Computer Science Engineering

Semester III						
S. No	**Course code**	**Course name**	**L**	**T**	**P**	**C**
1	CS 205	Design and Analysis of Algorithms	3	0	0	6
2	EE205T	Introduction to Probability	3	0	0	3
3	EE207T	Data Analysis	3	0	0	3
4	CS201T	Automata Theory	3	1.5	0	9
5	CS201C	Software Systems Laboratory	3	0	3	9
6	PH101T	Quantum Physics and Applications	3	0	0	6
Total credits						**36**

Computer Science Engineering

1	**Title of the course** (L-T-P-C)	**Design and Analysis of Algorithms (3-0-0-6)**
2	**Pre-requisite courses(s)**	Computer Programming and Utilization, Discrete Structures, Data Structures and Algorithms , Data Structures and Algorithms Laboratory
3	**Course content**	Syllabus is divided roughly 8 modules; each module roughly takes two weeks. **Module 1:** Introduction Examples and motivation. Asymptotic complexity: informal concepts, formal notation, examples **Module 2:** Searching in list: binary search, Sorting: insertion sort, selection sort, merge sort, quicksort, stability and other issues. **Module 3:** Divide and conquer: binary search, recurrence relations. nearest pair of points, merge sort, integer multiplication, matrix multiplication. **Module 4:** Graphs: Motivation, BFS, DFS, DFS numbering and applications, directed acyclic graphs, directed acyclic graphs, shortest paths: unweighted and weighted, Single source shortest paths: Dijkstra, Minimum cost spanning trees: Prim's algorithm, Kruskal's Algorithm **Module 5:** Union-Find data structure, Priority queues, heaps. Heap sort. Dijstra/Prims revisited using heaps, Search Trees: Introduction Traversals, insertions, deletions Balancing. **Module 6:** Greedy algorithms: Greedy: Interval scheduling, Proof strategies, Huffman coding. **Module 7:** Dynamic Programming: weighted interval scheduling, memoization, edit distance, longest ascending subsequence. matrix multiplication, shortest paths: Bellman Ford, shortest paths: Floyd Warshall **Module8:** Intractability: NP completeness, reductions, examples, Misc topics.
4	**Texts/References**	**1.** Algorithms, by Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, McGraw Hill Education, 2006. **2.** Introduction to Algorithms, 3rd edition, by Cormen, Leiserson, Rivest and Stein, PHI Learning Pvt. Ltd., 2010. **3.** Algorithm Design, 1st edition, by Kleniberg and Tardos, Pearson, 2014.

1	**Title of the course** (L-T-P-C)	**Introduction to Probability (3-0-0-3)**
2	**Pre-requisite courses(s)**	Basic calculus
3	**Course content**	**Introduction**: Motivation for studying the course, revision of basic math required, connection between probability and length on subsets of the real line, probability-formal definition, events and σ-algebra, independence of events, and conditional probability, sequence of events, and Borel-Cantell Lemma. **Random Variables**: Definition of random variables, and types of random variables, CDF, PDF and its properties, random vectors and independence, brief introduction to transformation of random variables, introduction to Gaussian random vectors. **Mathematical Expectations**: Importance of averages through examples, definition of expectation, moments and conditional expectation, use of MGF, PGF and characteristic functions, variance and k-th moment, MMSE estimation. **Inequalities and Notions of convergence**: Markov, Chebychev, Chernoff and Mcdiarmid inequalities, convergence in probability, mean, and almost sure, law of large numbers and central limit theorem. **A short introduction to Random Process:** Example and formal definition, stationarity, autocorrelation, and cross correlation function, definition of ergodicity.
4	**Texts/References**	1. **Robert B. Ash**, ``Basic Probability Theory," Reprint of the John Wiley & Sons, Inc., New York, 1970 edition. 2. **Sheldon Ross**, ``A first course in probability," Pearson Education India, 2002. 3. **Bruce Hayek**, ``An Exploration of Random Processes for Engineers," Lecture notes, 2012. 4. D. P. Bertsekas and J. Tsitisklis, “Introduction to Probability” MIT Lecture notes, 2000 (*link*: https://www.vfu.bg/en/e-Learning/Math-- Bertsekas_Tsitsiklis_Introduction_to_probability.pdf)

1	**Title of the course** (L-T-P-C)	**Data Analysis (3-0-0-3)**
2	**Pre-requisite courses(s)**	Introduction to Probability
3	**Course content**	The role of statistics. Graphical and numerical methods for describing and summarizing data. Sampling variability and sampling distributions, Estimation using a single sample, Hypothesis testing using a single sample, Comparing two populations or treatments, Simple linear regression and correlation, and Case studies.
4	**Texts/References**	Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists," Elsevier, New Delhi, 3rd edition (Indian), 1987. Papoulis and Pillai, "Probability, Random Variables and Stochastic processes," 4th Edition, Tata McGraw Hill, 1991. William Feller, "An Introduction to Probability Theory and Its Applications," Vol. 1, 3rd edition, John Wiley International, 1968.

1	**Title of the course** (L-T-P-C)	**Automata Theory** **(3-1-0-8)**
2	**Pre-requisite courses(s)**	Exposure to Discrete Structures
3	**Course content**	Finite state machines (DFA/NFA/epsilon NFAs), regular expressions. Properties of regular languages. My hill-Nerode Theorem. Non-regularity. Push down automata. Properties of context-free languages. Turing machines:Turing hypothesis, Turing computability, Nondeterministic, multi tape and other versions of Turing machines. Church thesis, recursively enumerable sets and Turing computability. Universal Turing machines. Unsolvability, The halting problem, partial solvability, Turing enumerability, acceptability and decidability, unsolvable problems about Turing Machines. Post`s correspondence problem.
4	**Texts/References**	**1.** Introduction to Automata Theory, Languages and Computation, by John. E. Hopcroft, Rajeev Motwani, J. D. Ullman, 3rd edition. Pearson. 2013. **2.** Elements of the Theory of Computation, by H.R. Lewis and C. H. Papadimitrou, 2nd Edition. Prentice Hall Inc, 1998.

1	**Title of the course** (L-T-P-C)	**Software Systems Laboratory (1-3-0-8)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	1. Vim/emacs HTML, CSS 2. Report and presentation software: latex, beamer,drawingsoftware(e.g. inkscape, xfig, open-office) 3. IDE (e.g. eclipse, netbeans), code reading,debugging Basic Java Java collections, interface 4. Java threads Java GUI Introduction todocumentation: e.g. doxygen/javadocs 5. Version management: SVN/Git 6. Unix basics: shell, file system, permissions, processhierarchy, process monitoring, ssh, rsync 7. Unix tools: e.g. awk, sed, grep, find, head, tail, tar,cut, sort 8. Bash scripting: I/O redirection, pipes 9. Python programming 10. Makefile, libraries and linking 11. Graph plotting software (e.g., gnuplot) 12. Profiling tools (e.g., gprof, prof) 13. Optional topics (may be specific to individualstudents302222 projects): intro to sockets, basic SQL for data storage, JDBC/pygresql A project would be included which touches upon manyof the above topics, helping students see the connection across seemingly disparate topics. The project is also expected to be a significant load: 20-30 hours of work.
4	**Texts/References**	1. Online tutorials for HTML/CSS, Inkscape, OODrawUnix Man Pages for all unix tools, AdvancedBash Scripting Guide from the Linux Documentation Project (www.tldp.org). 2. The Python Tutorial Online Book(http://docs.python.org/3/tutorial/index.html). 3. The Java Tutorials (http://docs.oracle.com/javase/tutorial/). 4. Latex- A document preparation system, 2/e, byLeslie Lamport, Addison-Wesley, 1994.

1	**Title of the course** (L-T-P-C)	**Quantum Physics and Applications** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	• Quantum nature of light: Photoelectric Effect and Compton Effect. • Stability of atoms and Bohr`s rules. • Wave particle duality: De Broglie wavelength, Group and Phase velocity, Uncertainty Principle, Double Slit Experiment. • Schrödinger Equation. • Physical interpretation of Wave Function, Elementary Idea of Operators, Eigen-value Problem. • Solution of Schrödinger equation for simple boundary value problems. • Reflection and Transmission Coefficients. Tunneling. • Particle in a three dimensional box, Degenerate states. • Exposure to Harmonic Oscillator and Hydrogen Atom without deriving the general solution. • Quantum Statistics: Maxwell Boltzmann, Bose Einstein and Fermi Dirac Statistics by detailed balance arguments. • Density of states. • Applications of B-E statistics: Lasers. Bose-Einstein Condensation. • Applications of F-D statistics: Free electron model of electrons in metals. Concept of Fermi Energy. • Elementary Ideas of Band Theory of Solids. • Exposure to Semiconductors, Superconductors, Quantum Communication and Quantum Computing.
4	**Texts/References**	1. Quantum Physics: R. Eisberg and R. Resnick, John Wiley 2002, 2nd Edition. 2. Introduction to Modern Physics: F. K. Richtmyer, E. H. Kennard and J.N. Cooper, Tata Mac Graw Hill 1976, 6th Edition. 3. Modern Physics: K. S. Krane, John Wiley 1998, 2nd Edition. 4. Introduction to Modern Physics: Mani and Mehta, East-West Press Pvt. Ltd. New Delhi 2000. 5. Elements of Modern Physics: S. H. Patil, Tata McGraw Hill, 1984. 6. Concepts of Modern Physics, A Beiser, Tata McGraw Hill, 2009.