Indian Institute of Information Technology Kalyani

Syllabus

Spring 2021

Course Code	**: CS 201**
Course Title	**: Data Structures and Algorithms**
Instructor	**: Dr. Sanjoy Pratihar**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**

Introduction

Introduction, objective, motivation. Definition of Data Structure, Classification of Data Structures, Operations on Data Structures

Algorithm and Asymptotic Analysis

Algorithm: Definition, Time Complexity, Space Complexity

Basic Data Structures and Applications

Arrays, Strings, Pointers, Structures ,
Singly Linked List: Traversal, Searching, Insertion, and Deletion.
Circular Linked List: Insertion, and Deletion. Doubly Linked List: Insertion, and Deletion. Circular Doubly Linked List: Insertion, and Deletion
Applications: Use of Linked List, Polynomial Representation of Linked List
Stack: Array Representation, Operations on a Stack (Push, Pop), Linked Representation of Stack, Operations on a Linked Stack
Applications of Stack: Evaluation of Arithmetic Expressions, Recursion: Factorial function, Towers of Hanoi
Queue: Array Representation, Linked Representation, Circular Queue, Deque, Priority Queues

Sorting

Sorting: Bubble Sort, Insertion Sort, Selection Sort, Merge Sort, Quick Sort, and Heap Sort

Tree

Tree: Binary Tree, Binary Search Tree, Creating a Binary Tree from a General Tree. Traversing a Binary Tree: Pre-order, In-order and Post-order Traversal, Huffman's Tree and Application.

Searching

Searching Techniques: Linear Search, Binary Search. Operations on Binary Search Tree: Searching, Insertion, and Deletion. Determining the Height of a Binary Search Tree, Search the Smallest Node in a Binary Search Tree, Search the Largest Node in a Binary Search Tree, Threaded Binary Tree. AVL Tree, Operations on AVL Tree, Searching for a Node in an AVL Tree, Red-Black Tree,

m-way Search Tree, B Tree, B+ Tree, 2-3 Tree, Binary Heap: Insertion, and Deletion, Binomial Heap, Fibonacci Heap

Graph

Graph: Directed Graph and Undirected Graph.
Representation of Graph: Adjacency Matrix.
Graph Traversal: Breadth-First Search and Depth-first Search.
Topological Sorting, Shortest Path Algorithms: Minimum Spanning Tree (Prim's Algorithm and Kruskal's Algorithm)

Hashing

Hashing: Definition, Hash Table, Hash Function.
Collision Resolution techniques: Open addressing and Chaining

Reference Books:

1. Seymour Lipschutz, Data Structures. Mc-Graw Hill Education.
2. Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tenenbaum, Data Structures Using C and C++. Pearson, 2nd Edition, 1996.
3. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Fundamentals of Data Structures in C. University Press.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms. Prentice Hall of India, 3rd ed., 2009

Course Code	**: EC 201**
Course Title	**: Digital Logic Design and Circuits**
Instructor	**: Dr. Dalia Nandi**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Number System:

Binary numbers, decimal, Octal & Hexadecimal Numbers, Number Base Conversion, 1's & 2's Complements, Binary arithmetic, Binary codes.

Boolean algebra & Logical Gates:

Basic Definitions, Boolean Algebra Theorems of Boolean Algebra, Boolean Functions, Digital Logic Gates, SOP, POS, Minterms, Maxterms, Simplification of Boolean functions: algebraic method, Karnaugh maps.

Combinational Logic Circuits

Half and Full adder, Half and Full subtractor, Parallel Adder, CLA, Code conversion circuit, Decoder, Encoder, Multiplexer, De- Multiplexer.

Sequential logic circuits:

Different flip flops and latches, Registers, Asynchronous and Synchronous counters. Finite state machine, State transition diagrams and state transition tables.

Memory elements:

ROM, PROM, RAM-SRAM, DRAM. PLA, PLD, FPGA

Analog-to-digital Converter
Digital-to-analog data converters.
Concept of programmable processors and microcontrollers.
Case studies: a simple computer, instruction coding and decoding, timing and controller circuits.

Reference Books:
1. Digital Electronics by Morris Mano
2. Digital Electronics by Salivahanan
3. Fundamental of Digital Circuits by A. Anand Kumar

Course Code	**: CS 202**
Course Title	**: Foundation of Data Science I (Probability and Statistics**
Instructor	**: Dr. Uma Das**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**

Introduction to Probability
Sample Spaces, Rules of Probability, Conditional Probability, Independent Events, Bayes Theorem

Probability Distributions and Probability Densities
Probability Distributions and Probability Densities, Joint Distributions, Marginal Distributions, Conditional Distributions.

Mathematical Expectation
Expectation value of a Random Variable, Moments, Chebyshev's Theorem, Moment Generating Functions

Special probability Distributions
Discrete Uniform, Bernoulli, Binomial, Negative Binomial, geometric, hypergeometric, Poisson distributions

Special Probability Densities
Uniform, Gamma, Exponential, Chi Square Distributions, Normal Distribution, Normal approximation to Binomial Distribution

Statistics
Sampling Distributions, Distribution of Mean, Chi Square Distribution, t distribution
Hypothesis Testing, Goodness of fit
Regression and Correlation, Method of least squares, linear regression

Reference Books:

1. John E. Fruend's Mathematical Statistics, 6th Edition by Irwin Miller and Marylees Miller.
2. An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md.E.Saleh.
3. Introduction to Probability and Statistics by J.S. Milton & J.C.Arnold.
4. Introduction to Probability Theory and Statistical Inference by H.J. Larson.
5. Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross
6. A First Course in Probability by S.M. Ross
7. Probability and Statistics in Engineering by W.W. Hines, D.C. Montgomery, D.M. Goldsman & C.M.Borror

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Course Code	**: CS 203**
Course Title	**: Discrete Mathematics**
Instructor	**: Dr. Debasish Bera**
Weekly contact	**: 3 – 1 – 0 (L – T – P)**

Sets, Relations, and Functions

Basics, Ordered pair, Power set, Cardinality, Operations on sets; Properties and classification of relations, Combining relations, Closures, Equivalence, Partial ordering. Sequences and Summations; Function: one-to-one, onto, inverse, composition, graphs.

Combinatorics

Basic counting rules, Pigeon hole principle, Permutations and combinations, Binomial theorem: Pascal's triangle and Multinomial theorems; Recursion and Recurrence relation.

Algebraic Structure

Binary operations; Group, Ring, Field, Semigroup, Subgroup, Coset. Order and Relation: POSET, Isomorphism; Lattices: Properties, classification, and types; Lattice Homomorphism.

Mathematical Logic and Proofs

Propositional logic, logical equivalence, predicates & quantifiers, logical reasoning, rules of inference, proof strategies and techniques. Mathematical reasoning: Mathematical Induction, Recursive definitions, Structural Induction

Matrix Algebra

Definition, types, operations on matrices; Rank of a matrix; Representation and solutions of linear equations; Eigenvalues and eigenvectors.

Graphs
Directed, undirected graphs.

Reference Books:

1. Discrete Mathematics- S. K. Chakraborty and B. K. Sarkar, Oxford Univ. Press.
2. Algebraic Coding Theory - Elwyn R. Berlekamp - McGraw-Hill

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Course Code	**: HU 201**
Course Title	**: Humanities (Economics)**
Instructor	**: Dr. Pradipta Bhattacharya (GF)**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Point of Initiation – Central Concepts of Economics
Scarcity and efficiency – Goods: Use & Exchange Value – The three fundamental questions of economic organization – Micro & Macroeconomics – Positive v/s Normative economics – Circular flow of income – Market, command and mixed economies – Society's technological possibilities

Introducing Demand & Supply
Demand Function and demand Curve, determinants of demand – Individual & Market Demand – changes in demand – Marshallian Law of Demand & its exceptions – Demand Elasticities – Techniques of Demand Forecasting.
The Supply Function & Supply Curve – general principle and exception – changes in supply – Supply elasticity – Concept of Market equilibrium & impacts of changes in demand and supply – Revenue

Theory of Consumer Behaviour
Concept of Utility – Cardinal v/s ordinal utility – Law of Diminishing Marginal Utility – Tools of analysis: Axiomatic Approach of Consumer Behaviour – Indifference Curves & Budget Space/Line – Consumer Equilibrium – Income & Substitution effects – derivation of Demand Curve from Indifference curve analysis – Price Consumption Curve and Income Consumption Curve – Engel Curve – Giffens & Inferior Goods - Taxes & Subsidies

Production & Cost
Production Function – the technological relationship between inputs & output – Short Run & Long Run Production analyses – Production with single variable input (short run) – stages of production & concept of economic zone of production; Long run production and tools of analysis: Isoquants and Isocost line, Producer's Equilibrium with two variable inputs, Ridge Lines and economic region – Expansion Paths
Different concepts of Cost of production, Fixed & variable Costs, Short run & Long run costs – concept of Opportunity Cost – The short run and long run

total, average and marginal cost curves and their relations – economies of scale and concept of Optimum Plant-size

Market Morphology
Market Equilibrium and the Rule of Profit-maximization – Concept of Profit – Financial Profit v/s Economic Profit – concepts of break-even & shut-down points; Types of markets & their characteristics – Perfect Competition and its short run & long run equilibrium – concepts of increasing, decreasing & constant cost industry; Monopoly – causes of monopoly – Natural Monopoly – measure of monopolistic power (Lerner's Index) – Short run and Long run equilibrium of Monopoly – Concepts of different types of monopoly pricing – Monopoly has no supply curve – Multi-plant Monopolist, Price-discriminating Monopolist – welfare costs of monopoly

Rudiments of Macroeconomics
Measurement of economic activity – National Income; Closed & Open economy - foreign trade and balance of payments; Inflation & Unemployment – Economic policies

Reference Books:
1. Economics, by P. Samuelson & W. Nordhaus, 19th Edn. Indian Adaption by Sudip Choudhury & Anindya Sen.
2. Managerial Economics - by Peterson & Lewis
3. Managerial Economics - by Mansfield
4. Economics - Principles & Applications - by G. Mankiw
5. Micro Economic Theory - by G.S. Maddala
6. Macroeconomics - by R. T. Froyen

Course Code	**: EC 211**
Course Title	**: Digital Logic Design and Circuit Lab**
Instructor	**: Dr. Dalia Nandi**
Weekly contact	**: 0 – 0 – 3 (L – T – P)**

Experiments on

1. Basic Gates & Universal Gates
2. Simplification of Boolean Expression and realization using Universal Gates
3. Adder and Subtractor
4. Design of different Code converters
5. Realization of comparator and other combinational circuits
6. Decoder circuit
7. Demultiplexer circuit
8. Multiplexer circuit
9. Design of Encoder circuit
10. Realization of different flip-flops

11. Design of Asynchronous/ Synchronous counter
12. Design of Shift Registers

Reference Books:

1. Digital Electronics by Morris Mano
2. Digital Electronics by Salivahanan
3. Fundamental of Digital Circuits by A. Anand Kumar

Course Code	**: CS 211**
Course Title	**: Data Structure and Algorithm Lab**
Instructor	**: Dr. Sanjoy Pratihar**
Weekly contact	**: 0 – 0 – 3 (L – T – P)**

List of Experiments

1. Experiments to understand concept of Array, Pointers and Structure
2. Experiments to understand and implement the concept of different types of linked lists
3. Experiments to understand the importance and applications of linked lists.
4. Experiments to understand the concept of different types of stack and queue.
5. Experiments to understand the importance and applications of stack and queue.
6. Experiments to understand the concept of different types of trees and the related algorithms, use of trees in problem solving.
7. Experiments to understand the importance and applications of trees and heap.
8. Experiments to understand the design and analysis of different searching and sorting algorithms.
9. Experiments to understand the concepts of different types of graphs.
10. Experiments to understand the different graph algorithms to solve the various problems.
11. Experiments to understand the concept of hashing and different collision resolution techniques

Reference Books:

1. Seymour Lipschutz, Data Structures. Mc-Graw Hill Education.
2. Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tenenbaum, Data Structures Using C and C++. Pearson, 2nd Edition, 1996.
3. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Fundamentals of Data Structures in C. University Press.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms. Prentice Hall of India, 3rd ed., 2009

Course Code	**: CS 212**
Course Title	**: Introduction to Environmental and Data Science**
Instructor	**: Dr. Uma Das**
Weekly contact	**: 1 – 0 – 2 (L – T – P)**

Theory

Environment & Ecology

Definitions, Components of environment and ecology, structure and function of an ecosystem, Major ecosystem of the earth (forest, desert, marine etc.). Ecological succession, Bio-geochemical cycles, Bio-magnification, Bio diversity and its conversation. Population growth, Renewable and non-renewable resources, Resource consumption, Sustainable Development. Environment degradation: Natural and man- made hazards (Flood, Earthquake, Landslide etc.), Disaster Management.

Pollution and Control

Basic Concepts of Air, Water, Land, and Noise Pollution.

Atmospheric Composition, Energy balance, Radiation heat transfer, Simple global temperature model (Earth as a black body, earth as albedo). Air pollutants such as aerosols, CO2, O3, SOx, NOx, PM10, PM2.5, etc. Surface water and ground water, Water pollutants - origin and effects.

Global Environmental Issues

EL-Nino phenomenon, Depletion of Ozone layer, Role of CFC & other greenhouse gases on ozone layer depletion and remedial measures. Global warming: Causes, Consequences and control measures.

Practicals - Environmental Data Science

(C or Python or any other programming language)

1. Reading environmental data* from files – txt, csv, etc.
2. Compute statistical parameters – mean, standard deviation, etc.
3. Grouping/Binning Data – with respect to time, location, etc.
4. Basic Visualization Techniques (in MS-Excel, python, etc.)

a. Exploring colour to highlight, distinguish data
b. Annotation of figures and plots for making them self-explanatory
c. Recognise data patterns, trends

5. Regressions – Linear Fitting, Curve Fitting, etc.
6. Introduction to reading, plotting and analysing Satellite Data (nc and hdf file formats)

a. Numerical and Image Data
b. Sampling Patterns
c. Spatio-Temporal and Spectral Resolutions

*Atmospheric temperature, rainfall, pressure, pollutant concentrations, El nino indices, ozone concentrations, water table levels, land coverage, etc, that are discussed in the theory part.

Reference Books:

1. 'Environmental Studies' by Erach Bharucha (For Undergraduate Courses of all Branches of Higher Education) and references therein.
2. Programming with C (Schaum's Outlines Series), by Byron Gottfried, Jitender Chhabra

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Course Code	**: CS 401**
Course Title	**: Operating Systems**
Instructor	**: Dr. Bhaskar Biswas**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Overview and Functions of operating systems

Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management.

System calls

System Calls, Types of System Calls, System Programs, Virtual Machines, System Booting.

Processes

Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication, Examples of IPC Systems, Synchronisation.

Threads

Basic Threads, Multithreading Models, Thread Libraries, Threading Issues, POSIX Threads.

CPU Scheduling

Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling, Examples.

Memory Management

Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Virtual Memory.

File Management

File Concept, Access Methods, Disk and Directory Structure, File-System Mounting, File Sharing, Protection.

I/O Systems

I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to Hardware Operations, STREAMS, Performance.

Protection and Security
Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of Access Matrix, Access Control, Revocation of Access Rights, Language-Based Protection, User Authentication, Miscellaneous Issues.

Reference books:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts. Sixth edition. Addison-Wesley. (2003)
2. Andrew Tanenbaum & Albert Woodhull, Operating Systems: Design and Implementation. Prentice-Hall. (2006)

Course Code	**:**	**CS 402**
Course Title	**:**	**Foundation of Data Science II (Numerical Analysis and Computing)**
Instructor	**:**	**Dr. Anirban Lakshman**
Weekly contact	**:**	**3 – 1 – 0 (L – T – P)**

Error Analysis
Exact and approximate numbers, Rounding of numbers,
Significant digits, Correct digits, various types of errors encountered in computations, Propagation of errors.

Solution of system of linear equations
(i) Direct methods: Gauss elimination
method without pivoting and with pivoting, LU-decomposition method.
(ii)Iterative methods: Jacobi and Gauss-Seidel methods.

Roots of non-linear equations
Bisection method, Regula-Falsi method, Newton-Raphson method, direct iterative method with convergence criteria, Newton-Raphson method for solution of a pair of non-linear equations.

Interpolation
Finite difference operator and their relationships, difference tables, Newton, Bessel and Stirling's interpolation formulae, Divided differences, Lagrange interpolation and Newton's divided difference interpolation.

Numerical differentiation
First and second order derivatives by various interpolation formulae.

Numerical integration
Trapezoidal, Simpsons 1/3rd and 3/8th rules with

errors and their combinations, Gauss Legendre 2-points and 3-points formulae

Solution of first and second order ordinary differential equations
Picard's method, Taylor's series method, Euler, Modified Euler, Runge-Kutta methods and Milne's method.

Case studies

Reference books:

1. Conte, S. D. and DeBoor, C., "Elementary Numerical Analysis", McGraw-Hill Publisher
2. Gerald, C. F. and Wheatly, P. O.," Applied Numerical Analysis", 6th
3. Edition, Wesley.
4. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., "Numerical Methods for
5. Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi.
6. Atkinson, K. E., "Introduction to Numerical Analysis", John Wiley

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Course Code	**: CS 403**
Course Title	**: Object Oriented Programming (Java)**
Instructor	**: Dr. Oishila Bandyopadhyay**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Principles of Object Oriented Programming
Programming Paradigms, Basic concepts, Properties of OOP, Benefits of OOP, Applications of OOP.

Introduction to Java
History of Java, Java byte code, JVM, JRE, Basic data types, Variables, Operators, Control structures including selection, Looping, Comparison with C and C++.

Classes and objects
Encapsulation, Class specification, member function specification, scope resolution operator, Access qualifiers, Instance creation, Constructors, parameterized constructors, Overloaded constructors, Constructors with default arguments, copy constructors, static class members and static objects.

Inbuilt classes
String, Character, StringBuffer, File, this reference, Array of objects.

Inheritance and Polymorphism
Inheritance in java, Super and sub class, Overloading, Overriding, Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java,

Package
Package in java, UTIL package, Collections in java

Exception Handling
Principle of Exception handling, Exception handling mechanism, multiple catch, Nested try, Rethrowing the exception.

Object Oriented Design
Introduction to Object oriented design and UML, Use case diagram, Class diagram, Sequence diagram

Event and GUI programming
Event handling in java, Event types, Mouse and key events, GUI Basics, Panels, Frames, Layout Managers- Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box, Applet and its life cycle, Introduction to swing.

I/O programming
Text and Binary I/O, Binary I/O classes, Object I/O, Random Access Files.

Thread in Java
Thread life cycle and methods, Runnable interface, Thread synchronization,

Design Patterns in Java
Introduction, Singletone design pattern, Creational design patterns, Structural design patterns

Case studies
JavaBeans, Network Programming, Graphics, Database handling.

Reference books:

1. Bruce, Foundations of Object Oriented Languages, PHI
2. Patrick Naughton, Herbert Schildt – "The complete reference-Java2" - TMH
3. Priestley – " Practical Object Oriented Design using UML" – TMH
4. "Advanced Programming for JAVA 2 Platform" Austin and Pawlan, Pearson
5. Ivor Horton, "Beginning J2EE 1.4" SPD Publication.
6. Rambaugh, James Michael, Blaha - "Object Oriented Modelling and Design" - Prentice Hall India/ Pearson Education

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Course Code	**: EC 401**
Course Title	**: Data Communication**
Instructor	**: Dr. Dalia Nandi and Dr. Rinky Sha**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction to Data Communication

Analog Data Transmission
Amplitude Modulation, Frequency Modulation, Phase Modulation, Performance of Analog Communication Systems in presence of Noise.

Digital Data Transmission
Sampling Theory,
Pulse Modulation: PAM, PPM, PWM, PCM.
Line Coding Techniques

Digital Modulation Techniques
ASK, FSK, PSK, QPSK, QAM
Performance of Digital Communication Systems in presence of Noise

Multiplexing techniques
FDM, TDM, CDMA

Source Coding
Fixed and Variable length coding, Huffman coding

Error Control Coding
Block code, linear block code, Hamming code, cyclic code

Reference books:

1. Data Communications and Networking by Behrouz A Forouzan
2. Introduction to Error Control Codes by Salvatore Gravano
3. Modern Digital and Analog Communication Systems by B.P. Lathi
4. Communication Systems (Analog and Digital) by Sanjay Sharma
5. Principles of Communication Systems by Taub and Schilling

Course Code	**: EC 402**
Course Title	**: Signals and Systems**
Instructor	**: Dr. Rinky Sha and Dr. Debasish Bera**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Signals and systems
Properties of signals and their classifications, Some Useful Signal Operations (Time Shifting, Scaling, Reversal and Combined Operations), Classification of Signals (Continuous-Time and Discrete-Time Signals, Analog and Digital Signals, Periodic and Aperiodic Signals, Energy and Power Signals, Deterministic and Random Signals), Some Useful Signal Models (Unit Step Function, Unit Impulse Function, Ramp Function, Sinc Function, Triangle Function, Rectangle Function), Even and Odd Functions and Some Properties of Even and Odd Functions, Systems, Classification of Systems (Linear and Nonlinear Systems,Time-Invariant and Time-Varying Systems, Instantaneous and Dynamic Systems, Causal and Noncausal Systems, Continuous-Time and Discrete-Time Systems, Analog and Digital Systems, Invertible and Noninvertible Systems, Stable and Unstable Systems)

Linear Time-Invariant Systems
Properties of Linear Time-Invariant Systems (the convolution integral, three basic properties of convolution as an algebraic operation), Impulse Response, Convolution, Causality, Stability

Sampling
The Bridge from Continuous to Discrete
The Sampling Theorem, Signal Reconstruction, Analog-to-Digital (A/D) Conversion, Dual of Time Sampling: Spectral Sampling

Fourier series & Fourier Transform (CT)
Expressing a periodic signal as a sum of complex exponentials, FS analysis and synthesis equations, orthogonality of the Fourier basis, Signal approximation using truncated Fourier series, Brief discussion of convergence issues and conditions for existence of the FS, Properties of the FS.
Aperiodic signals and their representation: the transition from the FS to the Fourier Transform. Finite power and finite energy signals. Brief discussion of convergence issues and conditions for existence of the FT. Extension of the FT for finite power signals: Properties of the FT: particular emphasis on convolution.

Discrete-time Fourier series & Discrete-time Fourier Transform
Discrete time systems and complex exponentials, Periodic discrete signal as a sum of complex exponentials, Analysis and synthesis equations, orthogonality of the Fourier basis, Signal approximation using truncated Fourier series, Convergence issues and the interpretation of the FS as a set of simultaneous linear equations, The DFT: N-point DFT of an M-point signal.
Aperiodic signals and their representation: the transition from the DTFS to the discrete-time Fourier Transform, Finite power and finite energy signals, Brief discussion of convergence issues and conditions for existence of the

DTFT, Extension of the DTFT for finite power signals: Properties of the DTFS and DTFT: particular emphasis on convolution

Laplace Transform
Introduction, Laplace Transform, the region of Convergence for Laplace Transforms, Inverse Laplace Transform, Properties of Laplace Transform, Analysis and characterization of LTI Systems using the Laplace Transform, First order and second order Systems

Z-Transform
Introduction, Z-Transform, the region of Convergence for the Z-Transform, Inverse Laplace Transform

Reference books:

1. "Signals and Systems", by Sanjay Sharma
2. "Principles of linear systems and signals", Oxford by B. P. Lathi
3. "Continuous and discrete signals and systems", Pearson by Samir S. Soliman and M. D. Srinath

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Course Code	**: CS 411**
Course Title	**: Operating Systems Lab**
Instructor	**: Dr. Bhaskar Biswas**
Weekly contact	**: 0 – 0 – 3 (L – T – P)**

Programming assignments on :
Basic shell commands.
System calls (fork(), pthread variants etc.).
Process concepts, threads, scheduling-criteria, algorithms.
Process synchronisation, hardware and software solutions.
CPU scheduling.
Memory management.
File Management.
I/O systems.
Protection and Security.

Reference books:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts. Sixth edition. Addison-Wesley. (2003)
2. Andrew Tanenbaum & Albert Woodhull, Operating Systems: Design and Implementation. Prentice-Hall. (2006)

Course Code : CS 412
Course Title : Data Science Lab II (R/Scilab)
Instructor : Dr. Anirban Lakshman
Weekly contact : 0 – 0 – 3 (L – T – P)

List of Experiments

1. Experiments to understand basic programming features using Scilab e.g variables & variable names, assignment statements, arithmetic, relational, logical operators, input & output, handling matrices with loops, arithmetic operators for matrices
2. Experiments to understand basic matrix processing, basic polynomial commands, polynomial arithmetic, miscellaneous polynomial handling
3. Experiments to determine the solution of system of linear equations:
    a. Direct methods: Gauss elimination method, LU-decomposition method.
    b. Iterative methods: Jacobi and Gauss-Seidel methods.
4. Experiments to determine the Roots of non-linear equations: Bisection method, Regula-Falsi method, Newton-Raphson method,
5. Experiments to determine interpolation by using Scilab programming: Newton, Bessel and Stirling's interpolation formulae, Divided differences, Lagrange interpolation and Newton's divided difference interpolation.
6. Experiments to demonstrate the numerical integration: Trapezoidal, Simpsons 1/3rd and 3/8th rules, Gauss Legendre 2-points and 3-points formulae
7. Experiments to determine solution of first and second order ordinary differential equations: Picard's method, Taylor's series method, Euler, Modified Euler, Runge-Kutta methods and Milne's method.

Course Code : CS 413
Course Title : Object Oriented Programming (Java)
Instructor : Dr. Oishila Bandyopadhyay
Weekly contact : 0 – 0 – 3 (L – T – P)

List of Experiments

1. Experiments using single class, creation of object instances, use of member variables and member functions of a class, use of single and multiple constructors
2. Experiments to demonstrate overloading of methods, interactive programs with user input and choices.
3. Experiments with command line arguments as input, programs using static methods, String
4. Experiments to demonstrate inheritance, overriding, polymorphism, interface and abstract classes

5. Experiments using inbuilt classes and methods of util package
6. Experiments to demonstrate exception handling in Java
7. Experiments using GUI design and event handling (Mouse and key events, GUI Basics, Panels, Frames)
8. Experiments to implement GUI programming with different layouts (Check Boxes, Radio Buttons, Labels, Text Fields, Text Areas, Combo Boxes, Lists, Scroll Bars, Sliders, Windows, Menus, Dialog Box)
9. Experiments to implement GUI design with swing
10. Experiments using file handling
11. Mini Project with (any one)
    a. GUI and backed database (MySql)
    b. Graphics
    c. Network programming

Reference books:

1. Bruce, Foundations of Object Oriented Languages, PHI
2. Patrick Naughton, Herbert Schildt – "The complete reference-Java2" - TMH
3. Priestley – " Practical Object Oriented Design using UML" – TMH
4. "Advanced Programming for JAVA 2 Platform" Austin and Pawlan, Pearson
5. Ivor Horton, "Beginning J2EE 1.4" SPD Publication.
6. Rambaugh, James Michael, Blaha - "Object Oriented Modelling and Design" - Prentice Hall India/ Pearson Education

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Course Code	**: CS 601**
Course Title	**: Computer Network**
Instructor	**: Dr. SK Hafizul Islam**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction

Introduction to Computer Network, Uses of Computer Networks, Modes of Communications, Different types of Networks, Network Structure, Communication Model, Internet, Protocol, OSI and TCP/IP models

Layers

Design Issues for the layers, Discussion about Layers.

Application Layer

DNS, Remote login (TelNet), Email (SMTP, MIME, POP3, IMAP4), WWW, HTTP, Cookie, Proxy Server, File Transfer Protocol, TFTP.

Transport Layer

Multiplexing, Demultiplexing, UDP, TCP, RTT Estimation and Timeout, TCP Flow Control. TCP Error Control and Congestion Control

Network Layer
Virtual Circuits and Datagram Networks, Inside a Router, Forwarding and Addressing in the Internet. IPv4 Addressing

Routing
Routing Algorithms, Shortest Path, Flooding, Link State, Distance Vector, Hierarchical Routing, Routing in the Internet: RIP, OSPF, Border Gateway Protocol, and Multicasting.

Data Link Layer
Services, Error Detection and Correction Techniques

Multiple Access Protocol
TDM, FDM, Slotted ALOHA, Pure ALOHA, CSMA, CSMA/CD, LAN, Ethernet, Point to Point Protocol.

Link Layer Addressing
MAC Addresses, ARP, DHCP.

Interconnections
Hubs, Bridges, and Switches.

Physical Layer

Reference books:

1. B. A. Forouzan, & F. Mosharraf. Computer Networks: A top down approach, 1st Edition, McGraw-Hill, 2012
2. B. A. Forouzan, TCP/IP Protocol Suite, 4th Edition, McGraw-Hill, 2010.
3. J. F. Kurose & K. W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Ed., Pearson, 2006.
4. B. A. Forouzan, Data Communications and Networking, 4th Edition, McGraw-Hill, 2009.
5. W. Stallings, Data and Computer Communication, Prentice Hall.
6. A. S. Tanenbaum, Computer Networks, 5th Edition, Pearson, 2006

Course Code	**: CS 602**
Course Title	**: Database Management System**
Instructor	**: Dr. Imon Mukherjee**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction
Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Entity-Relationship Model
Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Relational Model
Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

SQL and Integrity Constraints
Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, SQL queries, Nested Subqueries, PL/SQL, NoSQL, Query optimization: join algorithm, statistics and cost based optimization.

Relational Database Design
Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF,5NF

Transaction Management System
Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols, two phase locking.

File Organization & Index Structures
File & Record Concept, placing file records on Disk, Fixed and Variable Sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Index, Dynamic Multilevel Indexes using B-tree and B+ tree, Hashing.

Reference books:

1. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc.GrawHill.
2. Elmasri Ramez and Navathe Shamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System, McGraw-Hill
4. Gray Jimand Reuter Address, “Transaction Processing: Concepts and Techniques”, Moragan Kauffman Publishers.
5. Jain: Advanced Database Management System Cyber Tech
6. DateC.J.,“IntroductiontoDatabaseManagement”, AddisonWesley.
7. Ullman JD., “Principles of Database Systems”, Galgottia

Course Code	**: CS 603**
Course Title	**: Machine Learning**
Instructor	**: Dr. Sanjay Chatterji**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction
Concept Learning: Find-S, Candidate Elimination, Decision Tree

Learning Problems
Well-Posed Learning Problems, Designing A Learning System, Perspectives And Issues In Machine Learning, A Concept Learning Task, Concept Learning As Search, Find-S, Version Spaces And The Candidate-Elimination Algorithm, Inductive Bias

Decision Tree
Decision Tree representation, Appropriate problems for Decision Tree Learning, Basic Decision Tree Learning Algorithm, Hypothesis Space Search in Decision Tree Learning, Inductive bias in Decision Tree Learning, Issues in Decision Tree Learning

Artificial Neural Networks
Gradient Descent, Artificial Neural Networks, Bayesian Learning, Expectation Maximization, Cost Function, Gradient Descent, Linear Regression, Neural Network Representations, Problems for Neural Network Learning, Perceptron, Multilayer Networks and Backpropagation Algorithm.

Bayes Theorem and Concept Learning
Bayes theorem**,** Maximum Likelihood and Least-Squared Error Hypotheses, Maximum Likelihood Hypotheses for Predicting Probabilities, Bayes Optimal Classifier, Naive Bayes Classifier, Learning to Classify Text, Bayesian Belief Networks, EM Algorithm, EM Algorithm for Gaussian Distribution

Generative and Discriminative approaches
Difference between Generative and Discriminative approaches, Naive Bayes, Hidden Markov model, Gaussian mixture model, Latent Dirichlet Allocation, Conditional Random Fields, Maximum-Entropy Markov models

Instance Based Learning
k-Nearest Neighbor, Support Vector machine, Reinforcement Learning, Evaluation Methods, Application in NLP.

Reference books:

1. Tom M. Mitchell, Machine Learning, 2013 Indian Edition, McGraw-Hill Education, Inc.
2. Machine Learning Course in coursera by Andrew Ng, Link: https://www.coursera.org/learn/machine-learning#syllabus
3. Introduction to Machine Learning, Third Edition, Ethem Alpaydin, The MIT Press
4. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, The MIT Press
5. Online ppts: https://web.cs.hacettepe.edu.tr/~ilyas/Courses/BIL712/

Course Code	**: CS 604**
Course Title	**: Cognitive Science and Technology**
Instructor	**: Dr. Aruna Chakroborty (GF)**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction
Defining Cognition, Cognition cycle, Cognitive process, Representation and computation (tri level hypothesis), History of cognitive science, Disciplines of cognitive sciences, The interdisciplinary perspective: Philosophical, Psychological and Cognitive approaches, Neuro-science approach, Network approach, Evolutionary approach, Linguistic approach, Artificial intelligence approach, Robotics approach, issues in cognitive science.

Brain-Scanning Instruments
Structural techniques: CAT scan (Computer Axial Tomography), MRI(Magnetic Resonance Imaging), Functional techniques: PET scans (Positron Emission Tomography); fMRI(Functional MRI), Temporary lesions: TMS (Transcranial Magnetic Stimulation) Electrophysiological Techniques: EEGs(Electroencephalograms), ERPs(Event Related Potentials)

Cognitive Psychology
Mind and Brain, Reasoning Model, Decision making, Emotion and Cognition, Problem solving and reasoning, distributed reasoning by Petri Nets.

Cognitive Engineering
Cognitive Modeling, Computational Models of human cognition and various Cognitive Systems.

Models of Perception Engineering
Cognitive failures in visual perception motor planning and execution, Olfactory perceptual-ability of human subjects, Tactile perceptual-ability of Schizophrenic patients, Audio visual perception, Color perception (Cognitive experiments).

Modeling of memory and learning
Short term memory and long term memory, short-long term memory, Representation and knowledge in Long term memory, Encoding and retrieval from long term memory, memory experiments.

Motor Cognition and Control
Biology of neural and cognitive process, Human Computer Interaction Affective Computing, Brain computer interface, Motor control strategy, Application in Artificial limbs and robotics.

Bypassing Brain Lobes
Structure and function of the brain, Mapping brain lobe features to other lobe features, experiments.

Applications
Cognitive driving and failure detection, BCI gaming (Brain Computer Interface): Teaching the game to a robot, How does the robot teach the game to the children, experiments, Emotion recognition using brain signals and control/regulation.

Reference books:

1.Cognitive Science: An Introduction to the Science of the Mind by Jose Luis Bermudez, Cambridge University Press.
2.Cognitive Engineering: A Distributed Approach to Machine Intelligence by Amit Konar and Lakhmi Jain, Springer.
3.Cognitive Psychology: Mind and Body by Edward E. Smith and Stephen M. Kosslyn, Pearson.

Course Code	**: CS 637**
Course Title	**: Computer Vision and Image Understanding (Elective II)**
Instructor	**: Dr. Oishila Bandyopadhyay**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Digital Image Fundamentals
Imaging and image representation, digital distances, intensity transformation and image enhancement: point processing, basic intensity transformation functions, histogram processing, image binarization, segmentation of grey level images, advanced binarization techniques. Detection of edges and lines in 2D images, Canny's edge detection algorithm, Hough transform for detecting lines and curves, morphological processing, medial axis, skeletonization, connected-component labelling, thinning

Filtering and Images Enhancement
Spatial filtering, frequency domain filtering and enhancement, color models, color representation

Image Representation and Description
Chain codes, polygonal approximation, boundary descriptors, topological descriptors, curve and surface, digital straightness.

Camera Geometry and Feature Extraction
Predictive and camera geometry, Harris corner detection, Scale Invariant Feature Transform (SIFT), Speeded-Up Robust Features, (SURF) and other techniques.

Feature Matching and Model Fitting
Feature description, matching and model fitting, dimensionality reduction,

Deep Architecture
Deep neural architecture and application in Computer Vision problems.

Reference books:

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Pearson.
2. R. Klette and A. Rosenfeld, Digital Geometry: Geometric Methods for Digital Picture analysis, Morgan Kaufmann Publishers.
3. Rosenfeld and A. C. Kak, Digital Picture Processing, Elsevier.
4. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall.
5. Andrew Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press.
6. Computer Vision: Algorithms & Applications, R. Szeleski, Springer.
7. Computer vision: A modern approach: Forsyth and Ponce, Pearson

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Course Code	**: CS 632**
Course Title	**: Data Analytics and Optimization Techniques (Elective II)**
Instructor	**: Dr. Imon Mukherjee**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction
Introduction to Data Analytics, Data Analysis vs. Data Analytics, Data Analytics and its applications, Descriptive, Predictive and Perspective data analytics for optimal solutions, Basic concept of Probability & Statistics, Descriptive statistics – Different Approaches.

Statistical and Machine Learning Approaches

Inferential Statistics, Programming Approach for Distributions, Hypothesis Testing, ANOVA, Machine Learning Approaches: Classification and Regression, Linear and Non-linear Regression, Estimation, Prediction, Confusion Matrix, RoC analysis, Optimal Threshold Value Estimation and Analysis, Classification Report on Optimal Threshold Value, Goodness of Fit Test - Chi-square Test, Data analytics for Randomness, Concept of Big Data Analysis, Different Data Analytic Tools.

LPP

Canonical forms of LPP and its Economic Interpretation, Solving LPP using Simultaneous Equations and Graphical Methods, Cost optimization, Simplex Method, Charne's Method of Penalties, Duality Theory, Optimal solutions using NWC Rule, LCM, Vogel's Approximation, etc., Assignment problem - Hungarian method, IPP, Different Problem Solving Tools.

Optimization Algorithms

Particle Swarm Optimization, Ant Colony Optimization, Bee Colony Optimization, Butterfly Optimization, Artificial Fish Swarm Optimization, Project Data Analytics - Time-Cost Optimization Techniques, Optimum Scheduling Period.

Reference books:

1. Predictive Analytics - Eric Siegel
2. Core Concepts in Data Analysis: Summarization, Correlation, Visualization - Boris Mirkin
3. Data Science for Business - Tom Faucett
4. Optimization Techniques – Chader Mohan and Kusum Deep
5. Optimization Techniques – L.R. Foulds
6. Operation Research with C Programs – S. Kalavathy
7. Optimization Techniques – A.K. Malik, S.K. Jadav, S.R Jadav
8. Data Analytics using Python - Bharti Motwani

Course Code	**: CS 611**
Course Title	**: Computer Network Lab**
Instructor	**: Dr. SK Hafizul Islam**
Weekly contact	**: 0 – 0 – 3 (L – T – P)**

List of Experiments

1. Experiments
    a) to learn how to use commands to move around the file system hierarchy and manipulate the files.
    b) to learn how to use Linux networking commands.
    c) to learn how to view logs in Linux.

Commands need to be executed:
ps, pstree, top, kill, killall, service, head, tail, less, more, cat, grep

arp, dig, nslookup, netsta, tcpdump, ping, hostname, traceroute, tracepath, nmap, ifconfig, ifup, ifdown, route

2.Experiments to understand HTTP Traffic using Wireshark.

i) To learn capturing live packets using Wireshark, which is a network protocol analysis tool.

ii) Analysing HTTP traffic using Wireshark.

3. Experiments to understand Packet Tracer
   a) Implementing LAN using switch and hub, configuring static IP address of hosts, Learning ARP-table and MAC-table mechanism
   b) Connecting two separate LAN using proper interface in Packet Tracer. Configuring Static and dynamic routing. Configuring DHCP server.
   c) Simulate link failure (by turning it off) between any two routers. Change static routes in each of the routers to achieve seamless connectivity between all the LANs.

4. Configuring DNS server, FTP server, HTTP server in packet tracer

5. Configuring TELNET in packet tracer. Executing SSH and FTP command in Ubuntu and transferring file between SSH client and server and FTP client and server

6. Implementing VLAN and SUBNET in packet tracer

7. Experiment to understand SQUID Proxy Server configuration and analysis of HTTP traffic using Wireshark.
   a) To learn how to install SQUID Proxy Server
   b) To learn how to configure a Proxy Server

8. Socket Programming using TCP & UDP: Chat application between server and client

   Socket Programming using TCP & UDP: Chat application between two client

   The client first needs to connect with the server and can then issue two commands -

   1. GET - This command fetches the list of client's that are currently connected to server.

   2. SEND (client number) (message) - SEND followed by client number which can be used to send the message to particular to that particular client number.

   (please issue the complete send command in one go).

9. Socket Programming to implement HTTP GET method to download a file from server

10. Socket Programming to implement HTTP PUT method to upload a file to server

11. Introduction to Software Defined Network, Mininet and POX controller () Creating custom network topology in mininet. Adding remote controller to the topology. Understanding flow rule installation.

12. Implementing own forwarding logic, writing own forwarding rule to forward a traffic and implementing MAC table.

13. Implementation of firewall in Software Defined Network based on some pre-defined policy.

Reference books:

1. B. A. Forouzan, & F. Mosharraf. Computer Networks: A top down approach, 1st Edition, McGraw-Hill, 2012
2. B. A. Forouzan, TCP/IP Protocol Suite, 4th Edition, McGraw-Hill, 2010.
3. J. F. Kurose & K. W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Ed., Pearson, 2006.
4. B. A. Forouzan, Data Communications and Networking, 4th Edition, McGraw-Hill, 2009.
5. W. Stallings, Data and Computer Communication, Prentice Hall.
   A. S. Tanenbaum, Computer Networks, 5th Edition, Pearson, 2006

Course Code	**: CS 612**
Course Title	**: Database Management System Lab**
Instructor	**: Dr. Imon Mukherjee**
Weekly contact	**: 0 – 0 – 3 (L – T – P)**

List of Experiments

1. Using a TXT or CSV file as a database and manipulating records
2. Creating table using several attributes in SQL
   a. Insert record into table
   b. Fetch data from table
   c. Modify data in table
   d. Delete record from table
   e. Use of several constrains
3.
   a. Use of DDL command like DROP, ALTER, TRUNCATE, RENAME and COMMENT
   b. Use of Different Aggregate functions like COUNT, AVG, MAX, MIN, SUM, STDEV, VAR etc.

c. Use of GROUP BY and ORDER BY command

4. Repeating experiment no 2 in NoSQL environment using Neo4J graph DB and Cypher query
5. Repeating experiment no 3 in NoSQL environment using Neo4J graph DB and Cypher query
6. Joining
a. Creation of multiple table
b. Use of joining to fetch and manipulate data
7. SQL joining equivalence operations in NoSQL (Neo4J using Cypher query)
    a. Creation of nodes and relationships with different or multiple label
    b. Manipulating data from nodes and relationships that belongs to different label
8. Experiment on
    a. SQL CASE statement
    b. NULL Function
    c. SQL Procedure
    d. Views
9. Experiment on SQL Injection
10. Connecting and Manipulating SQL Database using Python
11. PL/SQL
    a. Writing PL/SQL code for calculating radius, area, Fibonacci series etc.
    b. Using loops in PL/SQL
    c. Manipulating table data using PL/SQL
12. Experiment on
    a. PL/SQL Package
    b. PL/SQL Trigger
13. Experiment on
    a. PL/SQL Autonomous Transaction: Commit, Rollback
14. Experiment on Dynamic SQL

Reference books:

1. SQL, PL/SQL: 4th Revised Edition by Ivan Bayross
2. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence by Pramod J. Sadalage, Martin Fowler

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Course Code	**: CS 613**
Course Title	**: Soft Skill Development**
Instructor	**: Dr. Debasish Dutta (GF)**
Weekly contact	**: 0 – 0 – 3 (L – T – P)**

Introduction to Soft Skill

Definition and Significance of Soft Skills; Importance, Process, and Measurement of Soft Skill Development.

Discovering/Relocating the Self
Strengths and Limitations; Habits; Goals Setting, Proactive Attitude Development, Faiths Beliefs, Values, Virtue.
Developing Positive Thinking and Driving out Negativity
Developing Self-Esteem and Building Self Confidence, Significance of Self-Discipline.

Motivation
Meaning and Theories of Motivation; Enhancing Motivation Levels.

Interpersonal relations
Communicating Clearly: Understanding and Overcoming barriers communication models, team communication; developing interpersonal relationships through effective communication

Active Listening
Listening is a skill.
Essential formal writing skills; corporate communication styles – Conducting Meetings, Writing Minutes, Sending Memos and Notices; Netiquette: Effective E-mail Communication; Telephone Etiquette; assertion, persuasion, negotiation.

Public Speaking
Skills, Methods, Strategies for effective public speaking.
Practice Tips
Practical in Language Lab
Group Discussion: Importance, Strategies for group discussion: Planning, Elements, Skills assessed; Effectively disagreeing, Initiating, Summarizing and Attaining the Objective.
Practical in Language Lab

Body Language
Introduction, Effective body language building during communication
Practical in Language Lab

Teamwork and Leadership Skills
Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills.
Presentation Skills: Introduction, Types, Content, Audience Analysis,
Strategy: Before, During and After
Effect of Adrenalin
Practical at Language Lab

Interview Skills
Introduction, Strategies behind successful Interview
Interviewer and Interviewee – in-depth perspectives. Before, During and After the Interview, Introduction to Emotional Intelligence Skill.

Practical in Language Lab

Time Management
Introduction, Importance and Strategy behind effective time management. Adverse Effects

Etiquettes and Manners
Introduction to Life Skills

CV Preparation
Introduction Importance and discussions on model CVs according to need of the employers.

Decision Management
Introduction and importance
Software behind Decision Management.

Conflict Management

Introduction and importance

Stress Management
Introduction and importance

Elective V

Course Code	**: CS 857**
Course Title	**: Information Theory and Coding**
Instructor	**: Dr. Debasish Bera**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction to Information Theory
What is information; Relationship of information theory to other fields, e.g., electrical sci-ence, computer science, physics, mathematics, economics;

Entropy
Relative entropy; Mutual Information; Asymptotic Equipartition Property (AEP); Entropy rate.

Data Compression

Lossy and loss-less compression; Huffman and Lempel Ziv coding.

Channel Capacity and Channel Coding
Noiseless Binary Channel; Binary Symmetric Channel, Binary Erasure Channel; Channel Coding theorem; Classification of Coding Schemes, Linear Block Code: Hamming Code.

Rate Distortion Theory
Definitions; Calculation of Rate Distortion Function; Converse and achievability of Rate Dis-tortion Function; Characterization of Rate Distortion Function;

Information Theory and Statistics
Law of Large Numbers; Large Deviation Theory; Hypothesis Testing; Fisher Information; Rao-Cramer inequality; Information Theory based Statistical Inference.
Kolmogorov Complexity

Information Theoretic Methods in Machine Learning
Information Theoretic (IT) Clustering; IT Feature Selection; IT Semi-Supervised Learning; Information Theoretic metrics.

Reference books:
1. Elements of Information Theory- Thomas M. Cover and Joy A. Thomas, 2nd ed, Wiley
2. Information Theory, Inference and Learning Algorithms - David J. C. MacKay, Ebook (http://www.inference.phy.cam.ac.uk/mackay/itila/)
3. Algebraic Coding Theory - Elwyn R. Berlekamp - McGraw-Hill
4. The Theory of Information and Coding - Robert J. McEllice

Course Code	**: CS 858**
Course Title	**: Advanced Cryptography**
Instructor	**: Dr. Hafizul Islam**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction and Classical Cryptography
Introduction and motivation, Classical Cryptography,
Security Attacks: Definition, Historical Ciphers and Their Cryptanalysis
Basic Principles of Modern Cryptography

Probability Theory
Probability theory, Information theory, Computational Complexity

Perfectly Secure Encryption
Perfect Secrecy: Definitions and Basic Properties

The One-Time Pad (Vernam's Cipher), Limitations of Perfect Secrecy
Shannon's Theorem

Private-Key Encryption
Basic Idea of Computational Security, Definition of Negligible Success, Proofs by Reduction, Computationally-Secure Encryption, Pseudorandomness and Secure Encryption, Chosen-Plaintext Attacks (CPA), CPA-Secure Encryption Schemes, Security Against Chosen-Ciphertext Attacks (CCA)

Collision-resistance Hash Function
Collision-resistance Hash Function: Definitions and Properties
Random Oracle Model and Birthday Attack

Digital Signature
The RSA signature scheme and attacks, The Rabin public-key signature scheme, The Fiat-Shamir signature schemes, The Guillou-Quisquater Signature Scheme

Public Key Cryptosystem
Publlic Key Encryption: Chosen-Plaintext Attack, RSA Encryption and Attacks, OAEP, The Rabin Encryption Scheme, The Paillier encryption scheme

Elliptic Curve Cryptography
Introduction to elliptic curves, Point representation and the group law
Point multiplication, The elliptic curve discrete logarithm problem, ECC-based Diffie-Hellman Key Agreement Protocol

Reference books:

1. J. Katz, Y. Lindell: “Introduction to Modern Cryptography”, Chapman & Hall/CRC Press, 3rd Ed., 2007.
2. Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone: “Handbook of Applied Cryptography”, CRC Press, 2018.
3. Wenbo Mao: "Modern Cryptography: Theory and Practice", Pearson, 1st Ed., 2003.
4. Darrel Hankerson, Alfred Menezes, Scott Vanstone: "Guide to Elliptic Curve Cryptography", Springer, 1st Ed., 2004.

Elective VI

Course Code	**: CS 831**
Course Title	**: Neural Network & Deep Learning**
Instructor	**: Dr. Sanjay Chatterji**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction
Introduction to the Neural Network, Training Feed Forward Network

Mechanics of Machine Learning
Building Intelligent Machines, The Limits of Traditional Computer Programs, The Mechanics of Machine Learning, The Neuron, Expressing Linear Perceptrons as Neurons, Feed-Forward Neural Networks, Linear Neurons and their Limitations, Sigmoid, Tanh, and ReLU Neurons, Softmax Output Layers

Gradient Descent
Gradient Descent, The Delta Rule and Learning Rates, Gradient Descent with Sigmoidal Neurons, The Backpropagation Algorithm, Stochastic and Minibatch Gradient Descent, Overfitting, Preventing Overfitting in Deep Neural Networks

Convolutional Neural Networks
Beyond Gradient Descent, Convolutional Neural Networks, Embedding

Challenges with Gradient Descent
The Challenges with Gradient Descent, Local Minima in the Error Surfaces of Deep Networks, Model Identifiability, How Pesky Are Spurious Local Minima in Deep Networks?, Flat Regions in the Error Surface

Architectural Description of Convolution Networks
Neurons in Human Vision, The Shortcomings of Feature Selection, Vanilla Deep Neural Networks Don't Scale, Filters and Feature Maps, Full Description of the Convolutional Layer, Max Pooling, Full Architectural Description of Convolution Networks

Lower-Dimensional Representations
Learning Lower-Dimensional Representations, Principal Component Analysis, Motivating the Autoencoder Architecture, Denoising to Force Robust Representations, Sparsity in Autoencoders, When Context Is More Informative than the Input Vector, The Word2Vec Framework, Skip-Gram Architecture

Sequence Analysis
Models for Sequence Analysis, Memory Augmented Neural Networks Analyzing Variable-Length Inputs, Tackling seq2seq with Neural N-Grams, Implementing a Part-of-Speech Tagger, Dependency Parsing and SyntaxNet, Beam Search and Global Normalization, A Case for Stateful Deep Learning Models, Recurrent Neural Networks, Long Short-Term Memory (LSTM) Units, Solving seq2seq Tasks with Recurrent Neural Networks

Neural Turing Machines
Neural Turing Machines, Attention-Based Memory Access, NTM Memory Addressing Mechanisms, Differentiable Neural Computers

Neural network using Tensorflow

What Is TensorFlow? How Does TensorFlow Compare to Alternatives? Installing TensorFlow, Creating and Manipulating TensorFlow Variables, TensorFlow Operations, Placeholder Tensors, Sessions in TensorFlow, Specifying the Logistic Regression Model in TensorFlow, Implementing an Autoencoder in TensorFlow.

Reference books

1. Fundamentals of Deep Learning - Designing Next-Generation Machine Intelligence Algorithms, Nikhil Buduma, O'REILLY publisher
2. Learning Tensorflow - A Guide to Building Deep Learning Systems, Tom Hope, Yehezkel S. Resheff & Itay Lieder, O'REILLY publisher

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Course Code	**: CS 886**
Course Title	**: Coding Theory**
Instructor	**: Dr. Bhaskar Biswas**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Overview of Coding Theory

Error detection, correction and decoding, Communication channels, Maximum likelihood decoding, Hamming distance.

Finite (Galois) fields

Groups, Rings, Fields, Polynomial rings, Structure of finite fields, Minimal polynomials

Linear Codes

Vector spaces over finite fields, Linear codes, Hamming weight, Bases for linear codes, Generator matrix and parity-check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Syndrome decoding.

Cyclic Codes

Definitions, Generator polynomials, Generator and parity-check matrices, Decoding of cyclic codes

Bounds on codes

The main coding theory problem, Lower bounds, Sphere-covering bound, Gilbert–Varshamov bound, Hamming bound and perfect codes, Singleton bound and MDS codes.

BCH Codes

Definitions, Parameters of BCH codes, Decoding of BCH codes
Additional codes (Reed-Muller, Goppa etc.) if time permits.

Reference books :

1. MacWilliams, F. J. and Sloane, N. J. A. The theory of error-correcting codes. North-Holland Mathematical Library. North-Holland Publish- ing Co., New York, 1977.
2. Van Lint, J. H. Introduction to coding theory, Third edition. Graduate Texts in Mathematics, 86. Springer-Verlag, Berlin, 1999.

Elective VII

Course Code	**: CS 825**
Course Title	**: Computational Complexity**
Instructor	**: Dr. Sanjoy Pratihar**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Introduction

Easy and hard problems. Algorithms and complexity.

Turing machines

Turing machines, Models of computation. Multitape deterministic and non deterministic Turing machines.

Decision problems

The Halting Problem and Undecidable Languages. Counting and diagonalisation. Tape reduction, Universal Turing machine. Undecidability of halting, Reductions, Rice's theorem.

Deterministic Complexity

Deterministic Complexity Classes, Linear Speed-up Theorem, Polynomial reducibility.

Polytime algorithms: 2-satisfiability, 2-colourability.

NP

NP and NP-completeness. Non-deterministic Turing machines, Polynomial time verification.

NP-completeness, Cook-Levin Theorem, Polynomial transformations: 3-satisfiability, clique, colourability, Hamilton cycle, partition problems. Pseudo-polynomial time. Strong NP-completeness, Knapsack, NP-hardness.

Space complexity

Space complexity and hierarchy theorems. Linear Space Compression Theorem, PSPACE, NPSPACE.

PSPACE = NPSPACE, PSPACE-completeness. The Quantified Boolean Formula problem is PSPACE-complete.

L, NL and NL-completeness, NL=coNL, Hierarchy theorems.

Optimization and approximation

Optimization and approximation, Combinatorial optimisation problems, Relative error, Bin-packing problem.
Polynomial and fully polynomial approximation schemes, Travelling salesman problem, minimum partition.

Randomized Complexity
Randomized Complexity, The classes BPP, RP, ZPP.

Reference books:

1. Computers and Intractability: A Guide to the Theory of NP-Completeness by Michael R. Garey, David S. Johnson
2. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
3. Vijay Vazirani, Approximation Algorithms, Springer.
4. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.
5. C H Papadimitriou. Computational Complexity, Addison-Wesley.
6. T H Cormen, S Clifford, C E Leiserson and R L Rivest. Introduction to Algorithms, MIT Press, Second edition.

Course Code	**: CS 845**
Course Title	**: Low Power Circuits & Systems**
Instructor	**: Dr. Rinky Sha**
Weekly contact	**: 3 – 0 – 0 (L – T – P)**

Basics of MOS circuits
MOS Transistor structure and device modeling
MOS Inverters
MOS Combinational Circuits - Different Logic Families

Sources of Power dissipation
Dynamic Power Dissipation
Short Circuit Power, Switching Power, Gliching Power
Static Power Dissipation
Degrees of Freedom

Supply Voltage Scaling Approaches
Device feature size scaling
Multi-Vdd Circuits
Architectural level approaches: Parallelism, Pipelining
Voltage scaling using high-level transformations
Dynamic voltage scaling
Power Management

Switched Capacitance Minimization Approaches
Hardware Software Tradeoff
Bus Encoding
Two's complement Vs Sign Magnitude
Architectural optimization
Clock Gating
Logic styles

Leakage Power minimization Approaches
Variable-threshold-voltage CMOS (VTCMOS) approach
Multi-threshold-voltage CMOS (MTCMOS) approach
Power gating
Transistor stacking
Dual-Vt assignment approach (DTCMOS)

Special Topics
Adiabatic Switching Circuits
Battery-aware Synthesis
Variation tolerant design

Reference books

1. Sung Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata Mcgrag Hill.

2. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint)

3. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Interscience, 2000