SEMESTER I

20XT11 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 0calculus. (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 Wyile C and Raymond Wyile 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”, Pearson, 2016.

20XT12 APPLIED PHYSICS

4 0 0 4

Mechanics: Displacement. First, second and third order time-derivatives of displacement. Concept of generalised coordinates. Inertial mass, moment of inertia, force, torque. Equilibrium and principle of virtual work. 2D Motion in a gravitational field. Conservative and non-conservative force-fields. Conservation of momentum. Elastic and inelastic collisions. Energy loss and deformation in inelastic collisions. Energy absorbed in material fracture. Applications to packaging, protection and inspection of equipment. (12)

Mechanical Oscillations: Hooke’s law. Characteristics of a spring and damper. Differential equation of a spring, mass and damper system and its solution. Natural frequency. Forced oscillations. Frequency response of the system and resonance. Damping and energy dissipation. Application to vibration control and shock absorbers. Considerations for mechanical isolation of equipment. Magneto-rheological fluids and application to adaptive dampers. (12)

Heat and thermal control: Temperature, specific heat-capacity. Temperature and temperature gradient in heat flow. Temperature gradient due to internal and external heat sources. Thermal conductivity. Differential equation of one and two dimensional heat conduction. Boundary conditions and solutions. Thermal insulation. Principles of convective and radiative heat transfer. Heat sinks and heat pipes for heat removal from equipment. Forced air convection. (12)

Hygrometry: Air and water-vapour mixtures. Saturation and condensation of moisture from air and its relation to temperature. Dew point. Moisture condensation in electronic equipment and its hazards. Relative humidity. Measurement of relative humidity by dry and wet bulb methods. Humidity sensors and software support for hygrometry. Need for humidity control in installations

and equipment. Methods to control humidity. Humidifiers, driers and dessicators. (12)

Optics: Light propagation through non-homogeneous refractive media. Fermat's principle and determination of optical path. Application to light propagation through optical fibres. Numerical aperture. Step-index and graded-index fibres, single mode and multi-mode fibres. Multiplexing and modulation. Bandwidth advantage. Digital optical communication principles. Pulse-broadening in digital communication by optical fibres. Signal degradation due to attenuation and dispersion. Advantages of optical communication. (12)

Total L:60

TEXT BOOKS:

1. Halliday, David, Robert Resnick, and Jearl Walker. Fundamentals of physics, John Wiley & Sons, 2010
2. Richard. Wolfson. Essential University Physics with Mastering Physics, Pearson education Limited, 2015
3. Young, Hugh D., Roger A. FreedmanUniversity Physics with Modern Physics Pearson Education, 2017

REFERENCES:

1. H C Verma, Concepts of Physics vol 1 and vol 2, Bharti Bhawan Publishers, 2015
2. BrijLal, M N Avadhanulu & N Subrahmanyam, A Text Book of Optics, S Chand Publishing, 2012

20XT13 ANALOG AND 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. (7)

NUMBER SYSTEM AND CODES: Binary - Octal - Hexadecimal - BCD - excess three - Gray codes - Error correcting and detectingcodes. (7)

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. (6)

BOOLEAN ALGEBRA AND KARNAUGH MAPS: Boolean relations - Laws and theorems - Simplifications - Karnaugh maps and simplifications - Don't care conditions - NAND-NAND realizations. (7)

COMBINATIONAL LOGIC: Design and Implementation of Half and Full adders - Subtractor - 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. (7)

OPERATIONAL AMPLIFIERS: Definition of terms - Inverting and non-inverting amplifiers, inverting summing amplifier, integrators and differentiators. (9)

A/D AND D/A CONVERTORS: DACs - weighted and binary ladder types – ADCs - counter, dual slope, successive approximation types. (9)

Total L:60

TEXT BOOKS:

1. Leach DP, "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, 2001.
2. Paul Horowitz and Winfield Hill, "The Art of Electronics", Cambridge University Press, 2015.
3. Hamachar V C, Vranesic Z G and Zaky S G, "Computer Organization", McGraw Hill, 2011.

20XT14 PROBLEM SOLVING AND 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.

20XT15 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)

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

Total L: 45

TEXT BOOK

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 Muhkopadhyay, et al., “English for Jobseekers”, Cambridge University Press, New Delhi, 2013.

20XT16 APPLIED PHYSICS AND DIGITAL ELECTRONICS LAB

0 0 4 2

APPLIED PHYSICS LABORATORY:

1. Determination of the moment of inertia of a flywheel.
2. Verification of Hooke's law using spring-mass system.
3. Determination of thermal conductivity of bad conductor - Lee's disc method.
4. Determination of thermal conductivity of good thermal conductor-Forbes method.
5. Determination of the relative humidity by using wet and dry bulb hygrometer.
6. Determination of refractive index of liquids using hollow prism.

DIGITAL ELECTRONICS LABORATORY:

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

Total P:60

20XT17 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 operations.
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

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

20XT18 MATHEMATICS LABORATORY

0 0 4 2

Prerequisites

- BASIC ALGEBRA
- CALCULUS AND GEOMETRY

Hands-on experiments and models include fundamental mathematical concepts given below but not limited to.Open-source mathematics software **SageMath will be used for demonstrations.**

Calculus: Sequences,golden ratio, Shortest Distance Problem, Brachistochrone Problem, Riemann sum for double and triple integrals, extrema and saddles, rate of change, Mobius strip, Visualization of vectors.

Geometry:Curve drawing, conics and properties using string art, spirals in nature, trajectories, tiling and tessellations, packing objects, polygons, polyhedrons, plane partition using polygons and nearest neighbor, origami, geometric folding and optimization.

Combinatorics: Pigeon hole principle, permutations, combinations, induction, recurrences,probability examples using cards and dice, counting symmetries, graph - structures, game of maze, cops and robbers, pebbling and rubbling.

Algebra: Graphing Functions, solving 2D and 3D linear equations and inequalities, symmetric groups, logical gates using simple circuits, counting operations – ordinary vsStrassenmatrix multiplication.

Total P:60

References

1. Adrian Y E O, “The Pleasures of Pi, e and Other Interesting Numbers”, World Scientific, 2006.
2. Akiyama Jin, “A Day's Adventure in Math Wonderland”, World Scientific, 2008.
3. Alfred S Posamentier and Stephen Krulik, “Strategy Games to Enhance Problem-Solving Ability in Mathematics”, World Scientific, 2017.
4. Erik D. Demaine and Joseph O'Rourke, “Geometric Folding Algorithms: Linkages, Origami, Polyhedra”, Cambridge University Press, July 2007.
5. Ian Stewart, “The Beauty of Numbers in Nature: Mathematical Patterns and Principles from the Natural World”, The MIT Press, 2017.
6. Jay Kappraff , “The Geometric Bridge between Art and Science”, World Scientific, 2001.
7. Jon Millington, “Curve Stitching: Art of Sewing Beautiful Mathematical Patterns”, Tarquin Group, 1999.
8. MiklósBóna, “A Walk Through Combinatorics: An Introduction to Enumeration and Graph Theory”, World Scientific, 2016.

SEMESTER II

20XT21 DISCRETE STRUCTURES

3 2 0 4

MATHEMATICAL LOGIC: Proposition - Logical operators - Truth tables – Laws of Logic – Equivalences – Normal forms - Rules of inference - Validity of arguments – Consistency of specifications – Propositional Calculus – Quantifiers and universe of discourse. (10+7)

PROOF TECHNIQUES: Introduction – Methods of proving theorems – Direct proofs, Indirect proofs – Mathematical induction – Strong mathematical induction and well ordering. (6+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. Functions - Injective, Surjective, Bijective functions, Composition, Identity and Inverse. (10+7)

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+4)

RECURRENCE RELATIONS: Some Recurrence Relation Models- Solutions of linearhomogeneous recurrence relations with constant coefficients- solution of linear non-homogeneous recurrence relations by the method of characteristic roots. (5+4)

LATTICES: Lattices as partially ordered set – Properties of Lattices– Lattices as algebraic system – Sublattices – Direct product and Homomorphism – Some special lattices. (6+4)

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.

REFERENCES:

1. Doerr Alan and Levasseur K, "Applied Discrete Structures for Computer Science", Galgotia Publications, 2010.
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.

20XT22 COMPLEX VARIABLES AND TRANSFORMS

3 2 0 4

Prerequisite

- 20XT11 CALCULUS AND ITS APPLICATIONS

COMPLEX VARIABLES: Introduction- Complex functions- Limits-Continuity- Derivative- Analytic functions – Necessary and sufficient conditions for analytic function- Properties of Analytic Functions - Finding analytic function whose real/ imaginary part is given- Conformal mapping, Bilinear map- Complex integration - Cauchy 's fundamental theorem and formula - Taylor's series- Laurent's series - Singularities - Residue theorem- Evaluation of real integrals using contour integration. (11+9)

LAPLACE TRANSFORM: Concept of Transformation. Laplace transform – Definition - Transform of Standard Functions - Transform of unit step function and Dirac delta function. – Transform of derivatives and integrals -Transforms 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 - Some applications to engineering problems. (10+7)

FOURIER SERIES: Dirichlet's conditions, statement of Fourier theorem, Fourier coefficients, change of scale, Even and odd functions, Half-range sine and cosine series, RMS value, Parseval's theorem, Applications to signals and systems. (6+3)

FOURIER TRANSFORM: Fourier integrals - Fourier transform - Fourier sine and cosine transform - Transforms of standard functions - Properties, Convolution theorem (Statement only). (8+5)

Discrete Fourier Transform: Discrete Convolution – Periodic sequence and circular convolution – Discrete Fourier Transform – Fast Fourier Transform-Decimation–in-time algorithm – Computation of inverse DFT. (5+2)

Z-TRANSFORM: Z - transform of standard functions- inverse Z-transform – properties of Z – transform – Difference equations – Modeling, Solution of difference equations. (5+4)

Total L:60

TEXT BOOKS:

1. Anthony Croft, Robert Davison and Martin Hargreaves, "Engineering Mathematics – A Foundation for Electronic, Electrical, Communications & Systems Engineers", Pearson Education, 2013.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley, 2014.

REFERENCES:

1. Michael D Greenberg, "Advanced Engineering Mathematics", Pearson Education, 2013.
2. Ray Wylie C and Louis C Barret , "Advanced Engineering Mathematics", McGraw Hill, 2013.
3. Roland E Thomas and Albert J Rosa, "Analysis and design of Linear Circuits", John Wiley, 2010.
4. H.C. Taneja, "Advanced Engineering Mathematics, Wiley, 2019.
5. Dennis G. Zill, Warren S. Wright, "Advanced Engineering Mathematics",Jones& Bartlett, 2014

20XT23 ABSTRACT ALGEBRA

4 0 0 4

GROUPS: Introduction to algebraic structures. Groups- Definition and examples, properties of groups, Permutation Groups, Symmetric Groups, Cyclic Groups, Check digit scheme. (12)

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. (12)

GROUP CODING: Coding of Binary information and Error detection – Group codes – Decoding and Error correction. (8)

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. (14)

FIELDS: Definition – subfields - Finite fields – structure of Finite field, GF (2^n). (7)

GEOMETRIC CONSTRUCTIONS: Constructible numbers, Angles and tri-sectors and circle-squarers (7)

Total L : 60

TEXT BOOKS:
1. Herstein I N., “Topics in Algebra”, John Wiley, 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 McGraw Hill, 2017.

REFERENCES:
1. Ron M. Roth, “Introduction to Coding Theory”, Cambridge University Press, 2016.
2. Ralph P. Grimaldi and Ramana B. V., “Discrete and Combinatorial Mathematics: An Applied Introduction”, Pearson Education, 2014.

20XT24 DATA STRUCTURES AND ALGORITHMS

3 0 0 3

Prerequisite
- 20XT14PROBLEM 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. (4)

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 queues– Applications. (4)

LISTS: Primitive operations - Singly linked lists, Doubly linked lists, Circular lists, Multiply linked lists - Application: Addition of Polynomials – Linked Stacks - Linked queues - Linked priority queues. (8)

TREES: Terminologies – Binary tree - Sequential and linked representation - Traversals - Expression trees - Infix, Postfix and Prefix expressions - Threaded trees – 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.

SORTING: Insertion Sort, Selection Sort, Bubble Sort, Heap Sort, Radix Sort – Algorithms and their time complexity (6)

Total L:45

TEXT BOOKS:
1. YedidyahLangsam, Moshe J Augenstein and Aaron M Tenenbaum, "Data structures using C and C++", Prentice Hall, 2016.
2. SartajSahni, "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”, Pearson Education, 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 and Tim Richards, “C++ Plus Data Structures”, Jones and Bartlett Learning, 2017.
4. Alfred V. Aho, John E Hopcraft,JeffreyD. Ullman,”Data structures and Algorithms”,Pearson Education, 2011

20XT25 OBJECT ORIENTED PROGRAMMING

3 0 0 3

Prerequisite
20XT14PROBLEM 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 - Arrays of Objects - Objects as Function Arguments - Friend Functions - Returning Objects - Const Member functions - Pointers to Members. (9)

CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors – Destructors overloading. (4)

OPERATOR OVERLOADING: Overloading Unary and Binary Operators - Overloading Binary Operators using Friend functions – Operator Type conversion. (5)

INHERITANCE: Defining Derived Classes - Single Inheritance - Making a Private Member Inheritable - Multiple Inheritance - Hierarchical Inheritance - Hybrid Inheritance - Virtual Base Classes - Abstract Classes - Constructors in Derived Classes - Member Classes - Nesting of Classes – Composition – Aggregation. (10)

POLYMORPHISM: Basics of polymorphism – Types of polymorphism - Compile and Run Time Polymorphism - Virtual function – Object Slicing – Virtual Destructor – Dynamic binding. (4)

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. (3)

Total L:45

TEXT BOOKS:
1. BjarneStroustrup, “The C++ Programming Language”, Pearson Education, 2014.
2. Stanley B Lippman, JoseeLajoie and Barbara E. Moo, “The C++ Primer”, Addison Wesley, 2013.

REFERENCES:
1. Scott Meyers, “More Effective C++”, Addison Wesley, 2008.
2. BjarneStroustrup, “The Design and Evolution of C++”, Addison Wesley, 2005

20XT26 COMPUTATIONAL MATHEMATICS LAB WITH PYTHON

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.

FILES: Opening files – Reading and writing files – Text files – Binary files.

Implementation of the following programs with suitable Python packages.
1. Programs on differentiation and integration.
2. Conformal mappings of standard functions.
3. Evaluation of real integrals using contour integration.
4. Finding Fourier series
5. Solving ordinary differential equations using Laplace transform techniques.
6. Evaluation of Discrete Fourier Transforms- DIT
7. Solving difference equations using Z transform.

Total P:60

TEXT BOOKS:
1. Langtangen, Hans Petter , “A Primer on Scientific Programming with Python”, Springer, 2012

2. Johansson, Robert, “A Practical Techniques Approach for Industry”, Apress, 2015

REFERENCES:

1. Hans Fangohr, “Introduction to Python for Computational Science and Engineering”, University of Southamoton, 2015.
2. Fuhrer, Solem, Verdier, “Computation with Python”, Pearson, 2013.

20XT27 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 sorting algorithms.

Total P:60

20XT28 OBJECT ORIENTED PROGRAMMING LAB

0 0 4 2

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 members and the public members of the base class.

Total P:60

SEMESTER III

20XT31 LINEAR ALGEBRA

4 0 0 4

Prerequisites

- 20XT21 DISCRETE STRUCTURES

SYSTEM OF LINEAR EQUATIONS: System of linear equations,Gauss – elimination, Gauss-seIdal 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 SAPCES: 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", Wiley, 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.

20XT32 GRAPH THEORY

4 0 0 4

Prerequisites

- 20XT21 DISCRETE STRUCTURES
- 20XT24 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-LászlóBarabási**,**Network Science, Cambridge University Press, 2016.

20XT33 PROBABILITY AND STATISTICS

4 0 0 4

Prerequisites

- 20XT11 CALCULUS AND ITS APPLICATIONS

SAMPLE SPACE AND PROBABILITY: Sets, probabilistic models, conditional probability, total probability theorem and Bayes'

rule, independence, gamblers ruin problem (6+4)

DISCRETE RANDOM VARIABLES: Random variables concept- Probability mass function. Expectation, mean, and variance. Bernoulli, Binomial, Poisson and Geometric random variables. Joint probability mass function of multiple random variables, conditioning, independence. (6+4)

CONTINUOUS RANDOM VARIABLES: Probability density function, cumulative distribution function, Uniform,Normal, Exponential, Weibull, and Gamma random variables. Joint probability density function of multiple random variables, conditioning, continuous Bayes' rule. Sums of independent random variables, convolution, covariance, correlation, and conditional expectation. (6+4)

LIMIT THEOREMS: Markov and Chebyshev inequalities, Weak Law of Large Numbers, Convergence in probability, Central Limit Theorem, Strong Law of Large Numbers. (5+3)

SAMPLE AND POPULATION: Sample mean, confidence interval construction, estimating the variance of the sample mean, confidence intervals for population means, standard error estimates. (6+4)

SIGNIFICANCE OF EVIDENCE: Significance, p-values, comparing the mean of two populations, other useful tests of significance. (6+4)

INFERRING PROBABILITY MODELS FROM DATA:Estimating model parameters with Maximum Likelihood, incorporating priors with Bayesian inference, Bayesian inference for Normal distributions. (6+4)

REGRESSION: Regression to make predictions, to spot trends, linear regression and least squares, Producing Good Linear Regressions. (4+3)

Total L:60

TUTORIAL PRACTICE:
Implementation of the following problems using R Language
1. Determination of point and interval estimates
2. Solving linear regression, polynomial regression and non-linear regression based problems and solving multiple regression
3. Solving the problems based on ANOVA.

TEXT BOOKS:
1. Dimitri P. Bertsekas and john N,Tsitsiklis, 'Introduction to Probability', Athena Scientific, 2008.
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

REFERENCE BOOK:
1. Saeed Ghahramani, ' Fundementals of probability with Stochastic Processes', Pearson, 2019.
2. Sheldon M. Ross, 'Probability and Statistics for Engineers and Scientists', Academic Press, 2014
3. H. Degroot, mark J. Schervish, 'Probability and Statistics' Addison Wesley,,2018.

20XT34 ADVANCED DATA STRUCTURES

4 0 0 4

Prerequisites
- 20XT21 DISCRETE STRUCTURES
- 20XT24 DATA STRUCTURES AND ALGORITHMS

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

HASH TABLES: Dictionaries – Dictionary ADT, Hash functions – Collision handling schemes - Separate chaining, Linear probing, Quadratic probing, Double Hashing – Load factor and rehashing-Analysis. (8)

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)

RED BLACK TREES : Searching, Insertion and Deletion Operations – Analysis (4)

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

MULTIWAY SEARCH TREES: Indexed Sequential Access – m-way search trees – B-Tree – height-Searching, Insertion and deletion - B^+ trees –kd trees-quad trees-Tries - dictionary applications-analysis. (14)

PRIORITY QUEUES (HEAPS): d-Heaps- Leftist Heaps - Leftist Heaps property and operations: Skew Heaps- Fibonacci heap.(8)

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 (10)

Total L:60

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. SahniSartaj, "Data Structures, Algorithms and Applications in C++", Silicon Press, 2013.

20XT35 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING

3 0 0 3

Prerequisites

- 20XT13 ANALOG AND DIGITAL ELECTRONICS

INTRODUCTION: Basic principles - Functional 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: Fylnns 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. (6)

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)

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.
4. Barry B. Brey, "The Intel Microprocessors - 8086/88, and 80186, 80286, 80386, and 80486", Pearson Education, 2009.

REFERENCES:

1. John P. Hayes, "Computer Architecture and Organization", Tata McGraw Hill, 2017.
2. Hamachar V. C., Vranesic Z. G. and Zaky S. G., "Computer Organization", McGraw Hill, 2012.
3. Douglus V. Hall, "Microprocessors and Interfacing", McGraw Hill, 2010.
4. James L. Antonakos, "An Introduction to the Intel family of Microprocessors", Pearson Education, 2007.

20XT36 STATISTICAL COMPUTING AND R PROGRAMMING LAB

0 0 4 2

1. Introduction to R syntax, expressions, variables and functions, Arithmetic operations and graphs with vectors.
2. Creating and graphing two-dimensional datasets, Calculating and plotting basic statistics, categorized data.
3. Organizing values into data frames, loading frames from files and merging them.
4. Implementation of classification and tabulation of data and Graphical and diagrammatic presentation of data.
5. Perform calculations that measure the central tendency and dispersion of data and Implementation of measures of Skewness, moments and kurtosis.
6. Continuous and discrete distributions.
7. Determination of point and interval estimates.
8. Solving linear regression, polynomial regression and non-linear regression based problems and solving multiple regression and correlation analysis based problems.
9. Solving the problems based on Time series analysis and forecasting
10. problem solving using ANOVA

20XT37 ADVANCED DATA STRUCTURES LAB

0 0 4 2

Implementation of the following problems:

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

20XT38 ASSEMBLY LANGUAGE PROGRAMMING LAB

0 0 4 2

1. Arithmetic operations of binary numbers using both one's complement and two's complement arithmetic.
2. Implement parity bit generation for a n-bit binary data.
3. Practice on the and8086 Emulator Tool.

Practice problems on

- Data Transfer and Data Manipulation Instructions.
- Multi precision addition, subtraction
- Block moves
- Implementation of Control Structures (FOR, LOOP, IF.. THEN, DO..WHILE etc.,).
- Array processing
- String processing
- Procedures and Interrupts
- Programs using Special Instructions DAA, XCHG, CMPSW etc.
- Interrupt Service Routines
- IO data transfer

SEMESTER IV

20XT41 STOCHASTIC PROCESSES

3 2 0 4

Prerequisites

- 20XT31 LINEAR ALGEBRA
- 20XT33 PROBABILITY AND STATISTICS

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.(9+7)

CONTINUOUS TIME MARKOV CHAINS: Introduction – Poisson Process - Birth and Death Processes – Kolmogorov Differential Equations – Pure Birth Process - Pure Death Process - Applications. (9+6)

RENEWAL THEORY: Introduction – Distribution - Renewal Theorems - Residual and Excess Life Times -Alternating Renewal Process - Renewal Reward Processes – Regenerative Processes. (8+6)

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. (8+6)

BROWNIAN MOTION: First Passage time distribution – The maximum of a Brownian Motion – The Zeros of Brownian Motion – Brownian Motion with Drift - Geometric Brownian Motion. (9+5)

Total L:45 + T:30 = 75

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.

20XT42 DATABASE DESIGN

3 0 0 3

Prerequisites

- 20XT21 DISCRETE STRUCTURES
- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT34 ADVANCED DATA STRUCTURES

BASIC CONCEPTS : Introduction to databases – Conventional file processing – Characteristics of a database – Data Models – Data abstraction - DBMS Architecture– Data Independence – Database Languages – Database System Environment – Advantages and disadvantages of DBMS – Users of DBMS. (5)

DATA MODELING: Introduction – entities, attributes, relationships – Structural and participation constraints – High Level conceptual data model - ER Diagrams (ERD) – Specialization and Generalization Constraints – Enhanced ER diagrams (EER) – Mapping of ER/EER into Relational Schema (6)

RELATIONAL MODEL AND CONSTRAINTS: Introduction – Relational data model – Data Integrity Constraints – Introduction to Relational Algebra – Relational algebra queries. (4)

RELATIONAL DATABASE MANIPULATION: Structured Query Language (SQL) - Basic data retrieval – SQL Joins – SQL complex queries – Views – Advanced SQL (5)

FILE ORGANIZATION : Storage device characteristics – Constituents of a file – Operations on file - Serial files – Sequential files – Hashing techniques - Index Sequential files – Direct files – Primary, secondary and cluster indexes – Indexing using Tree structures. (6)

DATA BASE DESIGN: Functional dependencies – Normal forms based on primary keys – First, Second and Third Normal forms - Boyce Codd Normal form - Multivalued dependencies – Fourth Normal form - Decomposition Algorithms for relational database design. (6)

QUERY PROCESSING AND OPTIMIZATION: Query processing - Query execution concepts – Query Optimization Techniques - Physical database design – Database tuning. (5)

TRANSACTION AND SECURITY MANAGEMENT: Introduction - Serializability and concurrency control – Locking techniques - Times Stamping Method – Deadlock - Recovery Techniques - Security and Integrity threats – Access Controls and Defense

mechanisms. (8)

Total L:45

TEXT BOOKS:
1. Elmasri R and Navathe SB, “Fundamentals of Database Systems”, Pearson Education, 2016.
2. Silberschatz A, KorthH andSudarshan S, “Database System Concepts”, McGraw Hill, 2011.

REFERENCES:
1. Hector Garcia-Molina, Jeffrey D. Ullman,JenniferWidom, ”Database Systems: The Complete Book,”, Pearson Education, 2011.
2. Raghu Ramakrishnan and Johannes Gehrke, “Database Management System”, McGraw Hill, 2014

20XT43 OPTIMIZATION TECHNIQUES

3 2 0 4

Prerequisites
- 20XT31 LINEAR ALGEBRA

LINEAR PROGRAMMING: Linear programming model - Graphical solution for two dimensional problems –Simplex method, Special cases in the Simplex method - Two phase simplex method – Revised Simplex method (7)

DUALITY AND POST-OPTIMAL ANALYSIS: 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 – Travelling salesman problem - Assignment problem and its solution by Hungarian method. (7)

INTEGER PROGRAMMING: Gomory cutting plane methods for all integer 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 problems
2. To perform sensitivity analysis
3. To solve Transportation and Assignment problems
4. To solve non linear programming problems 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 LievenVandenberaghe, “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 Lwinston, Operations Research: Applications and Algorithms, Thomson Brooks/Cole, 2004.
4. David G. Luenberger, Yinyu Ye, “Linear and Nonlinear Programming”, Springer, 2008

20XT44 OPERATING SYSTEMS

4 0 0 4

Prerequisites
- 20XT14 PROBLEM SOLVING AND C PROGRAMMING
- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT35 COMPUTER ORGANIZATION 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. (5)

PROCESS AND THREADS: Relationship between process and threads – Thread States – Thread Synchronization – Types of Thread – Multithreading model. (6)

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. (8)

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. (8)

VIRTUAL MEMORY MANAGEMENT: Need for Virtual Memory management – Demand Paging –Copy on write -Page Fault handling - Page replacement - Frame allocation- Thrashing - working set model. (6)

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. (5)

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. (5)

VIRTUALIZATION: Requirements for Virtualization - Type 1, Type 2 Hypervisors – Paravirtualization- Memory Virtualization - I/O Virtualization - Virtual machines on Multicore CPUs–Virtualization in Multiprocessor environment. (5)

Total: L: 60

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, A M and Flynn, I.M. “Understanding Operating Systems”, Cengage Learning, 2016.
3. Dhamdhere D M, “Operating Systems: A Concept-based Approach”, McGraw-Hill, 2015.

20XT45 COMPUTER NETWORKS

3 0 0 3

Prerequisites

- 20XT35 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)

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

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

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)

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)

IP: TCP/IP Protocol Structure - Internet Protocol – IP addressing-Subnetting-NAT- IPV6-ICMP-ARP-DHCP (9)

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

TRANSPORT LAYER- TCP concepts - Port number – Connection control – Flow control - Congestion Control (5)

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

Total L:45

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.

20XT46 RDBMS LAB

0 0 4 2

1. Defining and creating database structures such as tables, constraints and views using DDL
2. Manipulating and retrieving information from single and multiple tables using DML
3. Working with SQL complex queries to retrieve data from a database with multiple tables.
4. Database design using E-R model and Normalization
5. Creation of Views, Synonyms, Sequence, Indexes, Save point
6. SQL with query planning and optimization
7. Working with Functions, Stored procedures, Triggers etc.
8. Application using dynamic SQL
9. Web database connectivity
10. Design and develop a user interface and database design for a real time application

Total P:60

20XT47 OPERATING SYSTEMS LAB (LINUX)

0 0 4 2

Linux - History - General structure - Unix file system - file abstraction, directories, mount points, implementation details - Processes: memory image, life cycle, start of day. The shell: basic operation, commands, standard I/O, redirection, pipes, signals. Character and block I/O. Process scheduling.

1. Overview of an Operating System, Boots and Shutdown
2. UNIX File System Commands
3. UNIX Commands
4. SHELL Programming
5. Programs using UNIX System Calls
6. Process Creation and Execution
7. Thread Creation and Execution
8. Process / Thread Synchronization using semaphore
9. Developing Application using Inter Process communication (using sharedmemory, pipes or message queues)
10. Implementation of Memory Management Schemes
11. Creating Linux Modules

Total P:60

TEXT BOOKS:
1. Robert Love, “Linux System Programming”, O’Reilly, 2013
2. Neil Matthew and Richard Stones, “Beginning Linux programming”, John Wiley, 2011.
3. Dale Doughherty and Arnold Robbins, “SED&AWK programming”, O’Reilly, 2010.

REFERENCES:
1. Chris Simmonds, “Mastering Embedded Linux Programming”, Packt Publishing, 2017

20XT48 COMPUTER NETWORKS LAB

0 0 4 2

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 P:60

SEMESTER V

20XT51 THEORY OF COMPUTING

3 0 0 3

Prerequisites
- 20XT21 DISCRETE STRUCTURES
- 20XT24 DATA STRUCTURES AND ALGORITHMS

INTRODUCTION TO LANGUAGES AND GRAMMAR: Overview of Languages and grammars – Alphabets – Strings – Operations on languages – Introduction to Compilers - Analysis of the Source Program - Phases of a Compiler. (4)

FINITE STATE AUTOMATA AND REGULAR EXPRESSION: Finite state automata (FSA) – DFA – NFA – Equivalence of NFA and DFA - Myhill-Nerode Theorem - Minimization of FA. (5)

REGULAR EXPRESSION AND LEXICAL ANALYSIS: Regular expressions – Conversion between RE and FSA – Role of Lexical Analyzer – Specification and Recognition of Tokens (4)

MORE ON REGULAR LANGUAGES: Decision and closure properties of regular languages – Pumping Lemma for Regular languages – Finite State Transducers – Mealy and Moore Machines. (4)

CONTEXT FREE GRAMMARS: Derivations and Parse Trees – Leftmost and rightmost derivation – Ambiguity and unambiguity – Chomsky Normal Form – Greibach Normal Form – Backus Normal Form – CYK algorithm. (5)

SYNTAX ANALYSIS: Top-down Parsing – LL(1) parser – Shift Reduce Parser – LR(0) and SLR(1) parsers – LALR(1) and CLR(1) parsers. (5)

PUSHDOWN AUTOMATA: Pushdown Automata – Deterministic Pushdown Automata – Equivalence of CFG and PDA - Pumping Lemma for CFG – Decision and closure properties of context-free. (5)

TURING MACHINES: Turing Machines – Recursive and recursively enumerable languages – Chomsky hierarchy – Variants of Turing Machines – Universal Turing Machine – Decidable and closure properties of recursive and recursively enumerable languages – Rice’s theorem (5)

UNDECIDABLE AND INTRACTABLE PROBLEMS: Decidability and undecidability – Halting problem – Post Correspondence Problem –Complexity classes of P and NP - NP-Complete Problems. (4)

MODELS OF COMPUTATION: Primitive Recursive Functions – Ackermann’s Function – matrix rewriting grammars – L-systems. (4)

TOTAL = 45

TEXT BOOKS
1. Peter Linz, An Introduction to Formal languages and Automata, Jones & Bartlett Learning, 2017.

2. John E. Hopcroft, Rajeev Motwani, Jeffrey D Ullman, Introduction to Automata Theory, Languages and Computation, Pearson, 2014.

REFERENCES:

1. Michael Sipser, Introduction to Theory of Computing, Cengage Learning, 2012.
2. Kamala Krithivasan, R. Raman, Introduction to Formal Languages, Automata Theory and Computation, Pearson, 2009

20XT52 COMPUTATIONAL NUMBER THEORY AND CRYPTOGRAPHY

4 0 0 4

Prerequisites

- 20XT23 ABSTRACT ALGEBRA
- 20XT31 LINEAR ALGEBRA

BASICS OF NUMBER THEORY: Divisibility and Primality – Greatest common divisors - Euclidean and Extended Euclidean algorithms, Modular arithmetic- Computing modular inverse – modular exponentiation- efficient algorithms, Congruence's – Basic properties – Solving linear congruence's – Residue classes - Chinese remainder theorem - Euler's Phi function – Euler's theorem – Fermat's little theorem, generators and primitive roots in groups – Discrete logarithm. (15)

BASIC CRYPTOGRAPHIC TECHNIQUES: Encryption and Decryption, Classical ciphers- Monoalphabetic cipher - Substitution ciphers-Affine ciphers - Polyalphabetic ciphers – one time pad – Hill cipher – Cryptanalysis of above ciphers (6)

SYMMETRIC KEY CRYPTOGRAPHY: Basic idea – Types of Symmetric key cryptography – stream cipher – LFSR stream cipher, Block ciphers – AES – analysis of AES – modes of operation (5)

PUBLIC KEY CRYPTOGRAPHY: Concept of public key cryptography – One way functions – trap door functions – Computational indistinguishability – Pseudorandom generators and pseudo random functions – semantic security - RSA cryptosystem- cryptanalysis of RSA- the RSA problem – Primality testing -Legendre and Jacobi symbols – quadratic residues – Miller Rabin algorithm - Integer factorization problem, Discrete log problem, ElGamal cryptosystem, Elliptic curve cryptosystem, need for stronger security notions for public key cryptography – CCA security. (13)

DATA INTEGRITY TECHNIQUES : Symmetric techniques- Cryptographic hash functions – Security of hash functions, Random oracle model – Iterated hash function – Merkle – Damgard construction - MAC, unconditionally secure MAC- strongly universal Hash families, asymmetric techniques – Digital signatures – RSA signature, ElGamal signature, Digital signature standard algorithm, strong security notion for digital signatures- provable security for ElGamal signature (11)

AUTHENTICATION AND KEY DISTRIBUTION PROTOCOLS: Data origin authentication and entity authentication, challenge and response-certificates, Schnorr identification scheme, zero knowledge protocol, Diffie-Hellman key pre-distribution, session key distribution – The Needham Schroeder scheme, Kerberos, Diffie- Hellman key agreement scheme, man in the middle attack, station to station key agreement protocol. (10)

Total L:60

TEXT BOOKS:

1. Victor Shoup, "A Computational introduction to Number Theory and Algebra", Cambridge University Press, 2009.
2. Douglas R Stinson, "Cryptography Theory and Practice", CRC Press,2018
3. Jonathan Katz, Yehuda Lindell, "Introduction to Modern Cryptography", CRC press, 2015

REFERENCES:

1. Neal Koblitz, "A course in Number Theory and Cryptography", Springer, 2012.
2. Alfred J, Menezes, Paul C, Van Oorschot and Scott A Vanstone, "Hand Book of Applied Cryptography", CRC Press, 2010.
3. Wenbo Mao," Modern Cryptography- Theory and Practice", Pearson Education, 2008.
4. Tom Apostol, "Introduction to Analytic Number Theory",Springer, 2010.

20XT53 MACHINE LEARNING

3 2 0 4

Prerequisites

- 20XT11 CALCULUS AND ITS APPLICATIONS
- 20XT31 LINEAR ALGEBRA
- 20XT33 PROBABILITY AND STATISTICS
- 20XT43 OPTIMIZATION TECHNIQUES

INTRODUCTION: Machine learning – Types – Supervised learning, unsupervised, Reinforcement learning, semi supervised

learning - Regression – Linear – Polynomial – Multiple regression – Evaluation measures – Bias –variance – overfitting – under fitting – Regularization (10)

Classification: Linear classification – Logistic regression – linear discriminant analysis – Optimization – Convex set - Convex functions – Loss functions in machine learning - Gradient descent – variants – Perceptron - Support Vector Machines – Linear, Soft margin, Linearly non separable data - Kernel functions (10)

Neural networks: Multilayer perceptron - Back propagation – Training – Bayesian Classifier – Decision theory – Maximum A Posteriori estimate – maximum likelihood estimate - K nearest neighbor classifier. (10)

Decision trees: Introduction – Purity measures – Entropy, cross entropy, information gain, gain ratio, Gini Index – Regression trees – ID3 – Pruning – Model selection – Bootstrapping and cross validation – Model evaluation – Performance Measures – Receiver operating characteristic curve (ROC) – AUC. (8)

UNSUPERVISED LEARNING: Clustering –Types - K-means – Mixture of Gaussians –Spectral clustering - Cluster validity measures – dimensionality reduction- PCA (Principal components analysis) - ICA (Independent components analysis) - Applications : image segmentation – Image compression –Outlier analysis. (7)

TUTORIAL PRACTICE:

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 .

Total L:45 + T:30 = 75

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.

REFERENCES:

1. David Barber, “Machine Learning: A Probabilistic Approach”, http://www.idiap.ch/~barber, 2006.
2. AlpaydinEthem, “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.

20XT54 DESIGN AND ANALYSIS OF ALGORITHMS

3 0 0 3

Prerequisites

- 20XT21 DISCRETE STRUCTURES
- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT34 ADVANCED DATA STRUCTURES
- 20XT43 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 - Quick sort and Merge sort - Large Integer multiplication, -Strassen’s matrix multiplication - Closest pair. (5)

GREEDY METHOD: Optimal caching, 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- Optimal binary search trees- Traveling salesman problem. (7)

STRING MATCHING: The Naïve Method, Rabin – Karp Algorithm, The Knuth – Morris – Pratt Algorithm. (4)

NETWORK FLOW: Flow networks and Flows –Network with multiple sources and working with flows- The Ford - Fulkerson Method- Augmenting paths- Max- Flow min - cut theorem-The Edmonds - Karp algorithm. (4)

NP AND COMPUTATIONAL INTRACTABILITY: Basic concepts – Polynomial time reductions- vertex cover and independent sets, 3-SAT and independent sets, 3-SAT and Hamiltonian cycle, Hamiltonian cycle and traveling salesman problem, efficient certification and NP, NP hard and NP complete problems – co-NP and the asymmetry of NP, Examples, Space Complexity-P SPACE , Some hard problems in PSPACE-QSAT (7)

COPING WITH NP-COMPLETENESS: Backtracking: n- queens problem, Graph coloring problem, Hamiltonian cycle, Branch and bound: Assignment problem, Traveling salesman problem, 0/1 knapsack problem, Approximation algorithm – Introduction – Traveling salesman problem-Parametrized algorithm-Introduction-0/1 Knapsack problem. (7)

Total L:45

TEXT BOOKS:

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

REFERENCES:

1. AnanyLevitin, “ Introduction to design and analysis of algorithm”, Pearson Education, 2014.
2. Michael T. Goodrich, Roberto Tamassia, “Algorithms Design, Foundations, analysis and Internet Examples”, Wiley, 2014.
3. Parag H Dave, Himanshu B Dave, “Design and Analysis of Algorithms”, Pearson Education, 2014

20XT56 SCIENTIFIC COMPUTING LAB

0 0 4 2

Prerequisites

- 20XT31 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 ALGEBRAICSIMULTANEOUS 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, Explicitmethod and Crank – Nicolson method for parabolic equations. Explicit method for hyperbolic equations.

Implementation of the following problems.

1. Solution of algebraic and transcendental equations
2. Solving linear system of equations by direct and iterative methods
3. Computing Eigenvalues and Eigenvectors
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. Milne’s and Adams Bashforth predictor corrector methods for solving first order differential equations
8. 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

20XT57 DESIGN AND ANALYSIS OF ALGORITHMS LAB

0 0 4 2

To implement the following

1. Problem using closest pair algorithm
2. Prim's 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, optimal caching
5. Application of all pairs shortest path problem, longest common subsequence
6. Optimal binary search tree
7. Application of N QUEENS using back tracking
8. TSP, Assignment Problem using branch – and - bound

Total P:60

20XT58 JAVA PROGRAMMING LAB

0 0 4 2

Prerequisites

- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT25 OBJECT ORIENTED PROGRAMMING
- 20XT44 OPERATING SYSTEMS

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 overloading - Abstract classes - Virtual Functions. (10)

PACKAGES AND INTERFACES: Packages - Access protection - Importing packages - Interface - Defining and Implementing Interface - Applying Interface - Variables in Interfaces. (8)

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. (8)

MULTI THREADED PROGRAMMING: Java thread model - Priorities - Synchronization - Messaging - Thread class and runnable Interface - Main thread - Creating the Thread - Synchronization – Inter-thread Communication – Deadlock. (12)

I/O, APPLETS: I/O basics - Stream - Stream Classes - Predefined stream - Reading/Writing console input - Applet fundamentals - Native methods.- GUI Components - Applets - Java Scripts –Swing. (10)

COLLECTIONS FRAMEWORK: Generics – Autobox – Auto unboxing – Annotations – Collections Frame works – List – Set – Map (7)

NEW FEATURES : Functional Programming, lambda expressions. (5)

Total P:60

TEXT BOOK:

1. Herbert Schildt, "Java: the Complete Reference",McGraw Hill, 2014.

REFERENCES:

1. Joyce Farrell , "Java Programming", Cengage Learning, 2019.
2. Patrick Naughton and Herbert Schildt, "JAVA - The Complete Reference", McGraw Hill, 2011.
3. Douglas Lea, "Concurrent Programming in Java: Design Principles and Patterns",Addison-Wesley, 2019.

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 exception.
6. To create threads, thread groups.
7. To create inter-thread communication using shared memory, piper stream.
8. To implement socket connections (UDP, TCP).

SEMESTER VI

20XT61 SOFTWARE ENGINEERING

3 2 0 4

Prerequisites

- 20XT25 OBJECT ORIENTED PROGRAMMING

INTRODUCTION: 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. (7)

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 **-A**nalysis 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 - SEICMM 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 (6)

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– Defecttracking and testing tools.

Total L: 45+T:30=75

TEXT BOOKS:

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

REFERENCES:

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

20XT62 COMPUTER GRAPHICS AND VISUALIZATION

3 0 0 3

Prerequisites

- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT31 LINEAR ALGEBRA

GRAPHICS INPUT - OUTPUT DEVICES: Raster scan displays - Random scan displays - Direct view storage tubes - Flat panel displays - Mouse - Track Ball - 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. (4)

OPENGL: Architecture, 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. (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, feedback images. (8)

IMAGE PROCESSING FUNDAMENTALS: Sampling and Quantization, Image Enhancement - Histogram Processing, Filtering, Edge Detection, Image Transforms. (6)

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)

THREE DIMENSIONAL GRAPHICS: 3D transformations - Viewing 3D graphical data - Orthographic, oblique, perspective projections - Hidden lines and hidden surface removal. (6)

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 (4)

Total L:45

TEXT BOOKS:

1. Donald Hearn and Pauline Baker M, "Computer Graphics C Version", Pearson Education, 2014.
2. William M. Newmann, Robert F Sproull, “Principles of Interactive Computer Graphics”, Tata McGraw Hill, 2014.
3. Angel, “Interactive Computer Graphics- A top down approach with OpenGL”, Pearson Education, 2014.

REFERENCES:

1. Foley James D, VandamAndries and Hughes John F, "Computer Graphics: Principles and Practice", Addison-Wesley, 2013.
2. Rafael C Gonzalez., and Richard Eugene Woods, “Digital Image Processing”, Pearson Education, 2013.
3. Solomon, C., and Breckon, T,“Fundamentals of Digital Image Processing: A practical approach with examples in MATLAB”, Wiley- Blackwell, 2011.
4. F S Hill, “Computer Graphics Using OpenGL”, Prentice Hall, 2012.

20XT63 ARTIFICIAL INTELLIGENCE

3 0 0 3

Prerequisites

- 20XT21 DISCRETE STRUCTURES
- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT32 GRAPH THEORY
- 20XT33 PROBABILITY AND STATISTICS

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)

Total L: 45

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson Education, 2020.

2. David Pool 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.

20XT64 PRINCIPLES OF COMPILER DESIGN

3 0 0 3

Prerequisites

- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT32 GRAPH THEORY
- 20XT51 THEORY OF COMPUTING

INTRODUCTION TO COMPILERS: Phases of compilers – compilers and interpreters – Overview of Lexical analysis – Parsing Techniques – Top-down Parsing – Shift Reduce Parsing. (4)

SEMANTIC ANALYSIS: Syntax Directed Definitions – Inherited and Synthesized attributes – Attribute Grammars - Evaluation of Attribute grammars – Dependency Graph - Ordering the Evaluation – S-attributed and L-attributed grammars – Semantic Rules with controlled Side Effects – Type checking – type conversion. (6)

INTERMEDIATE CODE GENERATION: Syntax Tree, Three Address Code, Types and Declarations: Translation of Expressions, conditional statements, looping statements, break and continue statements, array indexing, function calls – Quadruples, Triples and Indirect triples – Short Circuit Evaluation for Boolean expression - Flow-of-control statements – Back patching. (8)

RUN-TIME ENVIRONMENTS: Storage Allocation – Activation Trees- Activation Records – Parameter Passing Methods – Data Access with and without Nested Procedures – Heap Management – Garbage Collection. (5)

CODE GENERATION: Issues in the design of code generation - Program and Instruction Costs – Static and Stack Allocation of addresses in Target Code – Producing Code generators automatically. (5)

FLOW ANALYSIS: Dominators and Post dominators – Loops and Strongly Connected Components – Reducibility – Interval and Structural analysis – Interval Trees - Iterative Data Flow Analysis – Lattices of flow functions – Control-Tree-based Data-flow analysis – Structural and Interval Analysis – Webs – Static Single-Assignment (SSA) Form - Alias Analysis - Dependence Relations – Direction Vector - Basic Block Dependence DAGs – Dependence in Loops – Dependence Testing – Program-Dependence Graphs. (10)

CODE OPTIMIZATION AND SCHEDULING: Basic Blocks – Control Flow Graph – Value Numbering – Copy and Constant Propagation – Common Subexpression Elimination – Loop-invariant Code Motion - Peephole Optimization – Register Allocation and Graph coloring - Instruction Scheduling – Software Pipelining – Trace and Percolation Scheduling. (7)

TotalL: 45

TEXT BOOKS:

1. Alfred Aho, Monica Lam, Ravi Sethi, Jeffrey Ullman, Compilers: Principles, Techniques and Tools, 2014.
2. Steven Muchnick, Advanced Compiler Design Implementation, 2003.
3. AhoA.V, Monica S Lam, RaviSethi and Ullman J.D., “Compilers : Principles, Techniques and Tools”, Pearson Addison Wesley, 2013.

REFERENCES:

1. Keith Cooper, Linda Torczon, “Engineering a Compiler”, Morgan Kaufman Publishers, 2012.
2. John J. Donovan, “Systems Programming”, McGraw Hill , 2017

20XT66 COMPUTER GRAPHICS AND VISUALIZATION LAB

0 0 4 2

1. Drawing a line, circle using algorithms.
2. Implementation of 2D Transformations (translation, scaling, rotation).

3. Window – viewport simulation with various aspect ratios.
4. Line clipping and Polygon clipping using algorithms.
5. Manipulation of raster images.
6. Image processing commands in Matlab.
7. Histogram processing
8. Filtering
9. Edge detection
10. Image Transforms
11. Drawing a 2D curve using Bezier and B-Spline generations.
12. 3d Projections – Orthographic and Perspective
13. Hidden Surface Removal algorithm
14. Mandelbrot and Julia Set Generation
15. Graftals Generation
16. Model a primitive (car / Aircraft) with OpenGL API.
17. Model and Animate the primitive.

Total P:60

Note: Algorithms in Computer Graphics have to be implemented by students using C++ and OpenGL.

20XT67 ARTIFICIAL INTELLIGENCE LAB

0 0 4 2

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 P:60

20XT68 COMPILER DESIGN LAB

0 0 4 2

Construction of NFA from Regular expression

1. Converting NFA into DFA
2. Converting Regular expression into DFA
3. Implementation of Symbol Table
4. Develop a lexical analyzer to recognize a few patterns in C. (Ex. identifiers, constants, comments, operators etc.)
5. Implementation of Lexical Analyzer using Lex Tool
6. Generate YACC specification for a few syntactic categories.
7. To recognize a valid arithmetic expressions that uses operator +, – , * , /.
8. Implementation of Calculator using LEX and YACC
9. Convert the BNF rules into Yacc form
10. Implementing Predictive Parser Table
11. Implementing CYK algorithm
12. Write code to generate Abstract Syntax Tree.
13. Implement type checking
14. Implement control flow analysis and Data flow Analysis
15. Implement stack storage allocation strategies
16. Construction of DAG
17. Implement the back end of the compiler which takes the three address code and produces target code. The target instructions can be simple move, add, sub, jump.
18. Implementation of Simple Code Optimization Techniques (Constant Folding., etc.)
19. Study of LLVM Target-Independent Code generator

SEMESTER VII

20XTP1 PROJECT WORK 1 – INDUSTRY / RESEARCH PROJECT

0 0 0 12

SEMESTER VIII

20XT81 DEEP LEARNING

3 2 0 4

Prerequisites

- 20XT63 ARTIFICIAL INTELLIGENCE

Introduction – Basic concepts – Convex sets, convex functions – loss functions – Gradient descent – Variants - Perceptron – Activation functions - Geometric representation – Perceptron Convergence theorem. (4)

Feed Forward Networks - Multi layer Perceptron – back propagation - Learning XOR – Auto encoder - Deep neural networks. (6)

Training neural Networks: Optimization methods for neural networks - Adagrad, Adadelta, 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 Auto encoders, Representational Learning, Structured probabilistic models for deep learning, Monte Carlo Methods, Generative adversarial networks - Deepgenerativemodels. (9)

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

Total L:45 =45

TUTORIAL PRACTICE:

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. Music
    b. Image processing
    c. Image captioning
    d. Text analysis (Next word prediction,etc)
    e. Speech processing
    f. OCR
    g. Machine translation

TEXT BOOKS:

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

REFERENCES:

1. Adam Gibson, Josh Patterson "Deep Learning: A Practitioner's Approach ", OReilly, 2016.
2. Nicholas Locascio and Nikhil Buduma "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", OReilly, 2017.

20XT82 PARALLEL AND DISTRIBUTED COMPUTING

3 0 0 3

Prerequisites

- 20XT35 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING
- 20XT44 OPERATING SYSTEMS
- 20XT45 COMPUTER NETWORKS

INTRODUCTION: Concepts and Terminology – Generic Processor / ASIC Processor Architecture – Pipeline Architecture – Instruction Set Architecture - Types of Parallelism - Flynn's Classical Taxonomy – Terminology. (5)

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. (4)

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. (8)

PRAM ALGORITHMS: 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. (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. (8)

Distributed COMPUTING: Introduction -- Definitions, motivation - Communication Mechanisms - Communication protocols,- RPC- RMI.Hadoop Architecture: History of Hadoop, Background-Architecture - Hadoop and RDBMS-Subprojects-Distributions-Documentation. Hadoop Distributed File System (HDFS): HDFS Clusters – NameNodes, DataNodes& Clients – MapReduce :- Processing & Generating large data sets, Map functions, Programming MapReduce using SQL / Bash / Python, Parallel Processing, Failover. (9)

Total L : 45

TEXT BOOKS:

1. John L. Hennessy and .2016 ,reivesIE ,"hcaorppA evitatitnauQ a erutcetihcrA retupmoC" ,nosrettaP .A divaD
2. Michael J Quinn, " Parallel Computing : Theory And Practice", Tata Mcgraw-Hill,2004.
3. Andrew S. Tanenbaum and Maarten van Steen, "Distributed Systems, Principles and Paradigm", Prentice Hall, 2013.

REFERENCES:

1. Vijay K Garg, "Elements of Distributed Computing", Wiley 2014.
2. Shane Cook , "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", Elsevier, 2013
3. Tom White, "Hadoop Definitive Guide", O'Reily, 2012.
4. David F. Bacon, Susan L. Graham and Oliver J. Sharp, "Compiler Transformations for High Performance Computing", Technical report, 1994.

20XT83 DATA MINING

3 0 0 3

Prerequisites

- 20XT53 MACHINE LEARNING

INTRODUCTION: Motivation for Data Mining – Importance – Definition – Kinds of data for Data Mining – Data Mining functionalities – Patterns – Classification of Data Mining Systems – Major issues in Data Mining-Overview of Data Mining Techniques. **DATA PREPROCESSING:** Types of data, Data cleaning-Smoothing, Handling missing values- Feature subset selection Sampling methods. (10)

DATA WAREHOUSE and OLAP TECHNOLOGY: Overview- Need for Data Warehouse- multidimensional data model-Data

Warehouse architecture -Data warehousing Schemas - Data Warehousing to Data mining. (4)

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. (7)

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. (8)

APPLICATIONS AND TRENDS IN DATA MINING: Spatial Data Mining –Graph Mining- Web Mining –Text Mining. (6)

Total L:45

TEXT BOOKS:

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

REFERENCES:

1. AnandRajaraman, 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.

20XT86 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
3. should be equally distributed to all processes).
4. Write a parallel program in SPMD to calculate the PI value using integral approximation method.
5. Simple Matrix multiplication, Transpose, using parallel algorithm in OpenMP
6. 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.
7. Implement data parallelization algorithm using CUDA and OpenCL
8. Hadoop setup – Map reduce – Programming models – Text mining.

Total P:60

20XT87 DATA MINING LAB

0 0 4 2

1. Familiarize with tools like WEKA and statistical package like R.
2. Getting to know your Data –Feature Selection.
3. Decision Trees. 4. Other Classification Methods.
4. Ensemble Learning.
5. Clustering.
6. Association Rules.
7. Analyzing data with log linear models and graphical models using R.
8. Handling massive data using map reduce.
9. A Package using data mining techniques preferably research papers

Total P:60

20XT88 RESEARCH SPECIALIZATION LAB - I

0 0 4 2

SEMESTER IX

20XT91 GAME THEORY

3 0 0 3

Prerequisites

- 20XT11 CALCULUS AND ITS APPLICATIONS
- 20XT21 DISCRETE STRUCTURES
- 20XT33 PROBABILITY AND STATISTICS

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. (5)

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. (8)

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. (8)

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. (8)

Total L:45

TEXT BOOKS:

1. Martin J Osborne, "An Introduction to Game Theory", Oxford University Press, 2009.
2. Vijay Krishna, "Auction Theory", Academic Press, 2009.

REFERENCES:

1. Joel Watson, 'Strategy: An Introduction to Game Theory', W. W. Norton & Company, 2013.
2. Steven Tadelis, 'Game Theory: An Introduction', Princeton University Press, 2013.
3. David Easley, Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.
4. Y. Narahari, 'Game Theory and Mechanism Design', IISc Press, World Scientific, 2014
5. N. Nisan, T. Roughgarden, E. Tardos, V. Vazirani, "Algorithmic Game Theory", Cambridge University Press, 2007.

20XT92 MATHEMATICAL MODELLING

3 0 0 3

Prerequisites

- 20XT33 PROBABILITY AND STATISTICS
- 20XT41 STOCHASTIC PROCESSES
- 20XT43 OPTIMIZATION TECHNIQUES

INTRODUCTION TO MODELLING: Modelling 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 m, 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. Hidden Markovian models, statistical methods, position specific scoring matrices. (15)

Total L:45 =45

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 ZastawniakT,"Mathematics for Finance: An Introduction to Financial Engineering",
4. 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

20XT93 INFORMATION RETRIEVAL AND WEB SEARCH

3 0 0 3

Prerequisites

- 20XT31 LINEAR ALGEBRA
- 20XT33 PROBABILITY AND STATISTICS
- 20XT34 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, PrabhakarRaghavan and HinrichSchütze, "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 BerthierRibeiro-Neto, “Modern Information Retrieval”, Pearson Education, 2010.
2. Francesco Ricci, LiorRokach, BrachaShapira, Paul B. Kantor, “Recommender Systems – Handbook”, Springer, 2015

20XT96 MODELLING AND SIMULATION LAB

0 0 4 2

1. Algebraic Models: Linear, Quadratic, and Exponential.
2. Polynomial curve fitting and cubic spline curve fitting.
3. Time series analysis and forecasting models.
4. Portfolio optimization models.
5. Cox-Ross-Rubinstein (CRR) model.
6. Risk analysis models.
7. Pair wise sequence alignment using dynamic programming.
8. Multiple sequence alignment using Hidden Markovian models

Total P:60

20XT97 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

20XT98 RESEARCH SPECIALIZATION LAB - II

0 0 012

SEMESTER X

20XTP2 PROJECT WORK II – INDUSTRY / RESEARCH PROJECT

0 0 0 12

PROFESSIONAL ELECTIVES

20XTE1 REINFORCEMENT LEARNING

3 2 0 4

Prerequisites

- 20XT53 MACHINE LEARNING
- 20XT63 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 (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 word.
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. CsabaSzepesvári, "Algorithms for Reinforcement Learning", Morgan & Claypool, 2010.
4. Masashi Sugiyama, "Statistical Reinforcement Learning : Modern Machine Learning Approaches", CRC Press, Taylor & Francis Group, 2015

REFERENCES

1. Lattimore, T. and Szepesvári, C." Bandit Algorithms", Cambridge University Press, 2018.
2. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Rearson, 2020

20XTE2 SOFTWARE PATTERNS

3 2 0 4

Prerequisites

- 20XT25 OBJECT ORIENTED PROGRAMMING
- 20XT58 JAVA PROGRAMMING LAB
- 20XT61 SOFTWARE ENGINEERING

INTRODUCTION TO PATTERNS: Reusable object oriented software, Motivation, Best design practices of object oriented

software, Coupling and Cohesion, Types of Cohesion and Coupling, Benefits of patterns, Definition of a Pattern, Types, Pattern description, Pattern Language, IDIOMS, Framework, Architecture. (6)

DESIGN PATTERNS: Creational patterns – 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, Distributed systems – Broker, Interactive Systems – Model View Controller (MVC), Presentation Abstraction Control, Adaptable Systems – Reflection, Microkernel. Anti-Patterns. (13)

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. (11)

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.
8. Refactoring Tool Usage.

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 Software Architecture: A System of Patterns”, John Wiley, 2011.
3. Martin Fowler, Kent Beck, William Opdyke and Don Roberts, “Refactoring: Improving the Design of Existing Code”, Addison-Wesley Longman, 2012.

REFERENCES:

1. GirishSuryanarayana, 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.

20XTE3 NATURAL LANGUAGE PROCESSING

3 2 0 4

Prerequisites

- 20XT53 MACHINE LEARNING
- 20XT63 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 – Probabilstic 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 sematic analysis – Attachments for a fragment of English – Word Sense Disambiguation – Machine learning approaches – Dictionary based approaches – Pragmatics : Discourse – Text coherence. (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 **-** Automatic summarization - Question answering - Named entity recognition and relation extraction - IE using sequence labeling - Open problems. (5)

TUTORIAL PRACTICE:

Sample lab assignments using NLTK

1. Tweet modeling using n grams
2. Part of speech tagging of text data using HMM
3. Sentiment analysis and classification using n gram models, RNNandLSTM
4. Document classification / Radiology reports classification using RNN and LSTM
5. Visualization of text data
6. POS tagging on text data using HMM
7. Language modeling using n gram models
8. Machine translation using Deep learning architecture and HMM
9. Optical character recognition using CNN, RNN and Named entity recognition
10. Analysis of machine learning algorithms on Word sense disambiguation

Total L:45 + T:30 = 75

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. Jacob Eisenstein, Introduction to Natural language processing, The MIT Press, 2019.

REFERENCES:

1. Christopher Manning and HinrichSchütze, “Foundations of Statistical Natural Language Processing”, MIT Press,2008.
2. James Allen, “Natural Language Understanding”, Addison Wesley,1995.

20XTE4 APPROXIMATION ALGORITHMS

3 2 0 4

Prerequisites

- 20XT31 LINEAR ALGEBRA
- 20XT43 OPTIMIZATION TECHNIQUES
- 20XT54 DESIGN AND ANALYSIS OF ALGORITHMS

INTRODUCTION: Definition-performance ratios, lower bounding OPT, vertex-cover problem- a greedy approach. (4)

COMBINATORIAL ALGORITHMS: Set cover problem, Metric TSP, multiway cut problem, the minimum k-cut problem, FPTAS, PTAS, FPTAS for knapsack, greedy algorithms for Makespan-PTAS for minimum Makespan, Euclidean TSP. (10)

LINEAR PROGRAMMING RELAXATIONS: LP-duality, min-max relations and LP-duality, rounding applied to vertex cover-simple rounding algorithm-randomized rounding, primal dual method and vertex cover. (9)

CUTS, METRICAL RELAXATIONS AND EMBEDDINGS: Multiway cut, sum multicommodity flow, some applications of multicut, rounding for Sparsest Cut via L1 Embeddings. (8)

SEMIDEFINITE PROGRAMMING: Strict quadratic programs and vector programs, properties of positive semidefinite matrices, the semidefinite programming problem, randomized rounding algorithm, improving the guarantee for MAX-2SAT. (7)

HARDNESS OF APPROXIMATION: reduction, graphs, and hardness factors, statement of the PCP theorem, hardness of MAX-3SAT. (7)

TUTORIAL PRACTICE:

1. Problem related to vertex-cover algorithm.
2. Solving problem using Greedy algorithm for makespan.
3. Problems related to Euclidean TSP.
4. Problem using different algorithms with rounding.
5. Applications of multicut.

Total L:45+T:30 = 75

TEXT BOOKS:

1. David P. Williamson, David B. Shmoys, “The design of approximation algorithms”, Cambridge university press, 2011
2. Vijay V.Vazirani, “Approximation Algorithms”, SpringerVerlag, 2010.

REFERENCES:
1. Thomas H Cormen, Charles E Leiserson and Ronald L Rivest, “Introduction to Algorithms”, MIT Press, 2015.

20XTE5 NETWORK ALGORITHMICS

3 2 0 4

Prerequisites
- 20XT4 COMPUTER NETWORKS LAB

INTRODUCTION: Algorithms VsAlgorithmics – Network algorithmics – Network bottlenecks – Endnode bottlenecks – Router bottlenecks – characteristics of network algorithmics. (4)

NETWORK IMPLEMENTATION MODELS: Protocols - Hardware - Network device architectures – Operating System Implementation Principles – System Principles – Principles for modularity and efficiency – Principles for speeding up routines – Principles in action. (8)

ENDNODEALGORITHMICS: Copying data – Transferring Control – Maintaining timers – Protocol Processing (8)

ROUTER ALGORITHMICS: Exact match lookup – Prefix match look ups – Packet Classification – Switching – Scheduling packets – Computing traffic matrices (15)

NETWORK SECURITY: Searching for multiple strings in packet payloads – IP trace back via probabilistic marking and logging – Detecting worms. (10)

TUTORIAL PRACTICE:
1. Implementation of CRC using a fast implementation technique.
2. Implementation of IP prefix lookup using lulea tries.
3. Implementation of binary search on prefixes.
4. Implementation of packet classification using linear search.
5. Implementation of packet classification using set pruning trees.
6. Implementation of decision trees approach for packet classification.
7. Implementation of packet scheduling algorithms.
8. Implementation of AhoCorasick algorithm.

Total L: 45+T:30 = 75

TEXT BOOKS:
1. George Varghese, “Network Algorithmics, An Interdisciplinary Approach to Designing Fast Networked Devices”, Morgan Kaufmann, 2006.
2. Michal Pioro and DeepankarMedhi, “Routing Flow and Capacity Design in Communication and Computer Networks”, Morgan Kaufmann, 2007.

REFERENCES:
1. James D McCabe, “Network Analysis, Architecture and Design”, Morgan Kaufmann, 2007.
2. Panos C Lekkas, “Network Processors, Architectures, Protocols and Platforms (Telecom Engineering)”, McGraw Hill, 2008.

20XTE6 SOCIAL NETWORK ANALYSIS

3 2 0 4

Prerequisites
- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT32 GRAPH THEORY

INTRODUCTION: Motivation - different sources of network data - types of networks - tools for visualizing network data - review of graph theory basics. (9)

GRAPH THEORETIC PROPERTIES OF SOCIAL NETWORKS: Notions of centrality - Strong and weak ties – Homophily - Structural Balance. (5)

DYNAMIC PROPERTIES OF NETWORKS: Information diffusion - networks effects on information diffusion - maximizing influence spread - power law and heavy tail - preferential attachment models - small world phenomenon - cascading behavior on networks - Epidemics. (11)

BEHAVIORAL PROPERTIES ON NETWORKS: Network economics - Bargaining and power in networks - Sponsored search

markets. (10)

MINING GRAPHS: Community and cluster detection: random walks - spectral methods - link analysis for web mining-overview of social tagging and applications. (10)

TUTORIAL PRACTICE:
1. Getting acquainted with UCINET and Netdraw.
2. Implementing graph-theoretic/social network metrics using UCINET.
3. Working with Visualization, Ego networks, Centrality, Community Detection etc.

Total L:45+T:30 = 75

TEXTBOOKS:
1. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.

REFERENCES:
1. Peter R. Monge and Noshir S. Contractor, "Theories of Communication Networks", Oxford University Press, 2003.
2. Duncan J Watts. "Six degrees: The Science of a Connected Age", Norton, 2004.
3. Narahari Y, Garg D, Ramasuri N, and Prakash H, "Game Theoretic Problems in Network Economics and Mechanism Design Solutions", Springer Verlag, 2008.
4. Charu C. Aggarwal,, "Social Network Data Analytics", Springer, 2015.

20XTE7 ADVANCED COMPUTER GRAPHICS

3 2 0 4

Prerequisites
- 20XT62 COMPUTER GRAPHICS AND VISUALIZATION

GEOMETRICAL TRANSFORMATIONS: Transformation as a change in coordinate system. Viewing in 3D: Projections – specifying arbitrary 3D viewing – The Mathematics of planar geometric projections – implementing planar geometric projections, Coordinate systems. (3)

OBJECT HIERARCHY: Geometric modeling- Characteristics of retained – mode graphics packages – Defining and displaying structure – Modeling transformations, Hierarchical structure networks. Input devices – interaction techniques And interaction task.
USER INTERFACE SOFTWARE: Basic interaction – handling models - window management systems – User-interface management systems. (9)

REPRESENTING CURVES AND SURFACES: Polygon meshing – parametric cubic curves, Parametric bicubic surfaces, Quadric surfaces. SOLID MODELLING**:** Representing solids – Regularized Boolean set operations – Primitive instancing – Sweep representations – Boundary representations – Spatial – Partitioning representations – Constructive solid geometry – Comparison of representation – User interfaces for solid modeling.
VISIBLE SURFACE DETERMINATION: Function of two variables – Techniques for efficient visible surface algorithms – Algorithms for visible line determination– Visible ray tracing. (12)

REALISM: Fundamental difficulties – Rendering techniques for line drawing, shaded images – Improved object models – Dynamics – stereopsis – Improved displays – Interacting with our other senses – *Aliasing and antialiasing.* ACHROMATIC AND COLORED LIGHT**:** Achromatic light – Chromatic color – Color Models for Raster Graphics – Reproducing Color – Using Color in Computer Graphics. illuminations and shading: Illumination models – Shading models for polygons – Surface detail – Shadows – Transparency – Inter object reflections – Physically based illumination models – Extended light sources – Spectral sampling – Improved camera model – Global Illumination algorithms – Recursive ray tracing – Radiosity methods – The rendering pipeline. (11)

IMAGE MANIPULATION AND SHADING: Filtering – Image Processing – Geometric transformations of Images – Multipass transformation – Image Composition – Mechanism for Image Storage – *Special Effects with images*. ANIMATION : Conventional and Computer assisted Animation – Animation languages – Methods of controlling animation - Basic rules of animation – Problems peculiar to animation. (10)

TUTORIAL PRACTICE:
Implement the following using OpenGL:
1. Using glRecti function, draw
   a) A flurry b) A checkerboard
2. Write the window to view port mapping functions, and use it to draw the since curve in real world coordinates.
3. Using user defined lineTo and moveTo functions, plot the Fibonacci series.

4. Write the Canvas class and it's supporting classes. Use the Canvas class to draw a simple meander.
5. Write functions to change the background and foreground colors.
6. Write a function to draw an n-sided polygon (using the basic Canvas class and line To and move To functions)
7. Write a program to draw the Sierpinski gasket.
8. Write a program to draw the graph of a given mathematical function f(x).
9. Write a program to read a data file that contains a collection of Polylines in the appropriate format and draw each polyline.
10. Write a parameterized function to display a house and call it a number of times by passing different values to form a village.
11. Write a program that displays a colored triangle and rectangle and rotates them at different angles along two axis.
12.

Total L:45+T:30 = 75

TEXT BOOKS:

1. Foley James D, VandamAndries and Hughes John F, "Computer Graphics: Principles and Practice", Addison-Wesley, 2013.
2. Donald Hearn, rekaB eniluaP .Mand ,"LGnepO htiw scihparG retupmoC" ,srehtiraC nerraW .2013 ,noitacudE nosraeP

REFERENCES:

1. Edward Angel and htiw hcaorppa nwod pot A-scihparG retupmoC evitcaretnI" ,enierhS evaD noitacudE nosraeP ,"LGnepO, 2012.
2. Anil K Jain., "Fundamentals of Digital Image Processing", Pearson Education, 2007.
3. F S Hill, "Computer Graphics Using OpenGL", Prentice Hall, 2007.

20XTE8 COMPUTER VISION AND IMAGE ANALYSIS

3 2 0 4

Prerequisites

- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT31 LINEAR ALGEBRA
- 20XT33 PROBABILITY AND STATISTICS

Image Formation: Geometric primitives and transformations - Photometric image formation - The digital camera. (3)

Image processing: Point operators - linear filtering - Neighborhood operators - Histogram - Fourier transforms - Pyramids and wavelets - Global optimization. (6)

Segmentation: Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy - based methods. (5)

Recognition: Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding. (4)

Feature Extraction: Spatial Feature - Edge Detection - Boundary Extraction - Boundary Representation - Region Representation - Moment Representation - Shape Features - Texture. (5)

Image Compression – Basic requirements - Types of compression - Coding Algorithms. (4)

Finding Templates using Classifiers: Classifiers - Feature Selection - Neural Networks - Support Vector Machine - Deep Learning - Convolutional Neural Networks - Multiple Classifiers. (9)

Motion Detection: Flow and correspondence - Optical flow - based motion estimation - Quadrature filter techniques - Correlation and matching - Modeling of flow fields. (5)

Case Studies: Applications of computer vision and image analysis. (4)

TUTORIAL PRACTICE:

1. Implementation of Image segmentation and edge detection.
2. Implementation of feature extraction.
3. Implementation of image classification and clustering.
4. Developing simple image analysis applications.

Total L:45 + T: 30=75

TEXT BOOKS:
1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer, 2010.
2. Anil K Jain, “Fundamentals of Digital Image Processing”, Prentice Hall, 2001.
3. David Forsyth and Jean Ponce, “Computer Vision: A Modern Approach”, Pearson, 2012.
4. Bernd Jahne, “Computer Vision and Applications A Guide for Students and Practitioners”, Elsevier, 2000.

REFERENCES:
1. Rafael C Gonzalez and Richard E Woods, “Digital Image Processing”, Prentice Hall, 2011.
2. J.R. Parker, “Algorithms for image processing and computer vision”, John Wiley & Sons, 2010.

20XTE9 DATA COMPRESSION

3 2 0 4

Prerequisites
- 20XT22 COMPLEX VARIABLES AND TRANSFORMS
- 20XT24 DATA STRUCTURES AND ALGORITHMS
- 20XT33 PROBABILITY AND STATISTICS

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 – LZY 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

20XTEA RANDOMIZED ALGORITHMS

3 2 0 4

Prerequisites
- 20XT33 PROBABILITY AND STATISTICS
- 20XT34 ADVANCED DATA STRUCTURES

- 20XT41 STOCHASTIC PROCESSES
- 20XT54 DESIGN AND ANALYSIS OF ALGORITHMS

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 fo 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 pairwise independent values modulo a prime – large cut (4)

TUTORIAL PRACTICE:

1. Find solution for s-t min-cut problem adapting min cut algorithm.
2. Problems using treap 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 RaghavanP,"Randomized Algorithms", Cambridge University Press, 2014.
2. Michael Mitzenmacher and Eli Upfal, "Probability & Computing: Randomized Algorithms and Probabilistic Analysis", Cambridge University Press, 2017.

REFERENCES:

1. Thomas H Cormen, Charles E Leiserson and Ronald L Rivest, "Introduction toAlgorithms", MIT Press, 2009.
2. AnanyLevitin, "Introduction to Design and analysis of algorithms", Pearson Education, 2014.

20XTEB SECURITY IN COMPUTING

3 2 0 4

Prerequisites

- 20XT44 OPERATING SYSTEMS
- 20XT45 COMPUTER NETWORKS
- 20XT52 COMPUTATIONAL NUMBER THEORY AND CRYPTOGRAPHY

INTRODUCTION: Security concepts –Threats- Attacks - vulnerabilities and exploiting vulnerabilities - Services and Mechanisms -attacks and defenses on Computer systems. (4)

SOFTWARE SECURITY AND TRUSTED SYSTEMS: Malicious and non-Malicious programs – Buffer overflows - Fast flux - Covert channels -Defense mechanisms – Security Policies - Types - Trusted Computing - Trusted OS design-Virtualization security –containers. (7)

OPERATING SYSTEM SECURITY : Windows security - Understanding User Authentication- Securing Access with Permissions- Unix Security Overview - Protecting User Accounts and Strengthening Authentication - Limiting Super user Privileges - Securing Local and Network File Systems - Network Configuration - Hardening Linux and Unix - Proactive Defense for Linux and Unix (12)

SECURITY AT NETWORK LAYER: Network layer threats and security controls –Security problems in TCP/IP protocol suite – DNS Cache poisoning - IPSec – modes – security protocols – SA – Internet key exchange. (8)

ETHICAL HACKING AND PENETRATION TESTING: Principles of Intrusion detection – types– Architecture - Intrusion Detection and response - Network penetration testing- reconnaissance – scanning- Exploitation. (7)

WEB APPLICATION SECURITY: Email security –S/MIME – Web Security – Cross site scripting – SQL injection attacks – Defense methods- Session integrity for web applications- SSL Architecture – Secure session management-- Session hijacking - securing a web server. (7)

TUTORIAL PRACTICE:

1. Password guesses using brute force in a web based application
2. Detection of a Buffer overflow attack.
3. Packet Sniffing using Wireshark Tool, Nmap to perform the traffic analysis attack.
4. Key distribution using RSA(KDC) – Key hacking.
5. Key exchange using Diffie- Hellman technique – MITM attack.
6. Digital signature, generation and verification.
7. Password authentication in a database
8. Transaction security using SQL Injection attacks.
9. Port scanning tools.
10. Performing attacks and testing with attack tools.
11. Security testing for Web applications

Total L:45+TP:30 = 75

TEXT BOOKS:

1. Roberta Bragg, Mark Rhodes, Keith Strass Berg J, “Network Security - The complete reference”, Tata McGraw Hill, 2017.
2. John r. Vacca , “Network and system security”, Syngress,imprint of Elsevier, 2014
3. Patrick Engebretson ,David Kennedy , “The Basics of Hackingand Penetration Testing”, Syngress publications ,Elseiver,, 2013.
4. Darril Gibson , Microsoft Windows Security Essentials, ,Wiley, June 2011

REFERENCES:

1. William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson Education, 2014.
2. Charles P. Pfleeger and Lawrence Pfleeger,”Security in Computing”, Pearson Education, 2006
3. Jaegar A, “Operating Systems Security – Synthesis Lectures on Information Security, Privacy and Trust”, Morgan & Claypool Publishers, 2008.
4. Matt Bishop, “Introduction to Computer security”, Pearson Education, 2009

20XTEC ADVANCED OPERATING SYSTEMS

3 2 0 4

Prerequisites

- 20XT14 PROBLEM SOLVING AND C PROGRAMMING
- 20XT35 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING
- 20XT44 OPERATING SYSTEMS

LINUX SYSTEM: Design Principles – Kernel Modules – Process Management Scheduling – Memory Management – Input-Output Management – File System –Inter-process Communication. iOS and Android: Architecture and SDK Framework – Media Layer – Services Layer – Core OS Layer. (6)

OVERVIEW OF SYSTEM CALLS: anatomy of a system call and x86 mechanisms for system call implementation - MMU/memory translation, segmentation, and hardware traps interact - create kernel-user context separation – virtualization. (6)

THE KERNEL EXECUTION AND PROGRAMMING CONTEXT: Live debugging and tracing– Hardware and software support for debugging –Dtrace: programming, implementation/design, internals–Kprobes and SysTrace: Linux catching up. (7)

Linking and loading– Executable and Linkable Format (ELF)– Internals of linking and dynamic linking –Internals of effective spinlock implementations on x86. (4)

Process and thread kernel data structures– process table traversal – lookup, allocation and management of new structures- /proc internals– optimizations. (4)

Virtual File System and the layering of a file system call from API to driver– Object-orientation patterns inkernel code– a review of OO implementation generics (C++ vtables, etc). (8)

Kmem and Vmem allocators. OO approach to memory allocation–Challenges of multiple CPUs and memory hierarchy–Overview of the kernel network stack implementation– Path of a packet through a kernel– Berkeley Packet Filter architecture– Linux Netflter architecture. (10)

TUTORIAL PRACTICE:
1. Implementation of Process and Memory System call
2. Writing Kernel Module
3. Accessing Kernel data structure
4. Using Dtrace and strace
5. Implementing kernel network stack

Total L:45+T:30 = 75

TEXT BOOKS:
1. Robert Love, Linux System Programming, O'Reilly, 2013
2. Yang Lixiang, Liang Wenfeng, The Art of Kernel Linux design, CRC Press, 2016
3. Rami Rosen, Linux Kernel Networking : Implementation and Theory, Apress, 2014.

REFERENCES:
1. W. Richard Stevens, Stephen A. Rago, Advanced Programming in the UNIX Environment, Addison-Wesley, 2013

20XTED EXACT ALGORITHMS FOR HARD PROBLEMS

3 2 0 4

Prerequisites
- 20XT54 DESIGN AND ANALYSIS OF ALGORITHMS

POLYNOMIAL TIME ALGORITHMS FOR TREES AND SPECIAL INSTANCES OF SAT: 2-SAT, Horn SAT - Algorithms for vertex cover, dominating set, independent set in trees. (7)

POLYNOMIAL TIME ALGORITHMS FOR SPECIAL GRAPHS: Vertex cover in bipartite graphs: Konig's theorem - interval graphs - chordal graphs - split graphs - permutation graphs - perfect graphs. (7)

PARAMETERIZED ALGORITHMS: Fixed-parameter tractability (FPT): Basic Algorithmic Techniques:Kernelization, Branching, Iterative Compression, Miscellaneous Techniques: Linear Programming, Color Coding. (10)

HARDNESS THEORY: Introduction to Reductions, W[1] & W[2] hard reduction – reduction with vertex and edge representation. (7)

EXACT EXPONENTIAL ALGORITHMS: Exponential-Time Hypothesis (ETH) – ETH and classical complexity – ETH and FPT problems – ETH and W[1] problems. (7)

ETH BASED LOWER BOUNDS: Branching - Hitting set - Dynamic Programming – Inclusion Exclusion – Treewidth. (7)

TUTORIAL:
1. Implementation of polynomial algorithm for 2-SAT.
2. Given a tree, find the vertex cover, domination set, and independent set.
3. Implement the algorithm for finding vertex cover in bipartite graphs.
4. Implement the various polynomial time algorithms for interval graphs, chordal graphs, split graphs, and permutation graphs.
5. Implement basic branching algorithm.

TEXT BOOKS:
1. Martin Charles Golumbic, "Algorithmic Graph Theory and Perfect Graphs", Annals of Discrete Mathematics, Elsevier, 2004.
2. Rolf Niedermeier, "Invitation to Fixed-Parameter Algorithms", Oxford Univ. Press, 2006.
3. Fomin F V., Kratsch D, "Exact Exponential Algorithms", Springer, 2010.

REFERENCES:
1. Andreas Brandstädt,Van Bang Le, Jeremy P. Spinrad, "Graph Classes: A Survey", SIAM Monographs on Discrete Mathematics and Applications, 1987.
2. Cygan M, Fomin F V., Kowalik Ł, Lokshtanov D, Marx D , Pilipczuk M, Pilipczuk M, Saurabh S, "Parameterized Algorithms", Springer, 2015.

20XTEE MOBILE COMPUTING

3 2 0 4

Prerequisites

- 20XT45 COMPUTER NETWORKS
- 20XT58 JAVA PROGRAMMING LAB

INTRODUCTION: 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
4. To Launch Activities
5. Application using GUI Widgets
6. Application with Notifications
7. Creating and Saving Shared Preferences and Retrieving Shared Preferences
8. Usage of SQLite Databases for storage
9. Working with Retrofit library in Android Applications
10. Android Automated Testing Frameworks
11. Case Study: Dagger Framework for Android

Total L: 45 + T: 30 = 75

TEXT BOOKS:

1. Jochen Schiller, “Mobile Communications”, Pearson Education, 2012.
2. Martyn Mallick, “Mobile and Wireless Design Essentials”, Wiley, 2003
3. John Horton, “Android Programming for Beginners”, Packt Publishing, 2017.

REFERENCES:

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

20XTEF BIG DATA AND MODERN DATABASE SYSTEMS

3 2 0 4

Prerequisites

- 20XT34 ADVANCED DATA STRUCTURES
- 20XT42 DATABASE DESIGN

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 VsNoSQL 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)

Tutorials:

1. ORDB, Spatial databases.
2. Distribution using Map-Reduce on Big Data (Hadoop).
3. Data Integration from heterogeneous Databases.
4. Creating and querying of object databases and object relational databases
5. Implementing of spatial databases and spatial queries
6. Implementation of No-SQL databases :DynamoDB, MongoDB, HBASE, Neo4J.

Total L:45+T:30=75

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
4. Holden Karau, Andy Konwinski, Patrick Wendell, MateiZaharia, “Learning Spark: Lightning-Fast Big Data Analysis”, O'Reilly Media, 2015

REFERENCES

1. RamezElmasri and ShamkrantNavathe, “Fundamentals of Database Systems”, Addison Wesley, 2013.
2. M.TamerOzsu, PatrickValduriez, “Principles of Distributed Database Systems”, 2020.
3. Anhai Doan, Alon Halevy, Zachary Ives, “Principles of data integration”, Morgan Kaufmann, 2012.
4. Elmasri R and Navathe SB, “Fundamentals of Database Systems”, Pearson Education, 2016.

20XTEG NETWORK SCIENCE

3 2 0 4

Prerequisites

- 20XT32 GRAPH THEORY
- 20XT33 PROBABILITY AND STATISTICS
- 20XT34 ADVANCED DATA STRUCTURES

INTRODUCTION: 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. (8)

EVOLVING NETWORKS: Bianconi-Barabási model, measuring fitness, Bose-Einstein condensation, evolving networks. (8)

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)

TUTORIAL PRACTICE:

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 L: 45+T:30 = 75

TEXT BOOK:

1. Albert-LászlóBarabási, Network Science, Cambridge University Press, 2016.
2. FilippoMenczer, 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", Wiley, 2013.
3. Guido Caldarelli, Alessandro Chessa, Data Science and Complex Networks: Real Case Studies with Python, Oxford University Press, 2016.

20XTEH SECURITY MODELLING AND ANALYSIS

3 2 0 4

Prerequisites

- 20XT52 COMPUTATIONAL NUMBER THEORY AND CRYPTOGRAPHY

INTRODUCTION: Computer security - Cryptographic protocols - Security analysis - Needham-Schroeder example - Model checker- Murphi. (5)

KEY EXCHANGE AND CONTRACT-SIGNING PROTOCOLS: Key management - Kerberos - Public-Key infrastructure - Security properties and attacks on them -Diffie-Hellman key exchange - IPSEC - IKE. Contract-Signing and Fair-Exchange - Trusted third party - Optimistic Contract-Signing -Asokan-Shoup-Waidner protocol - Desirable properties –fairness- timeliness- accountability - Abuse-Free Contract-Signing. (10)

MODELING SECURITY PROTOCOLS IN CSP: Data types for protocol models- Modeling intruder - Expressing protocol goals - Overview of FDR and Casper - Protocol specifications - Case study: Wide-Mouthed-Frog protocol. (10)

PROTOCOL COMPOSITION LOGIC: Proving protocols secure - Symbolic model - Challenge Response example - Informal 'hand' proof - Formalization: protocol specification language - syntax - semantics - proof system - Protocol composition - Complexity theoretic semantics. (10)

FORMAL PROOF OF COMPUTER SECURITY PROTOCOLS: Protocol Verification by BAN logic and Inductive Method: BAN logic- syntax and semantics -Inductive Method: Analysis by theorem proving - Inductive proofs - Protocol traces -Dolev-Yao attacker model. (10)

TUTORIAL PRACTICE:

1. Modeling Needham-Schroeder protocol
2. Analyzing Needham-Schroeder protocol in BAN logic
3. ModelingAsokan-Shoup-Waidner protocol
4. Modeling an intruder in CSP, FDR and Casper
5. Modeling Wide-Mouthed-Frog protocol
6. Analyzing Wide-Mouthed-Frog protocol in BAN logic

Total: L:45+P:30 = 75

TEXT BOOKS:

1. Peter Ryan, Steve Schneider, 'Modeling and analyzing security protocols: the CSP approach'. Addison-Weasley, 2001
2. Colin Boyd, Anish Mathuria, 'Protocols for Authentication and Key Establishment'. Springer, 2010.

REFERENCES:

1. Tobias Nipkow, Lawrence C. Paulson, Markus Wenzel, 'A Proof Assistant for Higher-Order Logic', Springer, 2010.
2. C. A. R. Hoare, 'Communicating Sequential Processes', Prentice Hall, 2004.

3. Bella, Giampaolo, " Formal Correctness of Security Protocols", Springer, 2007.

20XTEI INTERNET OF THINGS

3 2 0 4

Prerequisites

- 20XT44 OPERATING SYSTEMS
- 20XT45 COMPUTER NETWORKS

INTRODUCTION TO IoT: Introduction to Internet of Things (IoT) – 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 – ComponentsofIoT: Embedded Computation Units, Microcontrollers, System on Chip (SoCs) - Sensors – Actuators – Communication Interfaces. (7)

RF COMMUNICATION TECHNOLOGIES INIoT: 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 INIoT: 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, 2014.
3. Thomas Erl, Dr. ZaighamMahmood, Professor Ricardo Puttini,"Cloud Computing: Concepts, Technology &Architecture",PHI, 2013
4. Brian Russell, Drew Van Duren, "Practical Internet of Things Security", Packt Publishing, 2016.

REFERENCES:

1. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", John Wiley, 2012.
2. Kai Hwang, GeofferyC.Fox, Jack J.Dongarra, "Distributed and Cloud Computing", Elsevier, 2012.
3. William Stallings,"Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud" Addison-Wesley, 2015
4. Jim Doherty, "SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization", Addison-Wesley, 2016
5. Johnny Cache, Joshua Wright and Vincent Liu, "Hacking Exposed Wireless: Wireless Security Secrets and Solutions", Tata McGraw Hill, 2010.

20XTEJ EPIDEMIC MODELS

3 2 0 4

Prerequisites

- 20XT11 CALCULUS AND ITS APPLICATIONS
- 20XT32 GRAPH THEORY

INTRODUCTION: The epidemic in a closed population – Initial growth-the final size. Heterogeneity:Differences in infectivity, differences in infectivity and susceptibility. (9)

STRUCTURED POPULATIONS: The concept of state - i-states, p-states, recapitulation and problem formulation. (7)

THE BASIC REPRODUCTION RATIO: The definition of R_0, general h-state, on conditions that simplify the computation of R_0, sub models for the kernel, extended example, pair formulation models. Partially vaccinated populations, the intrinsic growth rate r, some generalities, separable mixing. (15)

MACROPARASITES: Introduction, counting parasite load, the calculation of R_0 for life cycles, seasonality and R_0, a pathological model. (8)

CONTACT: Introduction, Contact duration, consistency conditions, effects of subdivision, network models. (6)

TUTORIAL PRACTICE:

1. 1.Comprehensive, practical introduction to infectious disease modeling
2. 2.Builds from simple to complex predictive models
3. 3.Models and methodology fully supported by examples drawn from research literature
4. 4.Practical models aid students' understanding of fundamental epidemiological processes
5. 5.In-depth treatment of role of modeling in understanding disease control

Total L:45+P:30=75

TEXT BOOKS:

1. Diekmann, J.A.P. Heesterbeek, “Mathematical Epidemiology of Infectious Diseases: Model building, Analysis and Interpretation”, John Wiley , 2000.
2. FredBrauer, Carlos Castillo-Chawez, and Zhilan Feng, "Mathematical models in Epidemiology", Springer, 2019.
3. Diekmann O., Heesterbeek, J.A.P. and Britton, T. Mathematical tools for understanding infectious disease dynamics. Princeton University Press, 2012.

REFERENCES:

1. 1.Matt J .Keeling, PejmanRohani, "Modeling Infectious Diseases in Humans and Animals", Princeton University Press, 2007.
2. Roy M. Anderson and Robert M. May, “Infectious diseases of humans; dynamic and control” Oxford university press, 1992.

20XTEK STATISTICAL LEARNING

3 2 0 4

Prerequisites

- 20XT33 PROBABILITY AND STATISTICS
- 20XT53 MACHINE LEARNING

THEORETICAL FOUNDATIONS : Review of Statistical Inference, Review of Probability, Testing of Hypothesis – Introduction to Function **Spaces** – Vector Spaces - Metric Spaces – Cauchy Sequence – Complete Metric Space – Normed Space, Inner Product Space – Banach Space - Hilbert Space – Sobolev – Examples - Mercer Kernels - Reproducing Kernel Hilbert Space (RKHS), Concentration of Measure : Measures of Complexity - Rademacher Complexity (10)

LINEAR REGRESSION: Simple, Multiple, Other Considerations in the Regression Model – Resampling Methods – Cross-Validation, Bootstrap – Linear Model Selection &Regularisation – Subset Selection , Shrinkage Methods – Ridge, Lasso, Dimension Reduction Methods. (8)

NON-LINEAR REGRESSION : Polynomial Estimators, Step Functions, Basis Functions, Regression Spline, Smoothing Splines, Local Regression, Generalised Additive Models (4)

LINEAR CLASSIFICATION: Review of Classification Models, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Comparison of Classification Methods. (6)

TREE BASED METHODS: Regression Trees, Classification Trees,Bagging, Random Forests, Boosting. (9)

SUPPORT VECTOR MACHINES: Maximal Margin Classifier – Support Vector Classifiers - Support Vector Machines – Non-linear Decision Boundaries – SVMs with more than 2 classes. (4)

UNSUPERVISED LEARNING: Principal Components Analysis – Clustering Methods – K-Means Clustering, Hierarchical Clustering. (4)

TUTORIAL PRACTICE:

Solve the following problems using R

1. Simple Regression, Multiple Regression, Ridge Regression and Lasso Regression.
2. Non-linear Regression, Splines and Additive Models
3. Linear Classification,
4. Tree based methods
5. Support Vector machines
6. Clustering Methods

Total L: 45+P: 30 = 75

TEXT BOOKS:

1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, “An introduction to Statistical learning”, Springer, 2013.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, “Elements of Statistical Learning: Data Mining, Inference and Prediction”, Springer, 2013.

REFERENCES:

1. Vladimir N Vapnik, “Statistical learning theory”, Wiley, 1998.
2. Robert Schapire, Yoav Freund, “Boosting : Foundations and Algorithms”, The MIT Press, 2012.

20XTEL LARGE SCALE MACHINE LEARNING

3 2 0 4

Prerequisites

- 20XT43 OPTIMIZATION TECHNIQUES
- 20XT53 MACHINE LEARNING

Introduction - 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 - Fussed Lasso - Low-rank Matrix Recovery – Sketchingand Randomized Linear Algebra - Approximate nearest neighbor 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
2. theMNIST dataset.
3. Using different sampling schemes for stochastic gradient descent.(random sampling, sequential sampling, sub sampling)
4. Applications using Distributed ML - Spark MLLib and Graph labs
5. Application using Sparse models
6. 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 PurushottamKar “Non-convex optimization for machine learning”, Now publishers Inc., 2017
2. Greg W, Alice Guionnet, OferZeitouni, “An Introduction to Random Matrices”, Cambridge press, 2010

20XTEM COMPUTATIONAL GEOMETRY

3 2 0 4

Prerequisites

- 20XT32 GRAPH THEORY
- 20XT34 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. (2)

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 Voronoidiagram, 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, Mark Overmars, “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.

OPEN ELECTIVES

20XTO1 COMPUTATIONAL FINANCE

3 2 0 4

Prerequisites

- 20XT11 CALCULUS AND ITS APPLICATIONS
- 20XT33 PROBABILITY AND STATISTICS
- 20XT41 STOCHASTIC PROCESSES

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.

20XTO2 PRINCIPLES OF MANAGEMENT AND BEHAVIORAL SCIENCES

3 2 0 4

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 RamachandraAryasri, “Principles of Management”, Tata McGraw Hill, 2004.
2. Mamoria C B, “Personnel Management”, Sultan Chand, 2005.

REFERENCES:

1. John W Newstrom and Keith Davis, “Organizational Behavior”, Tata McGraw Hill, 2002.
2. Stephen P Robbins, ”Organisational behavior”, Prentice Hall, 2010.
3. Khanna O P, “Industrial Engineering & Management”, DhanpatRai Publications, 2010.

20XTO3 ENTREPRENEURSHIP

3 2 0 4

INTRODUCTION TO ENTREPRENEURSHIP: Definition – Characteristics and Functions of an Entrepreneur – Common myths about entrepreneurs – Importance of Entrepreneurship. Creativity and Innovation**:** The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process.(11)

FORMS OF BUSINESS ORGANIZATION: Sole Proprietorship – Partnership – Limited liability partnership - Joint Stock Companies and Cooperatives. Developing an Effective Business Model:The Importance of a Business Model – Starting a small scale industry - Components of an Effective Business Model. (9)

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

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**.** Intellectual Property Protection and Ethics**:** Patents – Copyright - Trademark- Geographical indications – Ethical and social responsibility and challenges. (9)

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

20XTO4 COMPUTATIONAL COMPLEXITY THEORY

3 2 0 4

Prerequisites

- 20XT51 THEORY OF COMPUTING
- 20XT54 DESIGN AND ANALYSIS OF ALGORITHMS

INTRODUCTION: The computational model - Modeling computation and efficiency - Review of Turing machines – Universal Turing machines – Uncomputable functions – Deterministic time and the class P . (5)

COMPLEXITY CLASSES: P, NP, NP Complete, NP-Hard - P vs NP – NP completeness – Relation between NP and NP completeness – The cook Levin theorem – The web of reductions – Decision vs Search – coNP, EXP and NEXP. (8)

DIAGONALIZATION: Time hierarchy theorem – Space hierarchy theorem – non deterministic time hierarchy theorem – Oracle machines - Space complexity – Configuration graphs – Some space complexity classes – PSPACE completeness – NL Completeness. (8)

POLYNOMIAL HIERARCHY AND ALTERNATIONS: The classes $\sum_2^p$ and π_2^p – The polynomial hierarchy – Alternating turing Machines – Time versus alternations – Defining the hierarchy via oracle machines. (8)

CIRCUITS – Boolean circuits – Karp Lipton theorem – Circuit lower bounds. (2)

RANDOMIZED COMPUTATION: Probabilistic Turing Machines (PTM) –Examples - RP (Randomized Polynomial) , BPP (Bounded Error probabilistic polynomial) ,Complement Randomized Polynomial (Co-RP) – Probabilistic Polynomial (PP) – Randomized logarithmic space polynomial time (RL) – Related problems. (5)

COUNTING PROBLEMS: Counting classes – Complexity of counting problems – An approximate comparison procedure - Constructing A-Comp - Non-Uniform Classes– Oracles – Relativization. (6)

APPLICATIONS - Randomized decision tree – Pseudo random number generators. (3)

TUTORIAL PRACTICE:

1. Implementation of finding a solution to different classes of problems
2. Implementation of randomized decision tree

Total L: 45 + T: 30 = 75

TEXT BOOKS:

1. Sanjeev Arora, Boaz Barak, “Computational Complexity : A modern approach”, Cambridge University Press, 2012.
2. Goldreich, “Computational Complexity: A Conceptual Perspective”, CUP 2010.

REFERENCES:

1. Michael Sipser, “Introduction to the Theory of Computation”,Cengage learning, 2012.
2. Luca Trevisan, “Lecture Notes on Computational Complexity”, 2004.

20XTO5 WIRELESS NETWORKS

3 2 0 4

Prerequisites

- 20XT45 COMPUTER NETWORKS

WIRELESS NETWORK OVERVIEW: Wired and wireless Networks- Effect of mobility on systems**-** Introduction to wireless technologies- RF Overview - Wireless Signal Propagation-Signal-to-Noise Ratio – Modulation - ISM Spectrum - Frequency Hopping Spread Spectrum (FHSS) - Direct Sequence Spread Spectrum (DSSS)- Orthogonal Frequency Division Multiplexing (OFDM) - Coordination mechanisms and MAC protocols for multi-user network access. (8)

WLAN TECHNOLOGIES: IEEE 802.11 Standard—WPA (Wi- Fi Protected Access)-WPA2- WEP (wired Equivalence Privacy)-Static WEP Wireless Architecture- Bluetooth –Zigbee Wireless data networks-Personal Area Networks-GPRS architecture. (9)

AD HOC AND SENSOR NETWORKS: Ad hoc Network- Characteristics- Table-driven and On Demand routing protocols, Hybrid protocols -. Wireless Sensor networks- Classification, MAC and Routing Protocols. (6)

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. (6)

WIRELESS THREATS AND RISKS: Security breaches on wireless Networks- Eavesdropping-Jamming - RF interference - Covert wireless channels-Traffic Analysis Spoofing- DOS attack - Malicious Code -Cryptographic threats- Rogue Access Points - MAC Filtering Attacks - Attack on MiC - RADIUS Vulnerabilities – WPA and 802.1x Vulnerabilities - Attacks on Wireless

Gateways. (8)

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

TUTORIAL PRACTICE:

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

Total L: 45+T: 30 = 75

TEXT BOOKS:

1. William Stallings, "Wireless Communication and Networks", Pearson Education, 2016.
2. Gary. S. Rogers and John Edwards, "An Introduction to Wireless Technology", Pearson Education, 2012.
3. SivaRam Murthy C and B.SManoj, "Ad hoc Wireless Networks Architecture and Protocols", Pearson Education, 2012.
4. KavehPahlavan, Prashant K. Krishnamurthy, "Principles of Wireless Networks : A Unified Approach", John Wiley, 2011.

REFERENCES:

1. Dharma Prakash Agrawal and Qing-An Zeng, "Introduction to Wireless and Mobile Systems", Thomson Press, 2007.
2. Feng Zhao and LeonidasGuibas, "Wireless Sensor Networks-An Information Processing Approach", Elsevier, 2004.
3. Ivan Stojmenovic, "Handbook of Wireless Networks and Mobile Computing", John wiley, 2006.
4. SavoGlisic, "Advanced Wireless Communications 4G Technologies", Wiley Publications, 2006.

20XTO6 COMPUTATIONAL FOUNDATIONS FOR ROBOTICS

3 2 0 4

INTRODUCTION: Robots and their applications in industry, mobile and service applications, Configurations of industrial and mobile robots. Robot controllers, drives, actuators and sensors, Spatial descriptions and Transformations: Positions, orientations and frames, Mappings, translations, rotations and transformations, transformation arithmetic, Transform equations, representation of orientation, free vector transformation, Introduction to ROS. (12)

FORWARD AND INVERSE KINEMATICS: Link co-ordinates, D-H Representation, Arm equation -Two axis and three axis, robots**,** Inverse kinematics of two axis and three axis robots, Maneuverability – Workspace – Control. (15)

LOCALIZATION AND MAPPING: Challenges in mobile robots, Introduction - Bayes filter – Kalman Filter - Extended Kalman Filter - Information Filter - Histogram Filter - Particle Filter –Localization- Map Representation- Probabilistic Map based Localization-Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems-Route based localization – Mapping – Metrical maps - Grid maps - Sector maps – Hybrid Maps – SLAM. (18)

DECISION MAKING: Discrete planning and dynamic programming principles, Configuration space abstraction, Sampling-based planners for mobile robots, Feedback-based planning for mobile robots- Feedback in discrete spaces, wave-front functions, Potential and navigation functions for mobile robots. (15)

PLANNING AND NAVIGATION: Overview of the three computational components and their interaction, sensing, planning, and control - Global path planning – A* Algorithm - local path planning - Road map path planning- Cell decomposition path planning-Potential field path planning-Obstacle avoidance – Path control. Markov Decision Process (MDP) in discrete spaces, optimal control and steering methods- Nonlinear optimization and gradient methods. (15)

TUTORIAL PRACTICE:

1. Robot Operation System (ROS) basics
2. Localization
3. Path planning and navigation
4. Multi-robot coordination

Total L:45 + T: 30 = 75

TEXT BOOKS:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson Education Company, 2008
2. Steven M. LaValle, Planning Algorithms, Cambridge University Press, 2006
3. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki, Sebastian Thrun,

Principles of Robot Motion Theory, Algorithms, and Implementations (PRMTAI), MIT Press, 2005.

REFERENCES:

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modeling and Control”, Wiley, 2006.
2. Kevin M. Lynch and Frank C. Park, “Modern Robotics: Mechanics, Planning, and Control”, Cambridge University Press, 2017.
3. Roland Siegwart, Illah Reza Nourbakhsh and DavideScaramuzza, “Introduction to Autonomous Mobile Robots”, MIT Press, 2004.

20XTO7 GEOMETRY FOR GRAPHICS

3 2 0 4

Prerequisites

- 20XT31 LINEAR ALGEBRA

Introduction: Coordinate systems – Cartesian, Polar, Cylindrical and spherical, Points, lines, angles, simple closed curve, Polygon, polyhedron, platonic solids. Vector space, basis, Dimension, change of basis, norm, linear transformations.(2)

Euclidean Geometry: Axiomatic system, Euclid’s postulates. Euclidean transformation, Isometry - Translation, scaling, reflection. Euclidean-Congruence of triangles, Triangle angle sum, Pythagorean Theorem. (9)

Conics: Degenerate and non-degenerate conics. Circles, Orthogonal Circles, Thales' theorem, Circles through Two Points. Parabola, Ellipse, hyperbola, rectangular hyperbola. Polar Equation of a Conic. Properties of Conics – Tangent, normal, reflection. Quadric Surfaces in R^3, classifications, ruled surface in R^3 - Hyperboloid of One Sheet, Hyperbolic Paraboloid.(9)

Affine Geometry: Affine Transformations, affine properties, Images of Sets, parallel projection, Properties. Ellipse - Midpoint Theorem, Conjugate Diameters Theorem, Fundamental Theorem of Affine Geometry, Barycentric Coordinates - Section Formula. Classifying Non-Degenerate Conics. (9)

Projective Geometry-Lines: Perspectivity, Desargues’ Theorem. Projective Points, Projective Plane RP^2 - Projective Lines, Collinearity Property, Incidence Property. Embedding Planes, projective transformation – properties, Fundamental Theorem of Projective Geometry. Perspectivity Theorem. (9)

Projective Geometry-Conics: Projective Conic- standard form, Parametrization Theorem, Tangents to Projective Conics, Eccentricity Formula, Plane Sections of a Right Circular Cone, Three Tangents Theorem, Tangents to Plane Conics.(7)

Tutorial Practice:

1. Basic transformations
2. Matrix transformations
3. Transformations between coordinate systems
4. Drawing lines, planes, conics
5. Finding direction ratios and cosines
6. Convex and non-convex polygons, convex hull of a polygon
7. Sweep line and Map overlay of polygons
8. Affine transformations - parallel projections, images, conics
9. Projections – projective planes and lines, transformations, cross-ratio, projective conics

Total L: 45+T:30 = 75

TEXT BOOKS:

1. David A Brannan, Matthew F Esplen, Jeremy J Gray, Geometry, Cambridge University Press, 2017.
2. Ray C. Jurgensen, Richard G. Brown, John W. Jurgensen, Geometry, McDougal Littell - A Houghton Mifflin Company, 2000.

REFERENCES:

1. John Vince,Mathematics for Computer Graphics, Springer-Verlag, 2011.
2. Donald D Hearn, Pauline Baker M, Computer Graphics, Pearson 2018.
3. Fundamentals of Computer Graphics**,** Peter Shirley, Steve Marschner, A K Peters/CRC Press, 2011.

20XTO8 DIGITAL TOPOLOGY

3 2 0 4

Prerequisites
20XT21 DISCRETE STRUCTURES

TOPOLOGICAL SPACES AND CONTINUOUS FUNCTIONS: Topological spaces, basis for a topology, subspace topology, order topology, closed sets and limit points, Hausdroff spaces, product topology, metric topology, continuous functions. (12+9)

CONNECTEDNESS AND SEPARATION AXIOMS: Connected spaces, connected sub sets of the real line, local connectedness, compact spaces, locally compact spaces, separation axioms- Regular, normal spaces. (8+5)

AXIOMATIC APPROACH TO DIGITAL TOPOLOGY: Axioms of Digital Topology, Relation between the suggested and classical Axioms, deducing the properties of Axiomatic Locally Finite spaces from the axioms. (7+4)

DIGITAL SPACES: Definitions, interiors, exterior, connectedness in digital spaces, isomorphism between digital spaces.. Digital Plane- Definition, Jordan curve theorem, graph of 4- and 8- topologies, line complex and cellular complex. (8 +5)

ABSTRACT CELL COMPLEXES: Topology of complexes, Cartesian complexes and combinatorial coordinates, AC complexes compared with other Locally Finite Spaces. (10+7)

Total L: 45 + T:30 = 75

TEXT BOOKS:

1. James R. Munkres, 'Topology- A First Course', Pearson, 2018.
2. ReinhardKlette , Azriel Rosenfeld,' Digital Geometry: Geometric methods for Digital Picture Analysis', Morgan
3. Kaufman , 2004.
4. Vladimir A. Kovalevsky, 'Geometry of Locally Finite Spaces: Computer Agreeable Topology and Algorithms for Computer
5. Imaginary', House Dr. BaerbelKovalevski, 2008.

REFERENCES:

1. Herbert Edlesbrunner and John Harer, 'Computational Topology– An Introduction', AMS, 2010.
2. Gabor T. Hermann, 'Geometry of Digital spaces', Birhauser, 1998.

20XTO9 ENVIRONMENTAL SCIENCE AND GREEN COMPUTING

3 2 0 4

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+P:30=75

TEXT BOOKS:
1. Mackenzie L. Davis, and David A. Cornwell, "Introduction to Environmental Engineering", Tata McGraw Hill, New Delhi, 2010
2. Chetan Singh Solanki, "Solar Photovoltaics", PHI, 2011.
3. Siraj Ahmed, "Wind Energy : Theory and Practice", PHI, 2011.
4. Mahajan S. P. Pollution Control in Process Industries, Tata McGraw Hill, 1985.
5. R. E. Hester and R. M. Harrison, "Electronic Waste Management", Royal Society of Chemistry, 2009.

REFERENCES
1. William W. Nazarodd and Lisa Alvarez-Cohen, "Environmental Engineering Science", Wiley-India, 2010
2. AnubhaKaushik and Kaushik C P, "Environmental Science and Engineering", New Age International, 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, RamzyKahhat, Eric Williams, "E-Waste Management : From Waste to resource", Routledge – Taylor and Fransis, 2012.
6. Diane GowMcdilda, "The Everything Green Living Book", Adams Media, 2007.

20XTOA FUNCTIONAL ANALYSIS

3 2 0 4

Prerequisites

20XT11 CALCULUS AND ITS APPLICATIONS
20XT31 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. LimayeB.V. "An Introduction to Functional Analysis", Newage International, 2014