INSTITUTE OF INFORMATION TECHNOLOGY
UNIVERSITY OF DHAKA

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BACHELOR OF SCIENCE IN SOFTWARE ENGINEERING (BSSE)

[Session 2017 – 2018]

Institute of Information Technology
University of Dhaka

Syllabus for
Bachelor of Science in Software Engineering (BSSE)

Semester 1

Course Code	Course Title	Credit	Theory	Lab
CSE101	Structured Programming	3	1	2
CSE 102	Discrete Mathematics	3	3	0
STAT 103	Probability and Statistics for Engineers I	3	3	0
MATH 104	Calculus and Analytical Geometry	3	3	0
GE 105	Sociology	3	2	1
SE 106	Introduction to Software Engineering	3	3	0
6 Courses		18	15	3

Semester 2

Course Code	Course Title	Credit	Theory	Lab
CSE 201	Data Structure and Algorithm	3	1	2
CSE 211	Computer Organization	3	2	1
STAT 203	Probability and Statistics for Engineers II	3	3	0
MATH 204	Ordinary Differential Equations	3	3	0
GE 212	Bangladesh Studies	3	3	0
SE 206	Object Oriented Concepts I	3	2	1
6 Courses		18	13	5

Semester 3

Course Code	Course Title	Credit	Theory	Lab
CSE 301	Combinatorial Optimization	3	2	1
SE 312	Theory of Computing	3	2	1
CSE 311	Computer Networking	3	2	1
MATH 304	Numerical Analysis for Engineers	3	2	1
SE 305	Software Project Lab I	3	0	3
SE 306	Object Oriented Concepts II	3	2	1
6 Courses		18	10	8

Semester 4

Course Code	Course Title	Credit	Theory	Lab
CSE 401	Operating System and System Programming	3	2	1
GE 402	Business Psychology	3	2	1
CSE 411	Information Security	3	2	1
CSE 404	Database Management System I	3	2	1
BUS 405	Business Studies for Engineers	3	3	0
SE 406	Software Requirements Specification and Analysis	3	2	1
6 Courses		18	13	5

Semester 5

Course Code	Course Title	Credit	Theory	Lab
SE 511	Professional Ethics for Information Systems	3	2	1
CSE 502	Web Technology	3	1	2
BUS 503	Business Communications	3	2	1
CSE 504	Database Management System II	3	1	2
SE 505	Software Project Lab II	3	0	3
SE 506	Design Patterns	3	2	1
6 Courses		18	8	10

Semester 6

Course Code	Course Title	Credit	Theory	Lab
CSE 601	Distributed Systems	3	1	2
SE 611	Software Metrics	3	2	1
SE 612	Software Security	3	2	1
CSE 604	Artificial Intelligence	3	2	1
SE 605	Software Testing and Quality Assurance	3	2	1
SE 606	Software Design and Analysis	3	2	1
6 Courses		18	10	8

Semester 7

Course Code	Course Title	Credit	Theory	Lab
SE 701	Internship	18	0	18
1 Course		18	0	18

Semester 8

Course Code	Course Title	Credit	Theory	Lab
SE 801	Project	6	0	6
SE 811	Software Maintenance	3	2	1
SE 803	Software Project Management	3	2	1
CSE / SE / BUS 8XX	Elective	3	–	–
CSE / SE / BUS 8XX	Elective	3	–	–
5 Courses		18	–	–

Elective Courses

No.	Course Code	Course Title
1.	CSE 802	Computer Data and Network Security
2.	CSE 823	Embedded Systems
3.	BUS 824	Numeric Computation for Financial Modeling
4.	CSE 825	Data Mining and Warehousing
5.	BUS 827	Enterprise Information Systems
6.	CSE 829	Pattern Recognition and Image Processing
7.	CSE 830	Mobile and Wireless Computing
8.	CSE 831	Computer Graphics and Multimedia
9.	CSE 837	Machine Learning
10.	CSE 839	Human Computer Interaction
11.	CSE 840	Information Retrieval
12.	BUS 842	Strategic Management
13.	CSE 844	Applied Data Science

Semester 1 (1st year 1st Semester)

Course Title: Structured Programming
Code: CSE 101
Credit: 3 Credits (1 Credit Theory and 2 Credit Lab)

Course Outline: Fundamentals of C programming; Introducing C's Program Control Statements; Data types, Variables and Expressions; Exploring Arrays and Strings; Understanding Pointers and Functions; Console and File I/O; Structures and Unions.

References:
1. Teach Yourself C, Herbert Schildt, McGraw Hill
2. C: The Complete Reference, Herbert Schildt, McGraw Hill
3. Schaum's Outline of programming with C, McGraw Hill

Course Title: Discrete Mathematics
Code: CSE 102
Credit: 3 Credits (3 Credit Theory)

Course Outline: The Foundations: Logic and Proofs: propositional logic, applications of propositional logic, propositional equivalences, predicates and quantifiers, nested quantifiers, rules of inference, introduction to proofs; **Basic Structures:** Sets, Functions, Sequences, Sums, and Matrices; **Number Theory:** The division algorithm, divisibility and the euclidean algorithm, prime numbers, congruence, applications of congruence; **Induction and Recursion:** Mathematical Induction, Recursive Definitions and Structural Induction, Program Correctness; **Counting:** The addition and multiplication rules, The principle of Inclusion-Exclusion, The pigeon-hole principle, permutations, combinations, Generalized Permutations and Combinations, Generating Permutations and Combinations; **Relations and Functions:** Symmetry, transitivity, reflexivity, equivalence classes, congruence, closure of relations, partial orderings; **Graphs:** Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths; **Trees:** Introduction to Trees, Tree Traversal, Spanning Trees.

References:
1. Discrete Mathematics and its Applications, Seventh Edition by Kenneth H. Rosen.

Course Name: Probability and Statistics for Engineers I
Code: STAT 103
Credit: 3 Credits (3 Credit Theory)

Course Outline: Introduction to Statistics: Concept of Data and Variables, Data Collection and Descriptive Statistics, Inferential Statistics, Populations and Samples; **Descriptive Statistics:** Frequency Tables and Graphs, Relative Frequency Tables and Graphs, Grouped Data, Histograms, Ogives, Stem and Leaf Plots, Sample Mean, Sample Median, Sample Mode, Sample Variance and Standard Deviation, Sample Percentiles and Box Plots, Chebyshev's Inequality, Normal Data Sets, Paired Data Set and Sample Correlation Coefficient; **Elements of Probability:** Basic Terminology

in Probability, Sample Space and Events, Venn Diagrams and Algebra of Events, Axioms of Probability, Conditional Probability, Bayes' Theorem and Independent Events; **Random Variables and Expectation:** Random Variables, Types of Random Variables, Jointly Distributed Random Variables, Expectation, Property of Expected Values, Use of Expected Values in Decision Making, Variance, Covariance and Variance of Sums of Random Variables and Moment Generating Functions; **Special Random Variables:** Binomial Random Variables, Poisson Random Variables, Uniform Random Variables, Normal Random Variables, Exponential Variables, Gamma Distribution, Chi-Square Distribution, t-Distribution and F-Distribution; **Distributions of Sampling Statistics:** Central Limit Theorem, Sampling Distribution for Normal Population, and Sampling from a Finite Population; **Parameter Estimation:** Maximum Likelihood Estimators, Interval Estimates, Estimating the difference in Means of Two Normal Population, Approximate Confidence Interval for the Mean, Confidence Interval of the Mean of the Exponential Distribution and Bayes' Estimator.

References:
1. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier/Academic Press, 3rd Ed.
2. M. Nurul Islam, An Introduction to Statistics and Probability, Book World, 3rd Edition.
3. Lipschutz, Lipschutz Seymour, 2000 Solved Problems in Discrete Mathematics, McGraw-Hill, 1st Ed

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Course Title: Calculus and Analytical Geometry
Code: MATH 104
Credit: 3 Credits (3 Credit Theory)

Course Outline: **Basic Concepts:** Real Numbers and Real Lines, Polar Coordinates, Parametric Equations, Functions, Algebra of Functions, Inverse Functions, Quadratic Functions, Shifting Graphs, Trigonometric Functions, Complex Numbers, Inequalities, Infinite Series and Sequences, Taylor Series, Rate of Change and Limit, Rules of Finding Limits, Formal Definition of Limit, Extension of the Limit Concepts, L'Hospitals Rule, Continuity, Tangent Lines; **Differential Calculus:** The Derivatives of a Function, Differentiation Rules, Rates of Change, Derivatives of Trigonometric Functions, Chain Rule Differentiation, Implicit Differentiation and Rational Exponents, Related Rates of Change, Extreme Values of Functions, Mean Value Theorem, First Derivative and Second Derivative Tests for Extreme Values, Optimization, Linearization and Differentials and Newton's Method; **Integral Calculus:** Indefinite Integrals, Integration by Substitution, Riemann Sums, Definite Integral, Fundamental Theorem of Calculus, Mean Value Theorem, Substitution in Definite Integrals, Areas between Curves, Finding Volumes by Slicing, Volumes of Solids of Revolution, Cylindrical Shells, Lengths of Plane Curves, Areas of Surfaces of Revolution, Moments and Center of Mass, Fluid Pressures and Forces, Integration by Parts, Improper Integrals, Multiple Integrals and Line Integrals; **Linear Algebra and Vector Calculus:** Matrices, Operation on Matrices, Inverse of a Matrix, Rank of Matrix, Determinant, Vectors, and Solutions of System of Linear Equations, and Eigen value Problems.

References:
1. G.B. Thomas and R.L. Finney, *Calculus and Analytical Geometry*, Addison Wesley, 9th Ed.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 9th Ed.

Course Title: Sociology
Code: GE 105
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introducing Sociology: Definition, Nature, Subject Matter, Sociology and Common Sense, Importance of Sociological Study; The Development of Sociology: The Origins, Early Sociologists (Auguste Comte, Herbert Spencer, Karl Marx, Emile Durkheim, and Max Weber), Modern Developments and Industrial Revolution; Capitalism and Socialism, The Theoretical Perspectives: The Functionalist Perspective, The Conflict Perspective, and The Interactionist Perspective.

Sociological Research Methods: Scientific Methods and their Application in Sociological Research: Fact, Concept, Variables, Correlations, Control, Hypothesis, Assumption, and Theory; The Methods of Social Research: Historical, Comparative, Statistical, Case-study, Experiments etc; The Research Process: Select the problem, Review the Literature, Formulate a Hypothesis, Choose a Research Design, Collect the Data, Analyze the Results, Draw a Conclusion, Report Writing and Use of SPSS in Sociological Research;

Basic Social Institutions, Marriage: Concept, Forms, and Functions; Family: Concept, Forms, and Functions, Changing Pattern of Marriage and Family in Modern Industrial Society; Culture, Society, and Socialization: Definition, Characteristics, Aspects and Elements of Culture, Cultural Lag, Culture and Civilization, Stages in the Evolution of Human Civilization; Agencies of Socialization: Family, Schools, Peer Groups, Mass Media etc;

Social Change and Social Stratification: Concept of Social Change, Social Evolution, Social Progress, and Social Development. Factors of Social Change and Its Impacts on Society; Social Stratification: of Concept, Forms, Social Stratification and Social Mobility; Social Problems and Applied Sociology: Concept of Social Problems; Major Social Problems: Crime, Juvenile Delinquency, Drug Addiction etc. Concept, Scope, Role of Sociologist in Applied Sociology; Social Policy and Planning: Objectives and prerequisites of Social Planning;

Globalization: Information and Communication Technology: Concept and Areas of Globalization, Impact of Globalization on Society, The Rise of Information and Communication Technology. Dimensions of Globalization: Technological and Information globalization; Technology and Society: Concept, Technological Innovation, and Technological Fix (Alvin Weinberg-1966), Technology and Society: Effects of technological factors on social life and Influence of Technology on Social Institution.

References:
1. Fairchild, Henry Pratt. Dictionary of Sociology.
2. Kalam ,Abul .Globalization and Bangladesh-In the New Century.
3. Koenig, Samuel. Sociology-An Introduction to the Science of Society.
4. Ogburn, William F. and Nimkoff, Meyer F. Sociology.
5. Robertson, Ian. Society-A Brief Introduction.
6. Rao, Shankor. Sociology.
7. Young,P.V. Scientific Social Survey and Research.

Course Title: Introduction to Software Engineering
Code: SE 106
Credit: 3 Credits (3 Credit Theory)

Course Outline: Overview of Software Engineering: history, nature, relation of software engineering to other discipline, software development life cycle, Programming language; **Software nature and qualities**: product qualities, project qualities, correctness, robustness, usability, maintainability, portability, quality measurements; **Software development life cycle**: requirement, design, development, testing, maintenance; Software development model: waterfall, agile, spiral, RDD, V model; **Software engineering principles**: modularity, abstraction, generality, object oriented, component oriented, structured.; **Specification and Verification**: requirement specification, descriptive specification, testing, analysis, debugging; **Modeling and Design**: basics of modeling diagram, UI design. **Software Project Management**: concepts, project metrics, estimation, risks management.

References:
1. Fundamentals of Software Engineering, 2nd Edition, by Carlo Ghezzi, M Zazayeri, Pearson Education.
2. Software Engineering: A Practitioner's Approach, 7th Edition, McGraw Hill Higher Education.

Semester 2 (1st year 2nd Semester)

Course Title: Data Structure and Algorithm
Code: CSE 201
Credit: 3 Credits (1 Credit Theory and 2 Credit Lab)

Outline: Introduction **-** Data Structures and Complexity of Algorithms, Time Space Tradeoff, Searching Techniques: Linear and Binary Searching; Sorting and Recursion **-** Discussion of Common Sorting Techniques: Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Merge Sort, Radix Sort; Factorial and Tower of Hanoi Problem; Linked Lists - Abstract Data Types, List ADTs, and Linked Lists: Singly, Two Way and Circular Linked Lists; Stacks and Queues - Stacks and Queues and their Implementation Strategies; Prefix, Infix and Postfix Expressions, their Transformation and Evaluation Algorithms; Hashing - Hash Indices and Hash Functions, Static and Dynamic Hashing, Collisions in Hash Indices and Collision Resolving Techniques; Trees - Tree Concepts, Binary Tree, BST, Heaps, Heap Sort, Huffman Encoding Technique, AVL Tree, B Tree and B+ Tree; Graphs - Graph Terminologies, Representing Graphs, Graph Searching: BFS and DFS, Shortest Path Problems, Minimum Spanning Tree, Minimum Spanning Tree Algorithms, and Topological Sorting; Problem Solving Strategy - Greedy Algorithms, Divide and Conquer Strategy, Dynamic Programming and Backtracking.

References:
1. *Data Structures*. Schaum's Outline Series.
2. E. Horowitz and S. Sahni, *Fundamentals of Data Structures*, London Pitman.
3. Robert L. Kruse, *Data Structures and Program Design*, Prentice Hall, 2nd Ed.

Course Title: Probability and Statistics for Engineers II
Code: STAT 203
Credit: 3 Credits (3 Credit Theory)

Course Outline: Hypothesis Testing: Tests Concerning the Mean of a Normal Population, Testing the Equality of Means of Two Normal Populations, Hypothesis Tests Concerning the Variance of a Normal Population, Hypothesis Tests in Bernoulli Populations and Tests Concerning the Mean of a Poisson Distribution. Regression and Correlation Analysis: Least Squares Estimators of the Regression Parameters, Distribution of the Estimators, Statistical Inference about the Regression Parameters, Coefficient of Determination and Sample Correlation Coefficient, Analysis of Residuals, Transforming to Linearity, Weighted Least Squares, Polynomial Regression, Multiple Linear Regression, Logistic Regression Models for Binary Output Data and Correlation Analysis. Analysis of Variance: One-way Analysis of Variance, Two-Factor Analysis of Variance: Introduction and Parameter Estimation, Testing Hypotheses and Two-way Analysis of Variance with Interaction Problems. Goodness of Fit Tests and Categorical Data Analysis: Goodness of Fit Tests when All Parameters are Specified, Goodness of Fit Tests when All Parameters are Unspecified, Tests of Independence in Contingency Tables, Tests of Independence in Contingency Tables Having Fixed Marginal Totals and Kolmogorov-Smirnov Goodness of Fit Test for Continuous Data. Nonparametric Hypothesis Tests: Sign Test, Signed Ranked Test, Two-Sample Problem and Runs Tests for Randomness. Quality Control: Control Charts for Average Values, The X-Control Chart, S-Control Charts, and Control Charts for the Fraction Defective, Control Charts for Number of Defects and Other Control Charts for Detecting Changes in the Population Mean.

References:
1. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists,

Elsevier/Academic Press, 3rd Ed.

2. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Son, 4th Ed.

3. Murray R Spiegel, John J Schiller, R Alu Srinivasan, Schaum's Outline: Probability and Statistics, McGraw Hill, 3rd Ed.

Course Title: Ordinary Differential Equations
Code: MATH 204
Credit: 3 Credits (3 Credit Theory)

Course Outline: Differential Equations and Mathematical Modeling, Initial Value Problem, Separable Differential Equations, Exact Differential Equations, Linear Differential Equations, Bernoulli Equation, Homogeneous Linear Equations of Second Order, Second Order Homogeneous Equations with Constant Coefficients, Euler-Cauchy Equation, Existence and Uniqueness Theory, Non-homogeneous Equations, Solution by Undetermined Coefficients, Solution by Variation of Parameters, Higher-Order Linear Differential Equations, Higher-Order Homogeneous Equations with Constant Coefficients, and Higher-Order Non-homogeneous Equations, Vectors, Matrices, and Eigenvalues, Homogeneous Systems with Constant Coefficients, Critical Points, Criteria for Critical Points, Stability, Qualitative Methods for Nonlinear Systems, Non-homogenous Linear Systems, Laplace Transform, Inverse Transform, Transforms of Derivatives and Integrals, Differentiation and Integration of Transforms, Convolution, and Partial Fractions, System of Differential Equations.

References:
1. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 8th Ed.
2. S.L. Ross, *Differential Equations.*
3. Earl A. Coddington, *An Introduction to Ordinary Differential Equations*, Dover Publications, Unabridged Ed.
4. Morris Tenenbaum and Harry Pollard, *Ordinary Differential Equations*, Courier Dover Publications, 1985 Ed.

Course Title: Object Oriented Concepts I
Code: SE 206
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Object Oriented Concepts - Introduction to Object Oriented Concepts – Procedural vs Object Oriented (OO) Programming, What is an Object – Object Data and Behavior, What is a Class – Attributes, Methods and Messages, Using UML to model a Class Diagram, Encapsulation and Data Hiding: Interfaces and Implementations, Inheritance: Superclasses and Subclasses, Abstraction and Is-a Relationships; Polymorphism, Composition: Abstraction and Has-a Relationships; How to think in terms of Objects – Interface vs Implementation, Abstract thinking when designing Interfaces and Giving the user minimal Interface possible; Object Oriented concepts in details – Constructors: Default constructor, When is a constructor called, Using multiple constructors and The design of constructors, Error handling and The concept of scope; The Anatomy of a Class – The Name, Comments, Attributes, Constructors, Accessors, Public Interface methods and Private implementation methods; Class Design Guidelines – Modeling Real World Systems, Identifying Public Interfaces, Designing Robust Constructors, Designing Error Handling to a Class, Documenting a Class and Using Comments, Designing with Reuse, Extensibility, Maintainability in Mind and Using Object Persistence; Designing with Objects – Proper Analysis, Statement of Work, Requirements Collection, Prototype of User Interface, Identifying the Classes,

Determining the responsibilities of Each Class, Class Collaboration, Class Model to Describe the System; Mastering Inheritance – Reusing Objects, Generalization and Specialization, How Inheritance weakens Encapsulation; Frameworks and Reuse – When should we Reuse, Frameworks, Contract: Abstract Classes and Interfaces. **Programming lessons** - Introduction to Java – Java Virtual Machine (JVM) and Java Runtime (JRE), Java Development Kit (JDK), Integrated Development Environment (IDE) for Java, Java installation, Hello World! Program, compiling and running Java program, using Java classpath and JVM Architecture; Java syntax – Package, Import, Class, Fields, Methods, Constructors, Primitive data types, Strings and literal, Wrapper class, Nonexistence type: null. Object Oriented Programming (OOP) - The students will implement each of the object oriented concepts which are discussed in the class. Java features to support practical OOP – String Operations: String creations and operations, immutability property of String, String comparison and searching, String buffers and builders; Java I/O: Streams, Input and Output Stream, File, Path, Directory and tree; Exception handling: try and catch, checked exception vs unchecked exceptions, throw and throws, Common exception and User defined exceptions; Logger and Debugging: Logger, Log levels, Formatters and Filters, Logger Handlers and Manager, Configuration, Introduction to Debugging and Debugging Workflow.

References:
1. The Object Oriented Thought Process, Matt Weisfeld, Addison-Wesley
2. Java How to Program, Paul Deitel and Harvey Deitel, McGraw Hill
3. Java: The Complete Reference, Herbert Schildt, McGraw Hill

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Course Title: Computer Organization
Course Code: CSE 211
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Outline: Introduction: Function and structure of a computer, Functional components of a computer, Interconnection of components, Performance of a computer; **Number representation and arithmetic**: Binary, octal, and hexadecimal numbers, One's and two's complements and other representations, Addition and subtraction; **Digital logic and integrated circuits**: Boolean algebra and truth tables, Boolean functions (Gates, Functions, Simplification), Integrated circuits (Combinational circuits - adders, shifters, decoders, multiplexers and ROM's; Flip-flops; Sequential circuits - registers, counters and RAM); **Representation of Instructions:** Machine instructions, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures; **Introduction to Assembly Language:** Programming with Assembly language, The assembly process, Linking and loading, Register-level debugging,
Processing Unit: Organization of a processor - Registers, ALU and Control unit, Data path in a CPU, Instruction cycle, Organization of a control unit - Operations of a control unit, Hardwired control unit, Micro-programmed control unit; **Memory Subsystem:** Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal Organization of a memory chip, Organization of a memory unit, Error correction memories, Interleaved memories, Cache memory unit - Concept of cache memory, Mapping methods, Organization of a cache memory unit, Fetch and write mechanisms, Memory management unit - Concept of virtual memory, Address translation, Hardware support for memory management; **Input/Output Subsystem:** Access of I/O devices, I/O ports, I/O control mechanisms - Program controlled I/O, Interrupt controlled I/O, and DMA controlled I/O, I/O interfaces - Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewall and InfiniBand, I/O peripherals - Input devices, Output devices, Secondary storage devices; **Multiprocessing Systems:** Shared memory multiprocessor, Message-passing multiprocessor, Hardware multithreading

References
1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann, 1998.
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw-Hill, 2002.
3. W. Stallings, "Computer Organization and Architecture - Designing for Performance", Prentice Hall of India, 2002.
4. J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998.

Course Title: Bangladesh Studies
Course Code: GE 212
Credit: 3 Credits (3 Credit Theory)

Outline: Introduction to the course and its objectives, History and Society of Bengal under the British rule and Pakistan rule: The impact of British and Pakistan rules on the economy and education of the people. Language Movement of 1952, Events Leading to the Mass Upsurge of 1969, War of Independence and the Emergence of Bangladesh in 1971, **Government and Politics:** Three branches of government- executive, legislative and judiciary, Formation and role of major political parties in Bangladesh and Constitutional development of Bangladesh, **Study of Geography and Resources of Bangladesh:** Location, Area, Boundary, Ecological Settings, River System, Climate, People and Resources of Bangladesh, **Social Structure of Bangladesh:** Rural society, Urban society, Family, household, and kinship, Women's role in society **Culture of Bangladesh:** Language, Literature, Art and Culture of Bangladesh, **Economy of Bangladesh**: Major Economic Sectors, potentials of various sectors and their prospective challenges; foreign aid and development, role of donor agencies, role of NGOs, **Achievements in different sectors of Bangladesh:** Economy, Culture, Sports, etc., **Socio-economic problems and prospects of Bangladesh:** poverty, health issues, natural disaster, social stratification and gender discrimination.

References
1. Islam, S. (2003). Banglapedia. National Encyclopedia, Asiatic Society of Bangladesh, Dhaka
2. Kibria, S. A. (1999). *Bangladesh at the Crossroads*. University Press Ltd.
3. Riaz, A. (2016). Bangladesh: A Political History since Independence. London: IB Taurus.

Semester 3 (2nd year 1st Semester)

Course Name: Combinatorial Optimization
Code: CSE 301
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction - Algorithms, Analyzing & Designing Algorithms, Correctness of Algorithms; Greedy Algorithms - Introduction to Greedy Algorithms, Greedy Choice Property, Greedy vs. Dynamic Programming, Fractional Knapsack Problem, Activity Selection Problem, Huffman Encoding, Task Scheduling Problem, Coin Changing Problem, Kruskal's and Prim's Minimum Spanning Tree Algorithms; Divide and Conquer Algorithms - Introduction to Divide and Conquer Design Technique, Quick Sort, Merge Sort, Proof of Correctness, and Run Time Analysis; Dynamic Programming - Introduction to Dynamic Programming Technique, Principle of Optimality, Optimal Substructure Property, Assembly Line Scheduling, Matrix Chain Multiplication, LCS, Viterbi Algorithm, Bitonic Euclidean Traveling Salesperson Problem and Runtime Analysis; Graph Searching and Shortest Path Problems - Breadth First Search, Depth First Search, Flow Networks, Single Source and All Pair Shortest Path Algorithms; Linear Programming -Overview of Linear Programming, Formulating Problem as Linear Programs, Simplex Algorithm and Integer Linear Programming; Selected Topics - Computational Geometry, Number Theoretic and String Matching Algorithms; NP Completeness and Approximation Algorithms - NP Completeness, Polynomial Time Verification, NP Completeness and Reducibility, NP Complete Problems and Approximation Algorithms.

References:
1. Thomas Corman, *Introduction to Algorithms*, Stein Pub MIT Press, 3rd Ed.
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, *The Design and Analysis of Computer Algorithms*, Addison Wesley Series, 1974 Ed.

Course Title: Numerical Analysis for Engineers
Code: MATH 304
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Outline: Introductory concepts and calculus review, 'C' programming, the sources and propagation of errors, root finding for nonlinear equations, solution of system of linear equations, interpolation and approximation theory, numerical integration and differentiation.

References:
1. Numerical Methods, E Balagurusamy, Tata McGraw-Hill Publishing Company, 2002

Course Title: Software Project Lab I
Code: SE 305
Credit: 3 Credits (3 Credit Theory)

Course Outline: Each of the students should complete the software project separately. They will be marked based on their individual software. Student will be encouraged to develop software which requires significant "problem solving" effort. The project should be sufficiently large and the size of the project will mostly depend on "problem solving" effort. Besides, students must showcase the skills they have acquired from their so far completed courses.

| **Course Title:** Object Oriented Concepts II |
| **Code:** SE 306 |
| **Credit:** 3 Credits (2 Credit Theory and 1 Credit Lab) |

Course Outline: Object Oriented Concepts - Review of Object Oriented Concept - Object Data, Object Behaviors, Class, Attributes, Methods, Encapsulation and Data Hiding: Interfaces and Implementations, Inheritance: Super classes and Sub classes, Abstraction and Is-A relationship, Polymorphism, Compositions: Abstractions and Has-A Relationship; Mastering Composition and Building Objects – Representing Composition with UML, Composition Relationships, Building in Phases, Types of Composition: Aggregation and Associations, Avoiding Dependencies and Cardinality; Details of Creating Object Models with UML – Class Diagram, Attributes and Methods, Access Designations, Inheritance, Interfaces, Composition: Aggregations and Associations, and Cardinality; Objects and Portable Data - Portable Data, The Extensible Markup Language (XML), XML Versus HTML, XML and Object-Oriented Languages, Validating the Document with the Document Type Definition (DTD), Integrating the DTD into the XML Document, and Using Cascading Style Sheets; Persistence objects – Basics of Persistence, Saving to a Flat File, Using XML in the Serialization Process and Writing to a Relational Database; Objects and the Internet – Object-Based Scripting Languages, Objects in a Web Page and Distributed Objects and the Enterprise; Objects and Client/Server Applications – Client/Server Approaches, Proprietary Approaches and Nonproprietary Approaches; Object Oriented Design Principles - Single Responsibility Principle, Open/Close Principle, Liskov Substitution Principal, Interface Segregation Principle and Dependency Inversion Principle; Introduction to Component Based Design, Design Patterns and Code Smells. **Programming lessons** - Object Oriented Programming (OOP) - The students will implement each of the object oriented concepts which are discussed in the class. Java features to support practical OOP – Generics: Wildcard, Generic class definitions, Generic method definitions, Using generics; Collection Framework: Collection interfaces, List and SortedList, Map and SortedMap, Navigable Map, Set and Sorted Set, Navigable Set, Queue and DeQueue, Stack, hashCode() and equals(), Comparator and Comparable; Reflection: The *Class* Class, reflect package, Fields and Methods, Exception Handling and Reflections and Dynamic Programming; Multi-Threaded Programming: Overview of Thread, Java Thread Model, Creating and Running Thread, Thread Pools, Thread Synchronization, wait and notify, join and sleep and The concurrency API; User Interface: Swing, Components, Container, Events, Layouts and SwingWorker; Serialization: Serializable interface, Writing and Reading an Object, Handling Exceptions, Customized Serialization and Controlling Serialization; Socket Programming: Clients and Servers, Ports, Addresses and Protocols, Communication using I/O, Servers, The ServerSocket Class, The URL lass and URLConnction Class; Java Servlet Programming: Introduction To Servlet, Servlet Life cycle, HttpServlet, HttpRequest, HttpResponse, RequestDispatcher, HttpSession and ServletContext, Servlet Configuration, Cookies, Servlet Filters and Http Headers and MIME types; The Java Beans AOI: Introspector, PropertyDescriptor, EventSetDescriptor and MethodDescriptor.

References:
1. The Object Oriented Thought Process, Matt Weisfeld, Addison-Wesley
2. Java How to Program, Paul Deitel and Harvey Deitel, McGraw Hill
3. Java: The Complete Reference, Herbert Schildt, McGraw Hill
4. Head First Java by Kathy Sierra and Bert Bates, O Reilly

Course Title: Computer Networking
Code: CSE 311
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction: Overview of the Internet, Overview of Networking Protocols, Network Edge, Network Core, Protocol Layers / Service Model, General Networking Example; Application Layer: Principles of Networking Applications, Web and HTTP, FTP, E-mail, DNS; Transport Layer: Transport Layer Services, Multiplexing and De multiplexing, Connectionless Transport: UDP, Principles of Reliable Data Transport, Connection-Oriented Transport: TCP, Principles of Congestion Control, TCP Congestion Control; Network Layer: Datagram Networks, Inside a Router, Details of the Internet Protocol (IP), IP Sub netting, Routing Algorithms (Link State, Distance Vector), Routing in the Internet (Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP)).

References:
1. Data Communications and Networking, B. A. Forouzan, 5/e

Course Title: Theory of Computing
Code: SE 312
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Brief Review of mathematical background: Binary relations, digraph, string, languages, proofs, inductive definitions; Finite automata and regular expressions: Deterministic and non-deterministic finite automata, regular expressions and regular sets, Kleene's Theorem; Properties of regular sets: pumping lemma, closure properties, decision algorithms; Context Free grammar and languages: Context-free grammars, regular grammars; Simplified forms and normal forms: useful symbols, productions, unit productions, chomsky normal form; Pushdown automata: pushdown automaton, equivalence between pushdown automata and context-free languages; Turing machine: introduction to Turing machines.

References:
1. Introduction to Automata Theory, Languages, and Computation by John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Third Edition, Pearson Education.

Semester 4 (2nd year 2nd Semester)

Course Title: Operating System and System Programming
Course Code: CSE 401
Course Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction: What is operating system? History of operating system Operating system concepts Operating system structure Processes and Threads Processes Threads Interprocess communication Scheduling Classical IPC problems Memory Management No memory abstraction Virtual memory Page replacement algorithms Design issues for paging systems Implementation issues File Systems Files Directories File system management Input / Ouptut Principles of I/O hardware Principles of I/O software I/O software layers Disks Clocks Thin clients Deadlocks Resources Detection Recovery Avoidance Prevention Virtualization and Cloud

Course Reference Books:
1. Operating System Concepts, 7th edition, by Silberschatz, Galvin, Gagne
2. Modern Operating Systems, 4th edition, Tanenbum, Bos

Course Title: Business Psychology
Code: GE 402
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline:
Fundamentals: Definition of Psychology, Subfields of Psychology, Major Perspectives of Psychology, Psychology in Business; Job Analysis: Job-oriented Approach, Person-oriented Approach, Purposes of Job Analysis, Methods of Job Analysis, Job Evaluation; Assessment Methods for Selection and Placement: Psychological Tests: Ability Test, Personality Test, Intelligence Test, Vocational Interest Test; Training and Development: Training Need Analysis, Training Designs, Training Methods, Evaluation of Training; Theories of Employee Motivation: Need Theories, Reinforcement Theory, Expectancy Theory, Goal Setting Theory; Job Attitude and Emotion: Nature of Job Satisfaction, Assessment of Job Satisfaction, Antecedents of Job Satisfaction, Potential Effects of Job Satisfaction, Organizational Commitment, Emotion at work; Productive and Counterproductive Employee Behavior: Productive Behavior, Job Performance; Counterproductive Behavior, Withdrawal, Aggression, Mistreatment, Sabotage, and Theft; Occupational Health Psychology: Occupational Health and Safety, Work Schedules, Occupational Stress, Work-Family Conflict, Burnout, Hawthorne Studies; Leadership: Approaches to the Understanding of Leadership Trait Approach, Leader Behavior Approach, Contingency Theory, Path-Goal Theory, Leader-Member Exchange (LMX) Theory, Transformational Leadership Theory; Organizational Development and Theory: Organizational Development Employee Acceptance of Change, Management by Objectives, Survey Feedback, Team Building, T-Group; Effectiveness of Organizational Development: Organizational Theories, Bureaucracy, Theory X and Theory Y, Open System Theory, Socio-technical System Theory.

References:
1. Industrial and Organizational Psychology: Research and Practice, Paul E. Spector, 5th Edition

Course Title: Database Management System I
Code: CSE 404
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction to Database Systems: Evolution of file processing systems, role of databases in organizations, core components of a database environment; Data Modeling: the Entity-Relationship Diagram and its symbols and constructs; The Relational Model and Normalization: relational model, normalization, transformation of an entity-relationship data diagram into a relational model; SQL - A Standard Navigation Language for Relational Databases; Overview of Object-Oriented Databases: object-oriented data model, implementation of object persistence using relational databases.

References:
1. Database System Concepts by Avi Silberschatz, Henry F. Korth and S. Sudarshan, Sixth Edition

Course Title: Business Studies for Engineers
Code: CSE 405
Credit: 3 Credits (3 Credit Theory)

Course Outline: Managers and Entrepreneurs: Management Defined, Role of a Manager, Small-Business Management, The Evolution of Management Thought, Organization, Organization Charts, Contrasting Theories of Organization, Organizational Effectiveness, Organizational Cultures, Change, Conflict, and Negotiation in Organization; The Strategic Management Process, Strategic Implementation and Control, Forecasting. **Accounting Basic:** Forms of Business Organization, Types of Activities performed by Business Organization, Financial statements of Business Organization, The Accounting Equation, The Account and Rules of Debit and Credit, The Journal: Recording of Transaction, Adjusting the Accounts, Closing Entries, and Preparing Financial statements from the Work Sheet. **Analysis and Interpretation of Financial Statement:** Objectives of Financial Statement Analysis, Analysis of a Balance Sheet, Analysis of Statement of Income and Retained Earnings, Ratio Analysis: Liquidity Ratios, Equity or Long Term Solvency Ratio, Profitability Test, Market Test.

References:
1. Stephen P. Robbins and Mary Coulter, *Management*, Prentice Hall, Latest Edition
2. Jerry J. Weygandt, Donald E. Kieso, and Paul D. Kimmel, *Accounting Principles*, Wiley, 8th Ed.

Course Title: Software Requirements Specification and Analysis
Code: SE 406
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Review of – The Nature of Software, Software Engineering, The Software Process, Software Engineering Practices, Generic Software Process Model, Process Assessment and Improvement, Prescriptive Process Models, Specialized Process Model and Agile Development. Requirements Engineering, Establishing the ground work, Eliciting Requirements, Negotiating Requirements, Validating Requirements, Requirements Analysis, Scenario-Based Modeling, UML Models, Data Modeling Concept, Class Based Modeling, Requirements Modeling Strategies, Flow-Oriented Model, Behavioral Model, Requirements Modeling for WebApps.

Lab: One small real life system will be given to all the students for analyzing in the class room. Three real life mid-scale systems will be distributed among groups (created randomly) of 5/6 students to analyze (one project per group). The output of both of the analysis will be specification reports.

References:

1. R. S. Pressman, Software Engineering. A Practitioner's Approach, 7/e or higher, McGraw Hill
2. Ian Sommerville. Software Engineering, 9th or higher Edition, Addison-Wesley.

Course Title: Information Security
Code: CSE 411
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Overview: Network Security Concepts, Security Attacks, Services and Mechanisms; Classical Encryption techniques: Symmetric Cipher Model, Substitution and Permutation Ciphers, Steganography; Block Ciphers and Data Encryption Standard: Design principles and modes of operation; Public-key cryptography: Introduction to number theory, RSA and Diffie-Hellman; Message Digest: Requirements for cryptographic hash functions,MD5 ,SHA, Message authentication codes, digital signatures; Key Management and Distribution: Symmetric Key Distribution using Symmetric Encryption, Symmetric Key Distribution using asymmetric Encryption, public key distribution, public key certificates, x.509 certificates; Network and Internet Security: Transport Layer Security, Wireless LAN security, e-mail security.

References:
1. Information Security: Principles and Practice by Mark Stamp 2nd Edition Wiley 2011

Semester 5 (3rd year 1st Semester)

Course Title: Web Technology
Code: CSE 502
Credit: 3 Credits (1 Credit Theory and 2 Credit Lab)

Course Outline: Introduction To Html, Java Script & CSS, Server Side Programming: HTTP Server, Application Server, MVC Web Framework, Web Services, Database Access: Object Relational Mapping, Lambda Expression, Language Integrated Query, Data Reader, Writer, Web Security: Denial of Service, Buffer Overflow, Cross Site Scripting, Authentication and Access Control

References:
1. Deitel & Deitel, Goldberg, "Internet and world wide web – How to Program", Pearson Education Asia, 2001.
2. Rajkamal, "Web Technology", Tata McGraw-Hill, 2001.
3. Teach yourself web technologies part I & II- I. Bayross. BPB
4. Web Design in a Nutshell- J. Niederst, SPD

Course Title: Business Communications
Code: BUS 503
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Outline: Communication Concept: The Role of Communication in Business, Importance of Communication Skills, Main Form of Business Communication, Process of Human Communication. **Fundamentals of Business Writing:** Adaptation and the Selection of Words, Construction of Clear Sentences and Paragraphs, Writing for Effect. **Basic Pattern of Business Messages:** Directness in Good News and Neutral Situations, Indirectness in Bad Message, Indirectness in Persuasion Message, Letter and Memorandum, Letter Writing Styles, Pattern Variations in Memorandums and the Email, Job Search Activities: Strategies in the Job Search Process, Job search activities, Writing CV, Facing Interviews, Feedback letters for goodwill, **Fundamentals of Report Writing:** Basics of Report Writing, Report Structure: Short Forms, Long and Formal Report, Usages of Graphics. **Other Form of Business Communication:** Informal Oral Communication, Technology-Enabled Communication.

References:
1. Raymond V. Lesikar, John D. Pettit, Maire E. Flatley, Lesikar's Basic Business Communication, Mc Graw Hill

Course Title: Database Management System II
Code: CSE 504
Credit: 3 Credits (1 Credit Theory and 2 Credit Lab)

Outline: Indexing and Hashing: Basic Concepts, Ordered Indices, B+-Tree Index Files, B-Tree Index Files, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing; Query Processing: Overview, Measures of Query Cost, Selection Operation, Sorting, Join Operation, Evaluation of Expressions; Query Optimization: Introduction, Transformation of Relational Expressions, Catalog Information for Cost Estimation, Statistical Information for Cost Estimation, Cost-based optimization; Transactions: Transaction Concept, Transaction State, Concurrent Executions, Serializability; Concurrency Control: Lock-Based Protocols, Timestamp-Based Protocols; Recovery System: Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery, Recovery With Concurrent Transactions; Data Analysis and Mining: Data Mining, Decision tree, Bayes theory, Randomize tree; Database System Architectures: Centralized and Client-Server Systems, Server System Architectures, Parallel Systems, Distributed Systems, Network Types; Parallel Databases: Introduction, I/O Parallelism, Interquery Parallelism, Intraquery Parallelism, Intraoperation Parallelism, Interoperation Parallelism; Distributed Databases: Heterogeneous and Homogeneous Databases: Distributed Data Storage, Distributed Transactions, Commit Protocols; Additional should be included: Database Design, Database Tuning Security and Authorization, Multidimensional query.

References:
1. Ramez Elmasri and Shamkant B. Navathe Fundamentals of Database Systems. Third Edition. Addison-Wesley Pub Co, 1999.
2. Database Systems: The Complete Book, Hector Garcia-Molina, Jeffrey D. Ullman and Jennifer D. Widom Prentice Hall. (best supporting book)
3. Fundamentals of Database Systems, by Ramez Elmasri and Shamkant Navathe, Addison Wesley.
4. Database System Concepts,Fifth Edition, Avi Silberschatz, Henry F. Korth, S. Sudarshan

Course Title: Software Project Lab II
Course Code: SE 505
Credit: 3 Credits (3 Credit Theory)

Course Outline: Students will create project teams of 3 members each. Number of team members can be varied for special cases, decided by the assigned course manager. All the project teams are required to prepare their Software Requirements Specification (SRS) first, and later develop the project accordingly.

Course Name: Design Patterns
Code: SE 506
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Revision of Concepts of OOP, Importance of learning design patterns, Types of Design Patterns - Structural, Behavioral and Creational Patterns, Creational Patterns – Singleton, Factory, Factory Method, Abstract Factory, Builder, Prototype and Object Pool, Behavioral Patterns - Chain of Responsibility, Command, Interpreter, Iterator, Mediator, Memento, Observer, Strategy, Template Method, Visitor and Null Object, Structural Patterns – Adapter, Bridge, Composite, Decorator, Flyweight and Proxy, REFACTORING CODE SMELL, Different type of code smells - Inappropriate Naming, Comments, Dead Code, Duplicated code, Primitive Obsession, Large Class, Lazy Class, Alternative Class with Different Interface, Long Method, Long Parameter List, Switch Statements, Speculative Generality, Oddball Solution, Feature Envy, Refused Bequest, Black Sheep and Train Wreck, Design Principles (SOLID) - Single responsibility principle, Open Close Principle, Liskov substitution principle, Interface segregation principle, Dependency Inversion principle.

References:
1. Gamma, Erich. *Design patterns: elements of reusable object-oriented software*. Pearson Education, 1995.

Course Title: Professional Ethics for Information Systems
Code: SE 511
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction to Ethics, Morals, Integrity, Ethical use of Information Technology, Ethics for IT Workers and IT Users - Trade secret, Whistle blowing, fraud, misrepresentation, bribery, professional code of ethics, IT professional malpractice and Common Ethical issues for IT users, Computer and Internet Crime - Exploit, Viruses, Phishing and Types of perpetrators, Privacy - Information privacy, fair information practices, EU data protection directive, key privacy and anonymity issues, Freedom of Expression - Right to freedom of expression, obscene speech, hate speech, defamation, controlling access to information on the internet, anonymity on the internet, corporate blogging and pornography, Intellectual property - Copyright, fair use doctrine, patent, software patents, trade secret and key intellectual property issues, Impact of IT on society, Social networking ethical issues, Ethics for IT organization.

References:
1. Ethics In Information Technology, George W. Reynolds

Course Title: Distributed Systems
Code: CSE 601
Credit: 3 Credits (1 Credit Theory and 2 Credit Lab)

Course Outline: Foundations **-** Characterization of DS, System Models, Networking and Internetworking, Interprocess Communication, Remote Invocation, Indirect Communication and Operating System Support **Middleware** - Dist. Objects and Components, Web Services and Peer-to-Peer Systems System services – Security, Distributed File Systems and Name Services Distributed algorithms - Time and Global States, Coordination and Agreement Shared data, Transactions and Concurrency Control, Distributed Transactions, and Replication, New challenges - Mobile and Ubiquitous Computing

Lab: Introduction to Message passing technology and its applications, Sockets Programming, Remote Procedure Calls code implementation, Synchronization assignments, Group Communication code implementation, Distributed mutual exclusion assignment, Implementation of Election Algorithms, Implementation of Distributed File system: MapReduce, Spanner, Distributed Systems Design assignments: Cloud Services and Content Delivery Networks configuration.

References:
1. Distributed Systems: Concepts and Design (5th Edition). George Coulouris (Author), Jean Dollimore (Author), Tim Kindberg (Author), Gordon Blair (Author)

Course Title: Artificial Intelligence
Code: CSE 604
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Intelligent Agents and their Environments - The concept of a Rational Agent, Specifying the Task environment (PEAS description), Different characteristics of environments (Fully vs Partially observable, Static vs Dynamic, Episodic vs Sequential etc.) and Different types of agents (Reflex, Goal-based, Utility-based etc.),Search - Formulating a search problem , Uninformed Search strategies: BFS, DFS, DLS, ID-DFS, their working principles, complexities, relative advantages and disadvantages, Informed (heuristic) Search strategies: Greedy Best-first search, A* search: Working principle, Characteristics of heuristics (admissibility and consistency), Proof of A*'s optimality, Local search: Hill Climbing, Searching with non-deterministic actions: AND-OR search trees and Searching with partial observability: Belief state-space search, Adversarial Search - Formulation of a Game tree, The minimax algorithm, Alpha-Beta pruning: Its rationale, working principle and Additional techniques such as Move ordering and Search cut-off, Probabilistic Reasoning - Bayes' rule and its uses, Bayesian Network: Building a Bayes-net and making inference from it, Markov Chains and Hidden Markov Models: Transition and Sensor models, Building and HMM, applications of HMM, Inference in temporal models: Filtering, Prediction, Most Likely explanations (Viterbi algorithm) etc. and Particle Filters: basic working principle, Making Decisions - Decision theory and Utility theory: Lottery, Utility functions, Maximum Expected Utility principle, Constraints of Utility (Orderability, Transitivity etc) and Markov Decision Processes: Policies, Rewards, Optimal policies and the Utility of States, Value Iteration, Supervised Learning - Basic concepts of classification and supervised learning: Training set, Test set, Overfitting, Underfitting etc., Decision trees: Basic understanding, Learning a Decision tree through entropy calculation, Nearest Neighbor classifier: Basic working principle,

Relative advantages and disadvantages, Naive Bayes classifier: Basic working principle, Calculating classification procedures, Relative advantages and disadvantages, Artificial Neural Network: Basic working principle, Basic structure and calculation of a perceptron, Basics of backpropagation algorithm and Support Vector Machines: Basic working principle, Unsupervised Learning (Clustering) - Basic concepts and applications of Clustering, Different types of Clustering: Partitional vs. Hierarchical, Exclusive vs Overlapping vs Fuzzy, Complete vs Partial, K-means Clustering: Basic working principle, characteristics, advantages, disadvantages, Agglomerative Hierarchical Clustering: Basic concepts, Representations (Dendrograms and Nested cluster diagrams), Different techniques to define cluster proximity: Single link, Complete link, Group average, Centroid method, their relative advantages and disadvantages and DBSCAN: Basic principle and applications, Classification of points (Core, Border and Noise), Reinforcement Learning - Understanding basics of Reinforcement Learning: MDPs, Policies, Rewards, Utilities etc., Passive and Active Reinforcement Learning, Exploration and Exploitation, Adaptive Dynamic Programming, Temporal Difference Learning and Q-Learning.

References:
1. Russell, Stuart, and Peter Norvig. "Artificial intelligence: a modern approach." (1995).

Course Title: Software Testing and Quality Assurance
Course Code: SE 605
Course Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: The Psychology and Economics of Software Testing, Software Testing Life Cycle (STLC), Software Testing Terminology and Methodology, V&V Model, Dynamic Black Box Testing – Boundary Value Analysis, Equivalence Partitioning, State Transition based Testing, Decision Table based Testing, Cause-Effect Graphing based Testing and Error Guessing, Dynamic White Box Testing – Basis Path Testing, Data Flow Testing and Mutation Testing, Inspections, Walkthroughs, Technical Reviews, Unit Testing, Integration Testing, Function Testing, System Testing, Acceptance Testing, Regression Testing, Test Management – Test Organization, Test Plan, Test Design and Specifications, Software Metrics, Software Quality, Quality Control and Quality Assurance, Quality Management and Project Management, Software Quality Metrics, Testing Internet Applications - Security and Performance Testing, Debugging, Test Driven Development (TDD), Behavior Driven Development (BDD). **Tools and Project** - The students will be divided into small groups having at most 3 members and a class project will be given to them for preparing a system test case. They must validate the requirements and create Mock UIs during the preparation of test cases. Besides, each of the students will relate their learnings on unit, regression, performance and security testing, debugging, behavior driven development via different tools like JUnit, Selenium, Apache JMeter, Sprajax, Sqlninja, Bugzilla, Cucumber

References:
1. Naresh Chauhan, Software Testing: Principles and Practices, 1st or higher Edition, Oxford University Press.

2. Glenford J. Myers, Corey Sandler, and Tom Badgett. The Art of Software Testing, 3rd or higher Edition, John Wiley & Sons.

3. Lisa Crispin and Janet Gregory. Agile Testing: A Practical Guide for Testers and Agile Teams, 1st or higher Edition, Pearson Education.

Course Title: Software Design and Analysis
Code: SE 606
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Design Concept - The Design Process, Design Concepts, The Design Model; Architectural Design: Software Architecture, Architectural Genres, Architectural Styles, Architectural Design, Assessing, Alternative Architectural Designs, Architectural Mapping Using Data Flow; Component-Level Design: What Is a Component, Designing Class-Based Components, Conducting Component-Level Design, Component-Level Design for WebApps, Designing Traditional Components, Component-Based Development; User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Web App Interface Design, Design Evaluation.

References:

1. Software Engineering – A Practitioner's Approach. 7th Edition, Roger S. Pressman
2. Software Engineering. 9th Edition, Ian Sommerville

Course Title: Software Metrics
Course Code: SE 611
Course Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Overview of Software Metrics, The basics of Measurement, Goal based framework for software measurement, Empirical Investigation, Measuring Internal Attributes : Size, Measuring Internal Attributes : Structure, Measuring Cost and Effort, Measuring External product attributes : Quality, Measuring Software Reliability, Object Oriented Metrics, For hands-on experiences: Students will implement different software metrics calculation related algorithms, utilize existing industry related tools for measuring software metrics and compare it with their implementations to gain concrete idea.

References:
1. Software metrics- A Rigorous and Practical Approach, (3rd Edition) Norman Fenton, and Jones Bieman.
2. Software Measurement and Estimation: A practical Approach (1st Edition) Linda M. Laird, and M. Carol Brennan

Course Title: Software Security
Course Code: SE 612
Course Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction: Security principles, concept of computer security, security services and policies Security risks: Database security, operating systems security, secure coding Countermeasures: methodologies and tools for identifying and eliminating security vulnerabilities, techniques to prove the absence of vulnerabilities, and ways to avoid security holes in new software. Secure software design: essential guidelines for building secure software, information security standards.

Suggested Readings:
1. Security in Computing, 4th Edition, by Charles P. Pfleeger, Prentice Hall; 4th edition

2. Computer security: principles and practices, William Stallings & Lawrie Brown, 2nd Edition
3. Brian Chess and Jacob West, Secure Programming with Static Analysis (required)
4. David A. Wheeler, Secure Programming for Linux and Unix HOWTO Version 3.5, Aug 2004 (required)
5. Goertzel et al, Software Security Assurance State of the Art Report, May 2007.
6. Aleph One, Smashing the Stack for Fun and Profit. Phrack Vol 7, Nr. 49
7. Tim Newsham, Format String Attacks, Guardent tech report, Sept 2000

Semester 7 (4th year 1st Semester)

Course Title: Internship
Code: SE 701
Credit: 18 Credits (18 Credit Lab)

Outline: The student will work full-time as an intern to particular company for a period of six months. S/he will be evaluated based on the marks provided by the company along with the marks of at least two presentations given at IIT.

Semester 8 (4th year 2nd Semester)

Course Title: Project
Code: SE 801
Credit: 6 Credits (6 Credit Lab)

Outline: Each student can perform a software development or research project. For a research project a student has to submit a thesis. For software development project, a student should submit documents having the following: Project proposal, Software Requirements Specification, Software Design Specification, Software Test Plan and User Manual. Besides, each of the students has to give multiple intermediate presentations to report their project progress.

Course Title: Software Project Management
Code: SE 803
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction to Project management: Historical background and evolution, Terminologies, Software project management objectives, Scope, focus and basic rules Principles of software project management: Basic PM Skills, SPM framework, elements, stakeholders, boundaries, challenges of SPM Software Project planning: Planning objective, project plan, variations, structure of SPM plan, project estimation, estimation methods, models and decision process. PM organization and scheduling: WBS, types of WBS, functions, activities, tasks, life cycles, phasing and purpose of phasing, building project schedule, network diagrams: PERT, CPM, Bar charts, Gantt charts Software project management techniques: Use of methodologies, Managing risks and issues, Managing Quality, Configuration, Change, Crisis, Documentation, Release. Project monitoring and control: Dimensions of monitoring and control, earned value indicators (BCWS, CV, SV, CPI, SPI), backlog management, dispute and error tracking, RMMM charts Industry scenarios: Domain analysis, Business case analysis, Dynamicity, Success and failure factors, case studies

References:

1. Stellman, Andrew, and Jennifer Greene. *Applied software project management*. " O'Reilly Media, Inc.", 2005.
2. Phillips, Joseph. *IT project management: on track from start to finish*. McGraw-Hill, Inc., 2002.
3. Rubin, Kenneth S. *Essential Scrum: A practical guide to the most popular Agile process*. Addison-Wesley, 2012.

Course Title: Software Maintenance
Code: SE 811
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Lifecycle roadmap is presented and different types of evolution and maintenance activities are placed on it. Status within industry and research is mapped out. Evolution laws are discussed and analyses in different contexts (the traditional, component-based, and open-source). Pre delivery and transition maintenance models are studied and criteria for their success are identified. Impact analysis is studied. Different ways to manage customer problems are surveyed,

both the critical (emergency) and non-critical ones. Retirement process model is considered. Finally, the quality attribute "maintainability" is discussed and compared to "bad smells". Techniques for evolutionary design in the small: refactoring. Techniques for large-scale evolutionary design, especially evolution of legacy systems. Architectural patterns for isolation/exposure of change.

References:
1. Effective Software Maintenance and Evolution: A Reuse-Based Approach by Stanislaw Jarzabek; Publisher Taylor & Francis
2. Software Maintenance: Concepts and Practice By Penny Grubb, Armstrong A. Takang 2nd edition World Scientific USA.

Elective Courses

Course Title: Computer, Data and Network Security
Code: CSE 802
Credit: 2 Credit Theory and 1 Credit Lab

Course Outline: Overview: Network Security Concepts, Security Attacks, Services and Mechanisms;
Classical Encryption techniques: Symmetric Cipher Model, Substitution and Permutation Ciphers, Steganography; Block Ciphers and Data Encryption Standard: Design principles and modes of operation; Public-key cryptography: Introduction to number theory, RSA and Diffie-Hellman; Message Digest: Requirements for cryptographic hash functions,MD5 ,SHA, Message authentication codes, digital signatures; Key Management and Distribution: Symmetric Key Distribution using Symmetric Encryption, Symmetric Key Distribution using asymmetric Encryption, public key distribution, public key certificates, x.509 certificates; Network and Internet Security: Transport Layer Security, Wireless LAN security, e-mail security.

References:
1. Data and Computer Communications By Stallings, 8th Edition, Pearson Education, 2007

Course Title: Data Mining and Warehousing
Code: CSE 825
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction to Data Mining, Knowing Data (Data objects, similarities and dissimilarities, statistical descriptions and visualizations), Data Pre-processing, Data Warehousing and Online Analytical Processing, Data Cube technology, Mining frequent patterns, Classification and Cluster Analysis, Research trends in Data mining and warehousing.

References:
1. Data Mining: Concepts and Techniques. Jiawei Han, Micheline Kambar, Jian Pei [Text Book]

Course Title: Pattern Recognition and Image Processing
Course Code: CSE 829
Course Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction to Image Processing; Digital Image Fundamentals - Elements of Visual Perception. Light and the Electromagnetic Spectrum. Image Sensing and Acquisition. Image Sampling and Quantization. Some Basic Relationships between Pixels. Linear and Nonlinear Operations; Image Enhancement in the Spatial Domain - Background. Some Basic Gray Level Transformations. Histogram Processing. Enhancement Using Arithmetic/Logic Operations. Basics of Spatial Filtering. Smoothing Spatial Filters. Sharpening Spatial Filters. Combining Spatial Enhancement Methods; Image Enhancement in the Frequency Domain - Background. Introduction to the Fourier Transform and the Frequency Domain. Smoothing Frequency-Domain Filters. Sharpening Frequency Domain Filters. Homomorphic Filtering. Implementation; Image Restoration - A Model of the Image Degradation/Restoration Process. Noise Models. Restoration in the Presence of Noise Only-Spatial Filtering. Periodic Noise Reduction by Frequency Domain

Filtering. Linear, Position-Invariant Degradations. Estimating the Degradation Function. Inverse Filtering. Minimum Mean Square Error (Wiener) Filtering. Constrained Least Squares Filtering. Geometric Mean Filter. Geometric Transformations; Color Image Processing - Color Fundamentals. Color Models. Pseudo color Image Processing. Basics of Full-Color Image Processing. Color Transformations. Smoothing and Sharpening. Color Segmentation. Noise in Color Images. Color Image Compression; Wavelets and Multiresolution Processing - Background. Multiresolution Expansions. Wavelet Transforms in One Dimension. The Fast Wavelet Transform. Wavelet Transforms in Two Dimensions. Wavelet Packets; Image Compression - Fundamentals. Image Compression Models. Elements of Information Theory. Error-Free Compression. Lossy Compression. Image Compression Standards; Morphological Image Processing - Preliminaries. Dilation and Erosion. Opening and Closing. The Hit-or-Miss Transformation. Some Basic Morphological Algorithms. Extensions to Gray-Scale Images; Image Segmentation - Detection of Discontinuities. Edge Linking and Boundary Detection. Thresholding. Region-Based Segmentation. Segmentation by Morphological Watersheds. The Use of Motion in Segmentation; Representation and Description - Representation. Boundary Descriptors. Regional Descriptors. Use of Principal Components for Description. Relational Descriptors; Object Recognition - Patterns and Pattern Classes. Recognition Based on Decision-Theoretic Methods. Structural Methods.

References:
1. Digital Image Processing - Rafael C Gonzalez and Richard E. Woods.

Course Title: Computer Graphics and Multimedia
Course Code: CSE 831
Course Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Introduction: History of computer graphics, graphics architectures and software, imaging: pinhole camera, human vision, synthetic camera, modeling vs. rendering OpenGL: architecture, displaying simple two-dimensional geometric objects, positioning systems, working in a windowed environment Color: Color perception, color models (RGB, CMY, and HLS), color transformations. Color in OpenGL. RGB and Indexed color. Input: working in a network environment, client-server computing; input measure, event, sample and request input, using callbacks, picking. Geometric transformations: affine transformations (translation, rotation, scaling, and shear), homogeneous coordinates, concatenation, current transformation and matrix stacks. Three dimensional graphics: classical three dimensional viewing, specifying views, affine transformation in3D, projective transformations. Ray Tracing. Shading: illumination and surface modeling, Phong shading model, polygon shading. Rasterization: line drawing via Bresenham's algorithm, clipping, polygonal fill, BitBlt. Introduction to hidden surface removal (z buffer). Discrete Techniques: buffers, bitblt, reading and writing bitmaps and pixel maps, texture mapping, compositing.

References:
1. Computer Graphics, Principle and Practices – James D. Foley, Andries van Dam, Steven K. Feiner and John F. Hughes.

Course Title: Information Retrieval
Code: CSE 840
Credit: 3 Credits (2 Credit Theory and 1 Credit Lab)

Course Outline: Boolean Retrieval: Inverted Index, Processing boolean queries, extended Boolean retrieval; Term Vocabulary and Postings lists: Document delineation and character sequence decoding, Tokenization, Dropping common terms: stop words, Normalization (equivalence classing of terms), Stemming and lemmatization, skip pointers, Biword indexes, Positional indexes; Dictionaries and tolerant retrieval: Search structures for dictionaries, General wildcard queries, k-gram indexes for wildcard queries, Spelling correction; Index Construction: Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing; Scoring and Ranking: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, variant tf-idf functions; Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system; Evaluation in information retrieval: Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance, Results snippets; Relevance feedback and query expansion: The Rocchio algorithm for relevance feedback, Relevance feedback on the web, Evaluation of relevance feedback strategies, Global methods for query reformulation; Language models for information retrieval; Enterprise Information Retrieval: Explore the capacity of Apache Lucene as a text search framework.

References:
1. An Introduction to Information Retrieval by Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Online Edition, 2009, Cambridge University Press, Cambridge, England.
2. Lucene in Action by Michael McCandless, Erik Hatcher, and Otis Gospodnetić, Second Edition, Manning publications.

Course Title: Strategic Management
Code: BUS 842
Credit: 3 Credits (3 Credit Theory)

Course Outline: Strategic Management Concept: Strategic Leadership, Competitive Advantage, Superior Performance, Performance in Nonprofit Enterprises, Strategic Manager, Strategy Making Process. **Industry analysis, External Environment and Internal Resources Analysis:** Industry and Sector, market segments, Porter's Five Forces Model, , Strategic Groups, Industry Life Cycle Analysis, Macroeconomic Forces, Competitive Advantage, Value Creation and Profitability, Avoiding Failures and Sustaining Competitive Advantage. **Functional and Business Level Strategy:** Achieving Superior Efficiency, Learning Effects, Materials Management, Strategy for Attaining superior Reliability, Responsiveness to Customers, Competitive Positioning and Business Level Strategy, Strategies in Fragmented Industries, Embryonic, Growth and Mature Industries. **Technological Support for Adopting Strategies and Global Strategy:** Format War, Strategies for wining in Format War, Information System Strategy, Managing Intellectual Property Rights, Capturing First-Mover Advantages, Technological Paradigm Shifts, Disruptive Technology, Profitability and Profit Growth through Global Expansion, Global Standardization Strategy. **Strategic Software Engineering:** Architecture-Centric Software Development Strategy, Software Product Lines, Software Effort and Cost Estimation Strategies, Openness of a Software, Software Supply Chain, Software Economics.

References:
1. Theory of Strategic Management (Eighth Edition) By: Hill/Jones
2. Strategic Management (Concepts and Cases) Twelfth Edition By: Fred R. David

Course Title: Applied Data Science
Course Code: CSE 844
Course Credit: 2 Credits Theory and 1 Credit Lab

Course Outline:
Theory: Introduction to applied data science, Data cleaning/Data Publishing, Data visualization techniques, Predictive analytics, Bayesian analytics, Building efficient models from complex data, Regularization, Opportunities involving applied data science. The course will cover techniques for collecting, storing, and analyzing data in varying formats. Scientific programming, supervised and unsupervised analytics and data visualization techniques will be covered. Topics will involve learning classifiers, Bayesian, maximum a posteriori, parameter estimation, decision trees, neural networks, support vector machines, bag of words classifiers, N-gram models, association rules, nearest neighbor classifiers, locally weighted regression, ensemble classifiers, Clustering, mixture models, k-means clustering, hierarchical clustering, distributional clustering, selected applications in data mining, automated knowledge acquisition, pattern recognition, program synthesis, text and language processing, internet-based information systems, etc.

Lab: The course lab aims to provide an introduction to various topics such as Big Data, Pattern Discovery, Data Visualization, along with a toolkit to use with data i.e., Hadoop, TensorFlow, etc..

References:
1. Mount and Zumel (2014), Practical data science with R.
2. Cathy O'Neil and Rachel Schutt, *Doing Data Science, O'Reilly, 2014*
3. Russell Jurney, *Agile Data Science, O'Reilly, 2013.*
4. Edward Tufte, *The Visual Display of Quantitative Information, Graphics Press, 2013 (2nd ed).*
5. Morgan Kaufmann, *Data Mining: Practical Machine Learning Tools and Techniques. 3 edition, 2011*
6. Matthew Russell, *Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More. O'Reilly, 2013*