MACHINE LEARNING FOR ANOMALY DETECTION –Introduction -Anomaly Detection -Machine learning in Anomaly Detection Systems -Machine-Learning Applications in Anomaly DetectionSupervised Anomaly detection - Spam detection - Unsupervised Anomaly Detection (8)

MACHINE LEARNING FOR PROFILING NETWORK TRAFFIC – Introduction - Network Traffic Profiling and Related Network Traffic Knowledge -Machine Learning and Network Traffic Profiling -Data-Mining and Machine-Learning Applications in Network Profiling - Network IDS – DDOS -Emerging Challenges in Intrusion Detection – Log Analysis (9)

BOTNETS AND INSIDER THREATS - Botnet topologies, botnet detection using NetFlow analysis - Botnet detection using DNS analysis, introduction to insider threats, Insider threat profiles -masquerader detection strategies - Using honey tokens for insiderthreat (8)

WEB SECURITY, EMAIL, SOCIAL NETWORK SECURITY: Web threat detection via web server log analysis - Alert aggregation for web security - Spam detection, Phishing detection -: Detecting compromised accounts, detecting social network spam (8)

TUTORIAL PRACTICE:

1. Identifying anomalies in IT systems using correlations and behavioral analytics
2. Searching historical data for attack patterns or signatures similar to known attacks.
3. Predicting CyberSecurity Incidents using Text mining
4. Study on whether intrusion detection should be a layer in the defense in-depth approach to securing systems
5. Analysing Security breach at Target

Total L: 45+T:30 = 75

TEXT BOOK:

1. Dua, Sumeet, and Xian Du. "Data Mining and Machine Learning in Cyber Security", CRC press, 2016.
2. Jacobs Jay and Bob Rudis, "Data Driven Security Analysis, Visualization, and Dashboards", John Wiley & Sons, 2014.

REFERENCES:

1. Stolfo, Salvatore J., Bellovin S M, Hershkop S., Keromytis, A.D., Sinclair S, Smith.S, " Insider Attack and Cyber Security: Beyond The Hacker", Springer, 2008.

- Bhattacharyya, Dhruva Kumar, and Jugal Kumar Kalita. "Network Anomaly Detection: A Machine Learning Perspective", CRC Press, 2013.

20XDAJ INTERNET OF THINGS

3 2 0 4

PREREQUISITES

- 20XD44 OPERATING SYSTEMS
- 20XD53 COMPUTER NETWORKS
- 20XD61 PARALLEL AND DISTRIBUTED COMPUTING

INTRODUCTION : Machine to Machine (M2M) -- Features and Definition of IoT-- Recent Trends in the Adoption of IoT -- Societal Benefits. (2)

IoT ARCHITECTURE: Functional Requirements - IoT Enabling Technologies – IPv6 - Basic Architecture – Components of IoT: Embedded Computation Units, Microcontrollers, System on Chip (SoCs) - Sensors – Actuators – Communication Interfaces. (7)

RF COMMUNICATION TECHNOLOGIES IN IoT: Wireless Sensor Networks (WSN): Overview, Fault Tolerance - RFID – NFC - Low Power Personal Area networks (LowPAN): Overview, 6LowPAN, IEEE 802.15.4, BLE, Zigbee, Zwave, and Thread - Wi-Fi - Low Power Wide Area Networks (LPWAN): Concepts and features, SigFox, LoraWAN, LPWAN-3GPP, Comparing different LPWAN technologies. (7)

APPLICATION LAYER PROTOCOLS IN IoT: Rest Architecture - HTTP – CoAP: Architecture, Features, Applications - MQTT: Architecture, Feature, Applications - Comparing different IoT Application Layer Protocols. (7)

MODERN NETWORKING: Cloud Computing: Introduction to the Cloud Computing, Cloud service options, Cloud Deployment models, Load balancing, Hypervisors, Comparison of Cloud providers - Introduction to SDN: Data Plane, Control Plane, Application Plane - OpenFlow Protocol – Relevance of SDN to IoT (8)

SECURITY IN IoT: IEEE 802.11 Wireless Networks Attacks: Basic Types, WEP Key Recovery Attacks, Keystream Recovery Attacks against WEP – RFID Security – Security Issues in ZigBEE: Eavesdropping Attacks, Encryption Attacks – Bluetooth Security: Threats to Bluetooth Devices and Networks – Blockchain in IoT security. (10)

PROTOTYPING: Prototyping embedded devices- Open Source versus Closed Source- Embedded Computing Basics- Arduino- Raspberry Pi- Implementation. (2)

APPLICATIONS IN IoT: Smart homes – Energy – Health Care – Smart Transportation – Smart Living – Smart Cities- Smart Grid – Smart Agriculture. (2)

TUTORIAL PRACTICE:

1. Simulating Wireless Sensor Networks
2. Connected Vehicle applications
3. Traffic Signal Monitoring & Control System
4. Smart home automation
5. IOT Based Person/Wheelchair Fall Detection
6. Gas Pipe Leakage Detector using Robot
7. Smart Energy Meter Monitoring
8. IOT Based Fire Department Alerting System

Total L:45+P:30=75

TEXT BOOKS :

1. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, 2011
2. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons, 2014.
3. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", John Wiley & Sons, 2012.

REFERENCES :

1. Michael Miller, "The Internet of Things", Pearson Education, 2015.
2. Massimo Banzì, "Getting Started with Arduino", Shroff Publishers & Distributors, 2014
3. Simon Monk, "Programming Arduino: getting started with sketches" McGraw Hill, 2012
4. Vedat Coskun, Kerem Ok, Busra Ozdenizci, "Near Field Communication from theory to practice", John Wiley & Sons, 2011
5. ARichard Wentk, "Teach yourself visually Raspberry Pi", John Wiley & Sons, 2014

20XDAK CLOUD COMPUTING**3 2 0 4****PREREQUISITES**

- 20XD61 PARALLEL & DISTRIBUTED COMPUTING

INTRODUCTION TO PARALLEL AND DISTRIBUTED COMPUTING: Introduction, Architecture and Distributed computing models and technologies SOA, Web Services. (5+5)

GRID, CLUSTER AND UTILITY COMPUTING: Introduction, Architecture, Pros & Cons, Real time applications. (4+2)

INTRODUCTION TO CLOUD COMPUTING: Definition, History, Comparison of Cloud Computing with Grid, Cluster and Utility Computing, Deployment models – Private, Public, Hybrid and Community - Pros and Cons of Cloud Computing. SaaS, PaaS, IaaS etc. (8+5)

VIRTUALIZATION: Types of Virtualization, Tools for Virtualization, Architecture of VMM, Virtualization for Cloud. (4+3)

ADVANCED WEB TECHNOLOGIES: AJAX and Mashup – Programming examples using applications. (4+2)

MAP REDUCE PARADIGMS: Introduction, GFS Architecture, HDFS Architecture, Hbase, Google big Table, Amazon's (key value) pair storage and Microsoft's Azure infrastructure, Map reduce programming examples. (6+3)

CLOUD COMPUTING FRAMEWORK: Amazon EC3, S3 storage services, Aneka framework, IBM blue Cloud. (7+5)

APPLICATIONS: Distributed search engine and distributed data mining in the cloud (7+5)

TUTORIAL PRACTICE:

Implement the following problems

1. Implement a distributed search engine.
2. Implement distributed data mining for an application.
3. Package to be developed using Virtualization and other cloud concepts.

Total: L: 45 +T:30=75**TEXT BOOK:**

1. Anthony T. Velte, Toby J. Velte and Robert Elsenpeter "Cloud Computing: A Practical Approach", McGraw Hill, 2012.
2. Liu M. L., "Distributed Computing Principles and Applications", Pearson Education, 2012.

REFERENCES:

1. Ron Schmelzer "XML and Web Services", Pearson Education, 2012.
2. Dean J. and Ghemawat S., " MapReduce: Simplified Data Processing on Large Clusters", In Proceedings of Operating Systems Design and Implementation (OSDI), San Francisco, 2004.
3. DeCandia et al G., "Dynamo Amazon's Highly Available Key-Value Store", Proceedings of the 21st ACM Symposium on Operating Systems Principles, Stevenson, 2007.

20XDAL LARGE SCALE MACHINE LEARNING**3 2 0 4****PREREQUISITES**

- 20XD41 OPTIMIZATION TECHNIQUES
- 20XD54 MACHINE LEARNING

HIGH DIMENSIONAL SPACE- Properties of High-Dimensional Space - Gaussians in High Dimension -Bounds on Tail Probability- Applications of the tail bound - Convex analysis (7)

RANDOM PROJECTIONS AND APPLICATIONS IN DIMENSIONALITY REDUCTION Random Projection and Johnson-Lindenstrauss Theorem - Best-Fit Subspaces and Large-Scale SVD using Random Projections - Spectral Decomposition (6)

OPTIMIZATION FOR LARGE SCALE MACHINE LEARNING First-order Methods for Large Scale Optimization - Stochastic gradient with sub sampling - Accelerating SGD with preconditioning and adaptive learning - Noise reduction - Dynamic sample size methods - Second order methods- Quasi-Newton methods - Distributed optimization - Derivative free optimization – Contrastive divergence – Markov Chain Monte Carlo – Gibbs sampling (14)

RANDOM MATRICES Introduction to random matrix theory - Concentration of measure and random matrices - Large Covariance matrix estimation (8)

SPARSE RECOVERY: THEORY AND ALGORITHMS Introduction to sparse recovery - A Statistical View of Sparse Recovery - Noiseless Sparse Recovery - Approximations - Sampling theorem - Elastic Net - Fused Lasso - Low-rank Matrix Recovery - Sketching and Randomized Linear Algebra - Approximate nearest neighbour in high dimensional data - Locality sensitive data structures (10)

TUTORIAL PRACTICE:

1. Implementing and evaluating gradient descent for empirical risk minimization on a multinomial logistic regression task on the MNIST dataset.
2. Using different sampling schemes for stochastic gradient descent.(random sampling, sequential sampling, sub sampling)
3. Applications using Distributed ML - Spark MLlib and Graph labs
4. Application using Sparse models
5. Finding neighbours using Locality Sensitive Hashing, min hash techniques

Total: L: 45 +T:30=75

TEXT BOOKS:

1. Martin J, Wain Wright, "High-dimensional statistics: A non-asymptotic viewpoint", Cambridge University Press, 2019
2. T. Tao, "Topics in random matrix theory," American Mathematical Society, 2012

REFERENCES:

1. Prateek Jain and Purushottam Kar "Non-convex optimization for machine learning", Now publishers Inc., 2017
2. Greg W, Alice Guionnet, Ofer Zeitouni, "An Introduction to Random Matrices", Cambridge press, 2010

20XDAM WIRELESS NETWORKS

3 2 0 4

PREREQUISITES

- 20XD53 COMPUTER NETWORKS

WIRELESS FUNDAMENTALS: Introduction to cellular networks,-wireless local area networks- Spectrum allocations – Radio propagation models-Narrowband digital modulation and wireless fading environments. – Modern Communications Systems – MAC – SDMA – TDMA – FDMA - CDMA - Cellular and Ad-hoc-Concepts. (7)

WLAN TECHNOLOGIES: wireless network architectures – 802.11 PHYs – 802.11 MAC – WPA and 802.11i: Security – 802.11e: MAC Enhancements for Quality of Service – Related Wireless Standards (Hyperlan, HomeRF, Bluetooth, Zigbee, Wireless USB)- WiFi and Wi MAX Standards. (8)

AD HOC AND SENSOR NETWORKS: Ad hoc Network- Characteristics- Table-driven and Source-initiated On Demand routing protocols, Hybrid protocols - Routing in intermittently connected mobile networks. Wireless Sensor networks- Classification, MAC and Routing Protocols. (8)

MOBILE NETWORK AND TRANSPORT LAYERS: Mobile IP – Dynamic Host Configuration Protocol-Mobile Ad Hoc Routing Protocols–Multicast routing-TCP over Wireless Networks – Indirect TCP – Snooping TCP – MobileTCP – Fast Retransmit / Fast Recovery – Transmission/Timeout Freezing-Selective Retransmission – Transaction Oriented TCP- TCP over 2.5 / 3G wireless Networks. (8)

WIRELESS PANS MANs – Physical and MAC layer details, Wireless PANS – Architecture of Bluetooth Systems, Physical and MAC layer details, Standards-WLAN deployment issues- Interference – Resource Allocation (6)

FUTURE TRENDS: Emerging WLAN Related Technologies – 802.11 Trends – Cellular – 802.16 – 802.20 – 802.22 – UWB, Cognitive Radios, RFID – 4G and Data Communications Convergence. (8)

TUTORIAL PRACTICE:

1. Study of NS-2 simulator.
2. Simulation of a IEEE 802.11 LAN under various conditions using NS-2 simulator.
3. Simulation of a priority MAC protocol using NS-2 simulator.
4. Simulation of different routing protocols using simulators.
5. Simulation of TCP over error-prone wireless network using NS-2 simulator.
6. Development of Mobile application using blue tooth.

Total: L:45+T:30 = 75

TEXT BOOKS:

1. Gary. S. Rogers and John Edwards, "An Introduction to Wireless Technology", Pearson Education, 2012.
2. SivaRam Murthy C and B.S Manoj, "Ad hoc Wireless Networks Architecture and Protocols", Pearson Education, 2005.
3. KavehPahlavan, Prashant K. Krishnamurthy, "Principles of wireless networks : A unified approach", John Wiley& Sons, 2011.

REFERENCES:

1. William Stallings, "Wireless Communication and Networks", Pearson Education, 2009.
2. Dharma Prakash Agrawal and Qing-An Zeng, "Introduction to Wireless and Mobile Systems", Thomson Press, 2007.
3. Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks-An Information Processing Approach", Elsevier, 2004.
4. Clint Smith, P.E. and Daniel Collins, "3G Wireless Networks", Tata McGraw Hill, 2007.
5. Ivan stojmenovic, "Handbook of wireless networks and mobile computing", John Wiley& Sons, 2006.

20XDAN SURVIVAL ANALYTICS**3 2 0 4****PREREQUISITES**

- 20XD25 THEORY OF PROBABILITY
- 20XD52 STOCHASTIC MODELS
- 20XD54 MACHINE LEARNING

FEATURES OF SURVIVAL DATA:Censoring, Time scale and the origin of time, Basic lifetime functions, Criteria for performing survival analysis (7)

DESCRIPTIVE APPROACHES: KapMeier estimates, Life table models, Group comparison of survival functions (5)

COX PROPORTIONAL HAZARD REGRESSION: The Cox semi-parametric hazard model, Estimation of Cox hazard model with tied survival times; The hazard rate model with time-dependent covariates, Stratified proportional hazard rate model (8)

COUNTING PROCESS AND DIAGNOSTICS OF COX MODEL:The martingale theory- Martingale central limit theorems, Cox-Snell residuals, Schoenfeld residuals, Score residuals, Deviance residuals, Residual analysis on the Cox model (10)

CLASSIFICATION: Classification and regression trees (CART), Chi-Squared automatic interaction detector (CHAID). (10)

CASE STUDIES (5)

TUTORIAL PRACTICE:

Implement the following problems using R/ Perl Programming

1. Classification Algorithms and Cox Model.
2. Extract information from customer support data.
3. KapMeier estimates, Life table models
4. Residual analysis on the Cox model

Total L: 45+T:30=75**TEXT BOOKS:**

1. Jolliffe I. T., "Principal Components Analysis (Springer Series in Statistics)", Springer publications, 2013.
2. Xian Liu, "Survival Analysis: Models and Applications", John Wiley& Sons, 2013.

REFERENCES:

1. David G Kleinbaum, Mitchel Klein, Survival Analysis, Springer, 2012.
2. Johannes Ledolter, "Data Mining and Business Analytics with R", John Wiley & Sons, 2013.

20XDAO RANDOMIZED ALGORITHMS**3 2 0 4****PREREQUISITES**

- 20XD25 THEORY OF PROBABILITY
- 20XD34 ADVANCED DATA STRUCTURES
- 20XD51 DESIGN AND ANALYSIS OF ALGORITHMS
- 20XD52 STOCHASTIC MODELS

INTRODUCTION: Randomized algorithms, generation of random numbers, randomized quick sort, Karger's min-cut algorithm Las Vegas and Monte Carlo algorithms, computational models and complexity classes. (5)

PROBABILISTIC INEQUALITIES: Union bound, Markov and Chebyshev inequalities-Applications- Occupancy problem, randomized selection- coupon collector's problem, the Chernoff bound- routing in a parallel computer- a wiring problem.(6)

PROBABILISTIC METHOD: Overview of the method-maximum satisfiability – finding a large cut, Independent Sets (4)

MARKOV CHAINS AND RANDOM WALKS: Markov chains, Random walk on graphs – connectivity in undirected graphs – Expanders and rapidly mixing random walks, Probability amplification of random walks on expanders (7)

DATA STRUCTURES AND GRAPH ALGORITHMS: Random Treaps, hashing – hash tables – perfect hashing, skip lists – Fast min-cut. (6)

ONLINE ALGORITHMS: Paging problem-adversary models- paging against an oblivious adversary-relating the adversaries-the adaptive online adversary, k-server problem. (4)

PARALLEL AND DISTRIBUTED ALGORITHMS: Sorting on a PRAM – Maximal Independent sets-parallel matching (5)

NUMBER THEORETIC ALGORITHMS:, Polynomial roots and factoring, primality testing. (4)

DERANDOMIZATION: The method of Conditional Probabilities – Derandomizing max-cut algorithm – Constructing pair wise independent values modulo a prime – Pair wise independent – large cut. (4)

TUTORIAL PRACTICE:

1. Find solution for s-t min-cut problem adapting min cut algorithm.
2. Problems using treaps data structure.
3. Problems using randomized hash table.
4. Comparison of performance analysis of Karger's min cut with fast min-cut algorithms.
5. Randomized primality testing.
6. Problem using K-server on-line algorithms.
7. Real time application of parallel algorithms for maximum independent set.

Total L:45+TP:30 = 75

TEXT BOOKS:

1. Motwani R and Raghavan P, "Randomized Algorithms", Cambridge University Press, 2010.
2. Michael Mitzenmacher and Eli Upfal, "Probability & Computing: Randomized Algorithms and Probabilistic Analysis", Cambridge University Press, 2009.

REFERENCES:

1. Thomas H Cormen, Charles E Leiserson and Ronald L Rivest, "Introduction to Algorithms", MIT Press, 2009.
2. James Aspens, "Notes on Randomized algorithms", Yale University, 2013,

OPEN ELECTIVES

20XDO1 COMPUTATIONAL FINANCE

3 2 0 4

PREREQUISITES

- 20XD11 CALCULUS AND ITS APPLICATIONS
- 20XD25 THEORY OF PROBABILITY
- 20XD52 STOCHASTIC MODELS

INTRODUCTION: Law of one price – Risk neutral pricing – Arbitrage and Hedging – Financial Products and capital markets – Futures, Forwards and options – Options pricing problem and three types of solutions. (3)

MATHEMATICAL PRELIMINARIES : Conditional expectation – Sigma Algebra – Filtrations, Time series analysis - Covariance stationary – autocorrelations - MA(1) and AR(1) models, Stochastic Calculus - Random walk – Brownian motion – Martingales – Ito's Lemma. (12)

PORTFOLIO THEORY - Introduction - Portfolio theory with matrix algebra - Review of constrained optimization methods, Markowitz algorithm, Markowitz Algorithm using the solver and matrix algebra – Portfolio choice and linear pricing – Statistical analysis of efficient portfolios. (10)

BASIC OPTIONS THEORY – Definitions – Pay off diagrams – Single period binomial options theory – Multi period binomial options theory – Real options – American options, Simulation methods for options pricing – Random variable generation – simulation of stochastic processes. (10)

THE CAPITAL ASSET PRICING (CAP) AND RISK BUDGETING - Mean variance portfolio theory – Asset returns – Variance as a risk measure - The one and two fund theorems, The capital market line – CAP as a pricing formula – Systematic and unsystematic risk – Euler's theorem – Asset contributions to volatility – beta as a measure of portfolio risk , Limitations of mathematical models in finance. (10)

TUTORIAL PRACTICE:

1. Problems using Capital Asset Pricing model.
2. Problems using Auto correlation.
3. Plot time series data and find outliers
4. Problems using Autoregressive models
5. Problems using Moving average models
6. Monte Carlo Simulation of options pricing

Total L: 45+T:30 = 75

TEXT BOOKS:

1. David Ruppert, "Statistics and Data Analysis for Financial Engineering", Springer-Verlag, 2011.
2. Edwin J. Elton, Martin J. Gruber, Stephen J. Brown and William N. Goetzmann "Modern Portfolio Theory and Investment Analysis", John Wiley& Sons, 2014.

REFERENCES:

1. Simon Benninga, "Financial Modeling", MIT Press, 2014.
2. Steven E Shreve, "Stochastic Calculus for Finance – I", Springer, 2012.

20XDO2 COMPUTATIONAL GEOMETRY

3 2 0 4

PREREQUISITES

- 20XD33 GRAPH THEORY
- 20XD34 ADVANCED DATA STRUCTURES

MATHEMATICAL & GEOMETRICAL REVIEW: Algorithm analysis – sorting, binary search, balanced binary search, divide and conquer, plane sweep, Kd-trees, Dijkstra's algorithm, points, lines and planes, basic geometric objects – polygons, polytopes, convexity, graphs - vertex coloring, planar, Euler's formula. (8)

CONVEX HULLS: Definition, lower bounds, algorithms - Graham's scan, divide and conquer, Jarvis march, 3D hulls. (5)

LINE SEGMENT INTERSECTION: Plane sweep algorithm, Doubly-connected edge list, computing overlay of two subdivisions, Map overlay algorithm, half-plane intersection, arrangements of lines. (8)

POLYGON TRIANGULATION: Art gallery problem – introduction, triangulation, bounds, partition into monotone pieces, triangulating monotone polygon, placement of guards. (8)

ORTHOGONAL RANGE SEARCHING: 1-D and 2-D range searching, range trees. (4)

VORONOI DIAGRAMS: Properties, beach line, computing Voronoi diagram, Delaunay triangulations, computing Delaunay triangulations. (8)

ROBOT MOTION PLANNING: Work space and configuration space, point robot, free space, Minkowski sums for convex and nonconvex polygons, translational motion planning, motion planning with rotations, Point location and trapezoidal maps. Visibility graphs - Shortest paths for a point robot, computing visibility graph, shortest paths for a translating polygonal robot. (10)

TUTORIAL PRACTICE:

Implementation of algorithms for the following problems.

1. Convex hull problems.
2. Line and half plane intersections.
3. Map overlay problems using Doubly-connected edge list.
4. Triangulation and Art gallery problem.
5. Orthogonal range searching (1D and 2D) using Kd-trees.
6. Construct Voronoi diagrams.
7. Translational algorithms for robot motion planning.

Total L:45+T:30 = 75

TEXT BOOKS:

1. Mark de Berg, Otfried Cheong, Marc van Kreveld, "Computational Geometry - Algorithms and Applications", Springer Verlag, 2011.
2. Joseph O'Rourke, "Computational Geometry in C", Cambridge University Press, 2008.

REFERENCES:

1. Franco P. Preparata and Michael Ian Shamos, "Computational Geometry - An Introduction", Springer, 2011.
2. Goodman J E and O'Rourke, "Handbook of Discrete and Computational Geometry", CRC Press, 2004.
3. Subir Kumar Ghosh, "Visibility Algorithms in the Plane", Cambridge University Press, 2007.

20XDO3 PRINCIPLES OF MANAGEMENT AND BEHAVIOURAL SCIENCES**3 2 0 4****PREREQUISITES**

PRINCIPLES OF MANAGEMENT: Meaning, Definition and Significance of Management, Basic Functions of Management – Planning, Organizing, Staffing, Directing and Controlling. Organizational Environment – Social, Economic, Technological and Political. Corporate Social Responsibility - Case discussion. (5)

INDUSTRIAL AND BUSINESS ORGANIZATION: Growth of Industries (Small Scale, Medium Scale and Large Scale Industries). Forms of Business Organizations. Resource Management – Internal and External Sources (8)

ORGANIZATIONAL BEHAVIOUR: Significance of OB, Impact of culture on organization. Role of leadership and leadership styles. Personality and Motivational Theories. Attitudes, Values and Perceptions at work - Case discussion (8)

GROUP BEHAVIOUR: Group dynamics, Group formation and development, group structure and group cohesiveness. Informal organization – Sociometry – Interaction analysis – Exercises (8)

GLOBALISATION: Issues for global competitiveness, proactive and reactive forces of globalization. Cross cultural management – Management of work force diversity. (8)

HUMAN RESOURCE MANAGEMENT: Objectives and Functions, Selection and Placement, Training and Development – Conflict management – Stress management - Human resource management in global environment - Human resource information system(HRIS) - Case discussion. (8)

TUTORIAL PRACTICE:

1. Case study on human resource information system.
2. Case study on organizational behavior.
3. Case study on human resource information system.
4. Case study on organizational behavior.

Total L:45+T:30=75**TEXT BOOKS:**

1. Harold Koontz, Heinz Weihrich and Ramachandra Aryasri, "Principles of Management", Tata McGraw Hill, 2014.
2. Mamoria C B, "Personnel Management", Sultan Chand & Sons, 2005.

REFERENCES:

1. John W Newstrom and Keith Davis, "Organizational Behavior", Tata McGraw Hill, 2010.
2. Stephen P Robbins, "Organisational behavior", Prentice Hall, 2010.
3. Khanna O P, "Industrial Engineering & Management", Dhanpat Rai Publications, 2010.

20XDO4 ENTREPRENEURSHIP**3 2 0 4****PREREQUISITES**

INTRODUCTION TO ENTREPRENEURSHIP: Definition – Characteristics and Functions of an Entrepreneur – Common myths about entrepreneurs – Importance of Entrepreneurship. Seminar in R5 & R6. (5)

CREATIVITY AND INNOVATION: The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process. (6)

DEVELOPING AN EFFECTIVE BUSINESS MODEL: The Importance of a Business Model – Starting a small scale industry - Components of an Effective Business Model. (5)

APPRAISAL OF PROJECTS: Importance of Evaluating Various options and future investments- Entrepreneurship incentives and subsidies – Appraisal Techniques. (8)

FORMS OF BUSINESS ORGANIZATION: Sole Proprietorship – Partnership – Limited liability partnership - Joint Stock Companies and Cooperatives. (4)

FINANCING THE NEW VENTURE: Determining Financial Needs – Sources of Financing – Equity and Debt Funding – Case studies in Evaluating Financial Performance. (8)

THE MARKETING FUNCTION: Industry Analysis – Competitor Analysis – Marketing Research for the New Venture – Defining the Purpose or Objectives – Gathering Data from Secondary Sources – Gathering Information from Primary Sources – Analyzing and Interpreting the Results – The Marketing Process. (5)

INTELLECTUAL PROPERTY PROTECTION AND ETHICS: Patents – Copyright - Trademark- Geographical indications – Ethical and social responsibility and challenges. (4)

TUTORIAL PRACTICE:
Case studies

Total L:45+T:30=75

TEXT BOOKS:

1. Donald F.Kuratko and Richard M.Hodgetts, "Entrepreneurship", South-Western, 2003.
2. Vasant Desai,"The Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 2010.

REFERENCES:

1. S.L.Gupta, Arun Mittal, "Entrepreneurship Development", International Book House, 2012.
2. G. S. Sudha, "Management and Entrepreneurship Development", Indus Valley Publication, 2009.
3. V. Badi, N. V. Badi ,"Business Ethics", Vrinda Publication (P) Ltd.,, 2012.
4. Prasanna Chandra "Projects- Planning, Analysis, Financing, Implementation andreview", TATA McGraw Hill, 2012.

20XD05 INFORMATION THEORY AND ERROR CONTROL CODING

3 2 0 4

PREREQUISITES:

- 20XD25 THEORY OF PROBABILITY
- 20XD32 LINEAR ALGEBRA
- 20XDA1 DATA COMPRESSION

MEMORYLESS FINITE SCHEMES : Self information measure – Entropy function – Conditional entropies – Characteristics of entropy function – Derivation of the noise characteristics of a channel – Mutual information – Redundancy – Efficiency and channel capacity – Capacities of channels with symmetric noise structure (10)

CONTINUOUS CHANNELS: Definitions of different entropies – Mutual information – Maximization of the entropy of a continuous random variable – Entropy maximization problems – channel capacity under the influence of additive white Gaussian noise – parallel Gaussian channel. (7)

ELEMENTS OF ENCODING : Source coding techniques – Necessary and sufficient conditions for noise less coding – Fundamental theorem of discrete noise-less coding – Fundamental theorem of discrete coding in presence of noise. (8)

ERROR CONTROL CODING – Need for error control coding – Linear block codes – Optimum soft decision decoding of linear block codes – Hard decision decoding – Polynomial representation of codes – Cyclic codes – Convolutional codes – Viterbi decoding algorithm – Other decoding methods of convolutional codes – Galois fields – BCH Codes – Reed Solomon codes – Berlecamp Algorithm – Interleaving and concatenated codes – Turbo codes – Low density parity check codes. (10)

ITERATIVE DECODING – Serial concatenation using inner block codes – serial concatenation using inner convolutional codes – product codes – generalized array codes – applications of multi stage coding – The BCJR algorithm – use of extrinsic information – recursive systematic convolutional codes – MAP decoding of RSC codes – Interleaving and Trellis termination – The soft output Viterbi algorithm – Gallager codes – Serial concatenation with iterative decoding – Performance and complexity issues – application to mobile communication. (10)

Total L : 45 + T :30 =75 hours

Tutorial Practice

1. Determination of entropy of a given source.
2. Determination of various entropies and mutual information of a given channel.
 - a) Noise free channel.
 - b) Error free channel
 - c) Binary symmetric channel
 - d) Noisy channel
 Compare channel capacity of above channels.
3. Generation and evaluation of variable length source coding.
 - a) Shannon – Fanocoding and decoding
 - b) Huffman Coding and decoding
4. Coding & decoding of Linear block codes.
5. Coding & decoding of Cyclic codes.
6. Coding and decoding of convolutional codes.
7. Coding and decoding of BCH and RS codes.
8. Performance of a coded and uncoded communication system (Calculate the error probability).
9. Implementation of source coding and channel coding for transmitting a text file.

TEXT BOOKS:

1. Ranjan Bose, Information Theory coding and Cryptography, McGraw-Hill Publication, 2016
2. Reza F M, An introduction to Information theory”, McGraw Hill, 2012.
3. Joy A Thomas and Cover M, Elements of Information theory, John Wiley, 2006.

REFERENCES:

1. Salvatore Gravano, Introduction to Error Control codes, Oxford University Press, 2001.
2. J. C. Moreira and P. G. Farrell, Essentials of Error Control Coding, Wiley, 2006.
3. T. D. Moon, Error Correction Coding: Mathematical Methods and Algorithms, Wiley, 2005.
4. Peter Sweeney, Error Control coding from theory to practice, John Wiley, 2002.
5. S. Lin & D. J. Costello, Error Control Coding, Prentice-Hall, 2004.

20XD06 ACCOUNTING AND FINANCIAL MANAGEMENT**3 2 0 4****PREREQUISITES**

COST ACCOUNTING: Cost classification - significance of overhead Cost - Preparation of Cost sheet - Concept of cost volume profit analysis - Concept of variance - Principles of Job Costing, batch costing and Process costing - Operating Costing - Modern techniques/concepts of Cost Control/ Cost Management. (10)

FINANCIAL ACCOUNTING: Double Entry Book keeping concepts - Journalisation of Business Transactions - Subsidiary Books - Preparation of Profit and Loss Account and Balance sheet from Trial balance - Simple problems - Methods of depreciation. (10)

FINANCIAL RATIO ANALYSIS: Uses and Nature - preparation of Liquidity Ratios - coverage Ratios and profitability Ratios from profit & Loss Account and Balance sheet - common size Income statement and common size Balance sheet. (10)

GOALS AND FUNCTIONS OF FINANCIAL MANAGEMENT: Finance function - Importance of Corporation finance - objectives of Financial Management - organization of the finance function - concept of time value of money. (5)

PRINCIPLES OF CAPITAL BUDGETING: Kinds of capital Budgeting Decisions - Evaluation of proposals from the given cash inflows - Net present value versus Internal rate of return method problems. (5)

WORKING CAPITAL MANAGEMENT: Definition and importance of working capital - factors affecting working capital - Inventory management - simple problems - Receivables Management - cash Budget Preparation - Estimate of overall working capital requirements - Various sources of financing . (5)

TUTORIAL PRACTICE:

Case studies

Total L:45+T:30=75

TEXT BOOKS :

1. Khan M Y, Jain P K, "Cost Accounting and Financial Management", Tata McGraw Hill, 2008.
2. Gupta R L, Radhaswamy M, "Advanced Accountancy", Sultan Chand & Sons, 2009.

REFERENCES :

1. Sharma R K and Shashi K Gupta, "Management Accounting - Principles and Practice", Kalyani Publishers, 2011.
2. Kuchal S C, "Financial Management", Chaitanya Publishing House, 2006.

20XD07 ENVIRONMENTAL SCIENCE AND GREEN COMPUTING**3 2 0 4****PREREQUISITES**

NATURAL RESOURCES, ECOSYSTEMS AND BIODIVERSITY: Environment, Definition, Scope and importance, Forest resources, Use and overexploitation, Water resources: Use and over utilization. Eco system ; Structure and functions of an eco-system, energy flow in the eco system. Bio Diversity; values of biodiversity, biodiversity at global, national and local levels – threats to bio diversity. Conservation of bio diversity – In-situ & Ex-situ conservation. (9)

ENERGY SOURCES: Growing energy needs, Renewable and non-renewable energy sources, Hydro power, Solar Power: Photovoltaic Energy – Motivation for going Solar – Solar Electricity – PV cells. Wind Power: – Using the Wind: Generating Power at Remote Sites,– Measuring the Wind – Estimating the output. Use of alternate energy sources. (9)

SOCIAL ISSUES AND THE ENVIRONMENT: From unsustainable to sustainable development, Urban problems related to energy, Water conservation, Rain water harvesting, Watershed management, Environment and human health, Role of information technology in environment and human health. Environment Protection Act: Air (Prevention and Control of Pollution) Act – Water Act, Forest Conservation Act, Wildlife Protection Act, Introduction to EIA and ISO 14000. (9)

ENVIRONMENTAL POLLUTION AND DISASTER MANAGEMENT: Definition – causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution and nuclear hazards. Disaster management - floods, earthquake, cyclone and landslides. Solid waste management - causes, effects and control measures of municipal solid wastes (Biomedical wastes, hazardous wastes). Role of an individual in prevention of pollution. (9)

GLOBAL ATMOSPHERIC CHANGE & GREEN FUNDAMENTALS: The Atmosphere of Earth – Global Temperature – Global Energy Balance, The Greenhouse Effect - Environmental Issues and Green Computing, Electronic waste management: Introduction;- Environment and society, producer responsibility legislation – the Waste Electrical and Electronic Equipment (WEEE) directive, Materials Composition of WEEE: Mobile Phones – Television – Washing Machines, - Current and new electronic waste recycling technology- Future perspectives of electronic scrap. (9)

TUTORIAL PRACTICE:

Case Studies

Total L:45+T:30=75**TEXT BOOKS:**

1. Mackenzie L. Davis, and David A. Cornwell, "Introduction to Environmental Engineering", Tata McGraw Hill, 2010
2. Chetan Singh Solanki, "Solar Photovoltaics", PHI Learning Private Ltd., 2011.
3. Siraj Ahmed, "Wind Energy: Theory and Practice", PHI Learning Private Ltd., 2011.

REFERENCES

1. William W. Nazarodd and Lisa Alvarez-Cohen, "Environmental Engineering Science", Wiley-India, 2010
2. Anubha Kaushik and Kaushik C P, "Environmental Science and Engineering", New Age International Pvt Ltd, 2005.
3. Martha Maeda, "How to Solar Power your Home", Atlantic Publishing Group, 2011.
4. Paul Gipe, "Wind Power – Renewable Energy for Home, Farm and Business", Sterling Hill Publications, 2008.
5. Klaus Hieronymi, Ramzy Kahhat, Eric Williams, "E-Waste Management : From Waste to resource", Routledge – Taylor and Fransis, 2012.

20XD08 FUNCTIONAL ANALYSIS**3 2 0 4****PREREQUISITES**

- 20XD22 ABSTRACT ALGEBRA
- 20XD32 LINEAR ALGEBRA

METRIC SPACES: Definition, examples, open and closed sets, neighborhood, compact sets, convergence, Cauchy sequence, completeness, completion of metric spaces. (12+8)

BANACH SPACE: Normed spaces, Banach space - Definition, examples, properties, finite dimensional normed spaces and subspaces, compactness and finite dimension. (8+6)

LINEAR OPERATORS:- Definition and examples, bounded and continuous linear operators, linear functional on finite dimensional spaces, normed spaces of operators, Hahn Banach theorem, open mapping theorem, closed graph theorem (12+8)

HILBERT SPACE; Inner product space, Hilbert space –Definition and examples, properties of inner product space, orthogonal complements, orthogonal sets and sequence, orthonormal sets and sequence, series corresponding to orthonormal sequences Bessel's inequality. (13+8)

Total L:45+T:30 = 75

TEXT BOOKS:

1. Erwin Kreyszig, "Introductory Function Analysis with Applications", John Wiley, 2007.
2. George F Simmons, "Introduction to Topology and Modern Analysis", Tata Mc-Graw Hill, 2017.

REFERENCES:

1. Limaye B.V. "An Introduction to Functional Analysis", Newage International, 2014.

20XDO9 ADVANCED OPTIMIZATION TECHNIQUES

3 2 0 4

PREREQUISITES

- 20XD32 LINEAR ALGEBRA
- 20XD41 OPTIMIZATION TECHNIQUES

LINEAR PROGRAMMING-Sensitivity Analysis and Interpretation of Solution, Advanced linear programming applications, Case Studies and applications of linear programming (4)

DYNAMIC PROGRAMMING:Deterministic dynamic programming-probabilistic dynamic programming- Applications of dynamic programming (5)

INTEGER LINEAR PROGRAMMING: Use of binary variable in model formulation-solving integer linear programming-Branch and Bound-Mixed integer linear programming-Applications (9)

CONVEX OPTIMIZATION: Convex set-Convex functions-Convex optimization problems-duality (10)

MULTI OBJECTIVE OPTIMIZATION: Dominant set, Pareto optimality, multi criteria decision making-examples. (8)

MODERN METHODS OF OPTIMIZATION: Basics to heuristics optimization -Genetic algorithms, multi objective genetic algorithm, Particle swarm optimization, Ant colony optimization (10)

TUTORIAL PRACTICE:

Case studies

Total L:45+T:30=75

TEXT BOOKS:

1. Frederick S. Hillier, Gerald J. Lieberman, "Introduction to Operations Research", McGraw-Hill Higher Education, 2010.
2. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, R. Kipp Martin, "An Introduction to Management Science: Quantitative Approaches to Decision Making, Cengage Learning , 2011

REFERENCES:

1. Stephen P. Boyd, Lieven Vandenberg he, "Convex Optimization", Cambridge University Press, 2004.
2. Carlos A Coello Coello, David A Van Veldhuizen, Gary B. Lamont, "Evolutionary Algorithms for solving multi objective problems", Springer Science Business media, 2002.