INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Computer Science and Engineering**

1. Subject Code: CSN-501 **Course Title:** Advanced Algorithms

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight**:** **CWS 25** **PRS 00** **MTE 25** **ETE 50** **PRE 00**

5. Credits**:** **4** 6. Semester **Autumn**

7. Pre-requisite**:** **NIL** 8. Subject Area**:** **PCC**

9. Objective: To introduce some advanced concepts in algorithms.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Revisit the notions of greedy strategy, dynamic programming, graph algorithms, complexity classes P, NP, NP-hard, NP-complete.	10
2.	Approximation Algorithms: performance ratio, vertex cover problem, travelling salesman problem, set covering problem, subset sum problem.	12
3.	Randomized Algorithms: Tools and techniques. Applications.	10
4.	Multithreaded Algorithms: Dynamic multithreaded programming, multithreaded matrix multiplication, multithreaded merge sort.	10
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors	Year of Publication
1.	Cormen T, Leiserson C, Rivest R, and Stein C: Introduction to Algorithms, MIT Press.	2009
2.	Motwani and Raghavan: Randomized Algorithms. Cambridge University Press.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Computer Science and Engineering**

1. Subject Code: CSN-502 **Course Title:** Advanced Operating Systems

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight**:** **CWS 25** **PRS 00** **MTE 25** **ETE 50** **PRE 00**

5. Credits**:** **4** 6. Semester **Autumn**

7. Pre-requisite**: CS 232** 8. Subject Area**: PCC**

9. Objective: To introduce the basic features in distributed operating systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Theoretical foundations: introduction, limitations of a distributed system, Lamport's logical clocks, vector clocks, causal ordering of messages.	6
2.	Global state reordering algorithm, Cuts of a distributed computation, termination detection.	6
3.	Distributed mutual exclusion: Lamport's algorithm, Ricart-Agrawala Algorithm, Maekawa algorithm, Suzuki-Kasami algorithm, Raymond's tree based algorithm.	10
4.	Distributed deadlock detection: centralized algorithms, distributed algorithms.	10
5.	Failure recovery and fault tolerance: classification of failures, Checkpoints, Synchronous checkpointing and recovery, Asynchronous checkpointing and recovery, Commit protocols, Voting protocols, Dynamic voting protocols.	10
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors	Year of Publication
1.	Singhal, M and Shivaratri, N. Advanced Concepts in Operating Systems. Tata McGraw Hill.	2001
2.	Kskhemkalyani, A and Singhal, M. Distributed computing: Principles, Algorithms, and systems. Cambridge University Press.	2011

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Computer Science and Engineering**

1. Subject Code: **CSN-503** Course Title: **Advanced Computer Networks**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight: **CWS 25** **PRS 00** **MTE 25** **ETE 50** **PRE 00**

5. Credits: **0 4** 6. Semester √
Autumn **Spring** **Both**

7. Pre-requisite: **EC - 203**

8. Subject Area: **PCC**

9. Objective: To familiarize students with the architecture of a processor and machine level programming.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Basic networking concepts revisited: introduction to networks, layering and link layer, network layer, routing, end-to-end layer, congestion control,	5
2.	Modeling and measurement: network traffic modeling, network measurement, simulation issues, network coding techniques	6
3.	Routing and router design, scheduling and QoS, integrated and differentiated services, RSVP	5
4.	Wireless networks and mobility supports, MAC protocol, routing, AODV, group communication, multicast	4
5.	Flow and congestion control, TCP variants, TCP modeling, active queue management	6
6.	Overlay networks: RON, P2P, CDN, Web caching, cross-layer optimizations, Emerging network types: data center, DTN, 4G mobile networks (LTE, Wi-Max), Online social networks (OSN), wireless sensor networks (WSN) – cross-layer sensor data dissemination	10
7.	Emerging applications – VoIP, SIP, video over P2P	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors
1.	J.F. Kurose and K.W. Ross, Computer networking: A top-down approach, 6th edition, Adison Wesley.
2.	L.L. Peterson and BS. Davie, Computer Networks ISE: A System Approach, 5th edition, Morgan Kaufman.
3.	B.A. Forouzan, Data communication & networking, 5th Edition, Tata Mc-Graw Hills.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Computer Science and Engineering**

1. Subject Code**:** **CSN-504** Course Title: **Programming Lab I**

2. Contact Hours: **L: 0** **T: 0** **P: 3**

3. Examination Duration (Hrs.): **Theory** **0 0** **Practical** **0 0**

4. Relative Weight**:** **CWS 00** **PRS 100** **MTE 00** **ETE 00** **PRE 00**

5. Credits**:** **0 2** 6. Semester **Autumn**

7. Pre-requisite**:** **NIL** 8. Subject Area**:** **PCC**

9. Objective: To provide programming experience.

10. Details of the Course:

Programming exercises in Object-oriented programming, Data structures, and Algorithms.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Computer Science and Engineering**

1. Subject Code**: CSN-505** Course Title: **Project Lab II**

2. Contact Hours: **L: 0** **T: 0** **P: 3**

3. Examination Duration (Hrs.): **Theory** **0 0** **Practical** **0 0**

4. Relative Weight**:** **CWS 00 PRS 100 MTE 00 ETE 00 PRE 00**

5. Credits**: 0 2** 6. Semester **Autumn**

7. Pre-requisite**: NIL** 8. Subject Area**: PCC**

9. Objective: To provide hand-on experience on different topics in computer science and engineering..

10. Details of the Course:

Programming exercises and experiments in Computer Networks and Security, Operating Systems, and Database management systems.

1. Experiments on LAN Trainer Kit:
(i) Performance study of data link layer protocols
(ii) Implementation and testing Network Layer routing protocols
(iii) Understanding the steps involved in RC4 algorithm encryption
2. Programming exercises using sockets
3. Design and implementation of a Data Sniffer

11. Suggested Books:

Sl. No.	Name of Books / Authors	Year of Publication
1.	LAN Trainer user Manual	
2.	Stevens, W. R., "Unix Network Programming: Vol. II", 2nd Ed., Pearson Education	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Electronics and Computer Engineering**

1. Subject Code: **CSN-506** Course Title: **Advanced Computer Architecture**

2. Contact Hours: **L : 3** **T : 1** **P : 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight: **CWS 25 PRS 00 MTE 25 ETE 50 PRE 00**

5. Credits: **0 4** 6. Semester: **Autumn** **Spring** √ **Both**

7. Pre-requisite: **EC - 252**

8. Subject Area: **MSC**

9. Objective: To expose students to advanced techniques of computer design such as pipelining, vector processing and multiprocessing.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Fundamentals of computer design, Amdahl's law, measuring and reporting performance.	2
2.	Principles of linear pipelining; Instruction level parallelism and instruction pipelines, speedup, data dependency hazards, remedial measures, branch handling; Arithmetic pipelines; Pipeline control methods; Job sequencing, collision prevention and pipeline chaining; Case study of pipelined systems.	8
3.	Loop unrolling, software pipelining and trace scheduling techniques for exposing instruction level parallelism.	4
4.	Dynamic scheduling algorithms, exploiting ILP using static scheduling and dynamic scheduling, hardware based speculation, multiple issues, and speculation.	8
5.	Data level parallelism, Vector processing characteristics and requirements, pipelined vector processing, vectorization methods, examples of vector processing.	4
6.	Graphics processing units (GPUs), Instruction set architecture, Programming on GPU, Comparison with vector processors	4

7.	Array processing, SIMD array processors, communication between PEs, SIMD interconnection networks, algorithms for array processing	2
8.	Data and control parallelism, PRAM model of parallel computation, parallel algorithms. Embedding of task graphs in processor graphs, dilation and loading, load balancing, Overview of parallel programming with MPI and Open MP.	4
9.	Multiprocessors and multi-computers; Processor organizations: mesh, binary tree, hypercube; Shared memory and message passing systems; Mapping and Scheduling:	6
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books / Authors**	**Year of Publication**
1.	Hennessy, J. L. and Patterson, D. A., "Computer Architecture", 4th Ed., Morgan Kaufmann.	2007
2.	Sima, D., Fountain, T. and Kacsuk, P., "Advanced Computer Architecture: A Design Space Approach", Pearson Education.	2007
3.	Michael, J.Q., "Parallel Computing: Theory and Practice", Tata McGraw-Hill.	2002
4.	Hwang, K., "Advanced Computer Architecture", Tata McGraw-Hill.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Computer Science and Engineering**

1. Subject Code: **CSN-510** Course Title: **Network Programming**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight: **CWS 25 PRS 00 MTE 25 ETE 50 PRE 00**

5. Credits: **0 4** 6. Semester: √
Autumn **Spring** **Both**

7. Pre-requisite: **CS- 341**

8. Subject Area: **PEC**

9. Objective: To familiarize students with advanced concepts of network programming in UNIX environment.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	OSI model, client server model, TCP/IP protocols, introduction to Unix; Process, groups, job control and non-job control shells, reliable and unreliable signals.	6
2.	Inter process communication in Unix, pipes, message queues, shared memory, mmap function and its use, RPC, authentication, timeout and retransmission, call semantics, XDR.	6
3.	Daemon processes and inetd daemon.	2
4.	Introduction to Berkeley sockets, socket addressing, TCP and UDP socket functions, sockets and Unix signals, socket implementation, client and server examples for TCP and UDP and their behavior under abnormal conditions.	8
5.	Socket options, IPv4, IPv6, TCP, I/O multiplexing, Unix I/O models, select and poll functions	4
6.	Unix domain protocols	2
7.	Routing sockets, raw sockets, example programs, ping, traceroute, methods for writing client and server in Unix, iterative server, concurrent server, preforking, prethreading.	6
8.	Data link access, libpcap, BPF, DLPI, Linux SOCK_PACKET, programming using libpcap	4
9.	Socket Programming in JAVA	4
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books / Authors	Year of Publication
1.	Stevens, W.R., Fenner, B. and Rudoff A.M., "Unix Network Programming: Vol. I", 3rd Ed., Pearson Education	2004
2.	Stevens, W.R., "Unix Network Programming: Vol. II", 2nd Ed., Pearson Education	2002
3.	Stevens, W.R., "Advanced Programming in Unix Environment", Pearson Education	2002
4.	Bovet, D.A. and Cesati, M., "Understanding the Linux Kernel", 2nd Ed., O'Reilly.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Computer Science and Engineering**

1. Subject Code: CSN-511 Course Title: **Advanced Database Management Systems**

2. Contact Hours: **L: 3 T: 1 P: 0**

3. Examination Duration (Hrs.): **Theory 3 Practical 0**

4. Relative Weight**: CWS 25 PRS 0 MTE 25 ETE 50 PRE 0**

5. Credits**: 4** 6. Semester: **Spring**

7. Subject Area**: PEC**

8. Pre-requisite**: CS351**

9. Objective: To educate students about advanced concepts pertaining to databases, database management systems and their applications

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Review of DBMS concepts; Relational database systems, applications of DBMS.	3
2.	Transactions & Serializability: Concurrent executions, Serializability View and conflict serializability, Recoverability,	6
3.	Concurrency Control: Lock based protocols, timestamp based protocols, validation based protocols, deadlock handling, insert and delete operations	6
4.	Recovery System: Failure classification, recovery and atomicity, log based recovery, shadow paging, buffer management, remote backup systems	6
5.	Distributed Databases: Homogeneous and heterogeneous databases, distributed transactions, commit protocols, concurrency control in distributed databases	6
6.	Advanced Data Types: Time in databases, spatial and geographic databases, multimedia databases	5
7.	Advanced applications : Knowledge discovery and data mining, data mining functionalities, classification of data mining systems, data warehousing concepts, slicing, dicing, schemas, data warehouse architecture, introduction to Data Mining Query Language (DMQL)	6
8.	Study of typical DBMS packages.	4
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication
1.	Silberchatz, A., Korth, H. F. and Sudarshan, S., "Database System Concepts", 6th Ed., Tata-McGraw Hill.	2010
2.	Han, J. and Kamber, M., "Data Mining: Concepts and Techniques", 2nd Ed., Morgan Kaufmann.	2006
3.	Ray Chhanda, "Distributed Database Systems", Pearson.	2009
4.	Date, C. J, "An Introduction to Database Systems", 8th Ed., Pearson.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Computer Science and Engineering**

1. Subject Code**: CSN-512** Course Title: **Formal Methods and Software Verification**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight**:** **CWS 25 PRS 00 MTE 25 ETE 50 PRE 00**

5. Credits**: 0 4** 6. Semester **Autumn**

7. Pre-requisite**: NIL** 8. Subject Area**: PEC**

9. Objective: To introduce the basic model checking techniques and tools for software verification.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Temporal logics:** syntax and semantics of temporal logics PLTL, CTL, and CTL*	6
2.	**Model checking**: Model checking CTL, PLTL, state explosion problem	6
3.	**Symbolic model checking**: binary decision diagrams (BDDs), representing automata by BDDs, BDD based model checking.	6
4.	**Reachability properties**: Safety properties, Liveness properties, deadlock freeness	6
5.	**Fairness properties:** PLTL, CTL	6
6.	**SMV:** symbolic model checker	6
7.	**SPIN:** model checker based on communicating automata	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors	Year of Publication
1.	Berard, B. Bidoit, M. Finkel, A. Laroussine, F. Petit, A. Petrucci, L. Schnoebelen, Ph. And McKenzie, P. Systems and Software verification. Springer.	2001
2.	Huth, M. and Ryan, M., "Logic in Computer Science: Modeling and Reasoning About Systems", Cambridge University Press.	2005

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF THE DEPARTMENT: Computer Science and Engineering

1. **Subject Code: CSN-513** **Course Title:** Information and Network Security
2. **Contact Hours:** L: 3 T:1 P: 0
3. **Examination Duration (Hrs.):** **Theory** 0 3 **Practical** - -
4. **Relative Weight: CWS 25 PRS 0 MTE 25 ETE 50 PRE 0**
5. **Credits:** 0 4 6. **Semester:**

Spring	Autumn	Both
	√	

7. **Pre-requisite:** CS106
8. **Subject Area: PEC**
9. **Objective of the course:** This course provides an introduction of symmetric key and public key encryption techniques, hash functions, message authentication codes, digital signatures. Application of these cryptographic techniques in different fields email, web and IP security is discussed. The goal of this course is to provide the students adequate foundation to apply cryptographic technique to emerging area of information and network security.
10. **Details of the Course:**

S. No.	Particulars	Contact Hours
1	**Classical Encryption:** symmetric cipher models, Vigenere cipher, stream ciphers, LFSR based ciphers.	02
2	**Block Ciphers:** Substitution and permutation networks (SPN), Feistel structure, description of Data Encryption Standard (DES). Review of finite fields. Advanced Encryption Standart (AES). Linear and differential attacks on block ciphers.	06
3	**Public Key Encrytion:** Principles of public key cryptosystems, RSA, El Gamal cryptosystems. Testing primality: quadratic reciprocity, Chinese Remainder Theorem (CRT), Miller – Rabin algorithm, Solovay Strassen algorithm.	08
4	**Hash Functions:** Random oracle model, security of hash functions, Merkel Damgard iterative construction. Message Authentication and has functions. MD5 message digest algorithm. Secure Hash Algorithm.	06
5	**Digital Signatures:** Properties of digital signatures. Generic signatures. RSA signature, El Gamal signature.	04
5	**Authentication Application:** Kerberos. X.509 Authentication service.	04
6	**Electronic Mail Security:** Pretty Good Privacy (PGP). S/MIME.	04
7	**IP Security:** IP security overview, architechture, key management.	04
8	**WEB SECURITY:** Secure Sockets Layer (SSL) and Transport Layer Security (TLS). Secure Electronic Transaction.	04
	Total	**42**

11. Suggested Books:

S.No.	Author(s)/Name of Books/Publishers	Year of Publication
1	Stallings W., **Cryptography and Network Security**, 4/E, Pearson Education India.	2006
2	Stinson D., **Cryptography Theory and Practice,** 3/E, (Special Indian Edition, first reprint 2011) Chapman & Hall/CRC	2006
3	Pieprzyk J., Hardjono T. and Seberry J. **Fundamentals of Computer Security**, Springer (International Edition) (First Indian reprint 2008)	2003
4	Koblitz N. **A Course in Number Theory and Cryptography**, 2/E, Springer	1994
5	Menezes, A. **Handbook of Applied Cryptography**, CRC Press, (available free of cost at: http://cacr.uwaterloo.ca/hac/)	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Computer Science and Engineering**

1. Subject Code: CSN-514 **Course Title:** Advanced Automata Theory

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight**:** **CWS 25** **PRS 00** **MTE 25** **ETE 50** **PRE 00**

5. Credits**:** **0 4** 6. Semester **Spring**

7. Pre-requisite**:** CS353 8. Subject Area**:** **PEC**

9. Objective: To provide a deeper understanding of automata theory.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Automata and Logical specification: MSO logic over words, The equivalence theorem, consequences and applications in model checking, FO and MSO definability.	7
2.	Congruences and minimization: homomorphisms, quotients, and abstraction; minimization and equivalence of DFAs; equivalence and reduction of NFAs.	7
3.	Tree automata: trees and tree languages;deterministic tree automata,nondeterministic tree automata,emptiness, congruences and minimization; logic oriented formalisms over trees; applications.	8
4.	Pushdown and counter systems	8
5.	Communicating systems	6
6.	Petri nets	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors	Year of Publication
1.	Thomas, W. “Applied Automata Theory”. Springer	2005
2.	Pin, J. “Mathematical foundations of automata theory.” Springer	2012

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Electronics and Computer Engineering**

1. Subject Code: **CSN-515** Course Title: **Data Mining and Warehousing**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory 3** **Practical 0**

4. Relative Weight**:** **CWS 25** **PRS 0** **MTE 25** **ETE 50** **PRE 00**

5. Credits**:** **4** 6. Semester: **Spring**

7. Pre-requisite**: CS102** 8. Subject Area**: PEC**

9. Objective: To educate students to the various concepts, algorithms and techniques in data mining and warehousing and their applications.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Introduction to data mining:** Motivation and significance of data mining, data mining functionalities, interestingness measures, classification of data mining system, major issues in data mining.	3
2.	**Data pre-processing:** Need, data summarization, data cleaning, data integration and transformation, data reduction techniques – Singular Value Decomposition (SVD), Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT), data discretization and concept hierarchy generalization.	6
3.	**Data warehouse and OLAP technology:** Data warehouse definition, multidimensional data model(s), data warehouse architecture, OLAP server types, data warehouse implementation, on-line analytical processing and mining,	4
4.	**Data cube computation and data generalization:** Efficient methods for data cube computation, discovery driven exploration of data cubes, complex aggregation, attribute oriented induction for data generalization.	4
5.	**Mining frequent patterns, associations and correlations:** Basic concepts, efficient and scalable frequent itemset mining algorithms, mining various kinds of association rules – multilevel and multidimensional, association rule mining versus correlation analysis, constraint based association mining.	6
6.	**Classification and prediction:** Definition, decision tree induction, Bayesian classification, rule based classification, classification by backpropagation and support vector machines, associative classification, lazy learners, prediction, accuracy and error measures.	6
7.	**Cluster analysis:** Definition, clustering algorithms –	6

	partitioning, hierarchical, density based, grid based and model based; Clustering high dimensional data, constraint based cluster analysis, outlier analysis – density based and distance based.	
8.	**Data mining on complex data and applications:** Algorithms for mining of spatial data, multimedia data, text data; Data mining applications, social impacts of data mining, trends in data mining.	7
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication
1.	Han, J. and Kamber, M., "Data Mining - Concepts and Techniques", 3rd Ed., Morgan Kaufmann Series.	2011
2.	Ali, A. B. M. S. and Wasimi, S. A., "Data Mining - Methods and Techniques", Cengage Publishers.	2009
3.	Tan, P.N., Steinbach, M. and Kumar, V., "Introduction to Data Mining", Addison Wesley – Pearson.	2008
4.	Pujari, A. K., "Data Mining Techniques", 4th Ed., Sangam Books.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Computer Science &Engineering**

1. Subject Code: **CSN-516** Course Title: **Modeling and Simulation**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0** **3** **Practical** **0** **0**

4. Relative Weight: **CWS 25 PRS 00 MTE 25 ETE 50 PRE 00**

5. Credits: **0** **4** 6. Semester: √

Autumn **Spring** **Both**

7. Pre-requisite: **Knowledge of Probability theory**

8. Subject Area: **PEC**

9. Objective: To acquaint the student to modeling and simulation techniques for discrete, dynamic and stochastic systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Introduction:** Systems, models, deterministic and stochastic systems, static and dynamic systems, discrete event simulation, continuous simulation, Monte Carlo simulation.	4
2.	**Discrete Event Simulation:** Time-advance mechanisms, event modeling of discrete dynamic systems, event graphs, process oriented and event oriented approaches, single-server single queue model.	4
3.	**GPSS:** Program model, entities and transactions, blocks in GPSS, user defined functions, SNA, logic switches, save locations, user chains, tabulation of result, programming examples.	8
4.	**Random Number Generation:** Congruence generators, long period generators, statistical quality measures of generators, uniformity and independence testing, chi-square and other hypotheses testing, runs testing.	5
5.	**Random Variate Generation:** random variable, probability density and distribution functions, Location, scale and shape parameters, discrete and continuous probability distributions; Inverse transform method, composition and acceptance-rejection methods, efficiency and quality measures of generators; Input Modelling, selection of distribution for a random source, fitting distributions to data, constructing empirical distributions from data.	6

6.	**Random Processes and Queuing Models:** random process, discrete/continuous time processes, Markovian property, Markov chain, state transition diagrams, birth-death process, Little's theorem, steady state analysis of M/M/1 model; multi-server models, M/G/1 and other queuing models, Burke's theorem, network of queues, Jackson theorem.	10
7.	**Network Simulation:** SimEvent tool box in MATLAB, general features of network simulation packages, case study of OMNET++/ns2/ns3/NetSim.	5
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books / Authors	Year of Publication
1.	Karian, Z.A. and Dudewicz, E.J., "Modern Statistical Systems and GPSS Simulation", 2nd Ed., CRC Press.	1999
2.	Banks, J., Carson, L.S., Nelson, B.L. and Nicol, D.M., "Discrete Event System Simulation", 4th Ed., Pearson Education.	2007
3.	Law, A.M. and Kelton, W.D., "Simulation, Modeling and Analysis", 3rd Ed., Tata McGraw-Hill.	2003
4.	Alberto Leon-Garcia, "Probability and Random Processes for Electrical Engineers", 2nd Ed., Pearson Education	2011

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Computer Science and Engineering**

1. Subject Code: **CSN-517** Course Title: **Advanced topics in Software Engineering**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0** **3** **Practical** **0** **0**

4. Relative Weightage: **CWS 25 PRS 00 MTE 25 ETE 50 PRE 00**

5. Credits: **0 4** 6. Semester **Autumn** **Spring** √ **Both**

7. Pre-requisite: Student must have the knowledge of basics concepts of software engineering.

8. Subject Area: **PEC**

9. Objective: To introduce the advanced concepts related to software engineering, metrics, and technical aspects of project management.

10. Details of Course:

Sl. No.	Contents	Contact Hours
1.	Product Metrics: Software Quality, Framework for product metrics, metrics for analysis model, metrics for design model, metrics for source code, metrics for testing, metrics for maintenance.	5
2.	Web Engineering: Engineering Layers, Engineering Process, Formulating web based systems, Planning, Team, Project Management, Metrics for Web Engineering and WebApps, Analysis model for WebApps, Content Model, Interaction Model, Functional model, Configuration model, Navigation analysis, WebApp Design and Testing.	8
3.	Cleanroom software engineering: Clean Room approach, functional specification, Cleanroom design, Cleanroom testing.	4

4.	Component based Development: The CBSE Process, Domain engineering, Component based development, Classifying and Retrieving Components, Economics of CBSE.	5
5.	Formal Methods: Basics, Mathematics in Software Development, mathematical preliminaries, applying mathematical notations for formal specification, Object Constraint language.	7
6.	Formal Specification: Formal Specification in the Software process, Sub-system interface specification, Behavioral Specification.	7
7.	Agile Development: Agile practices, extreme programming, planning, testing, refactoring, Agile design basics. Software process models and metrics for evolving technologies.	6
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books / Authors**	**Year of Publication**
1.	Duke, R. and Rose, G., "Formal Object Oriented Specification Using Object-*Z*"**,** Cornerstones of Computing Series (editors: R. Bird, C.A.R. Hoare), Macmillan Press.	2000
2.	Diller,A., "*Z:* An Introduction to Formal Methods", 2nd ed., Wiley.	1994
3.	Heineman, G.T., and Councill, W.T., "Component-Based Software Engineering: Putting the Pieces Together", Pearson Higher Education/Addison Wesley.	2001
4.	Prowell, S.J., Trammell, C.J., Linger, R.C., Poore, J.H., "Cleanroom Software Engineering: Technology and Process", Addison Wesley.	1999
5.	Pressman R., S., "Software Engineering: A Practitioner's Approach", 6th Ed., Tata McGraw-Hill.	2010
6.	Sommerville, I., "Software Engineering", 6th Ed., Pearson Education.	2007
7.	Pressman, R. S. and Lowe, D., "Web Engineering: A Practitioner's Approach", Special Indian Edition, Tata McGraw-Hill.	2008
8.	Martin, R.C., Agile Software Development: Principles, Patterns, and Practics, Pearson Education Publisher.	2011

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Computer Science and Engineering**

1. Subject Code: CSN-518 **Course Title:** Logic and Automated Reasoning

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight**:** **CWS 25** **PRS 00** **MTE 25** **ETE 50** **PRE 00**

5. Credits**:** **0 4** 6. Semester **Spring**

7. Pre-requisite**:** **NIL** 8. Subject Area**:** **PEC**

9. Objective: To provide the foundations of some basic logical languages and their mechanization.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Propositional Logic: syntax, semantics, soundness and completeness theorems.	8
2.	Boolean satisfiability problem (SAT): normal forms, Horn clauses, resolution principle, DPLL algorithm, recent SAT solvers.	6
3.	First-order Logic**:** syntax, semantics, soundness and completeness theorems.	8
4.	Higher-order Logic (HOL): syntax, semantics, and types.	8
5.	Automated theorem proving: First-order theorem proving, unification, term rewriting.	6
6.	Theorem provers for HOL: Isabelle/Coq	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors	Year of Publication
1.	Huth, M. and Ryan, M., "Logic in Computer Science: Modeling and Reasoning About Systems", Cambridge University Press.	2005
2.	Nipkow, T. Paulson, L. Wenzel, M. "Isabelle/HOL a proof assistant for higher-order logic."	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Computer Science and Engineering**

1. Subject Code: **CSN-519** Course Title: **Social Network Analysis**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0 3** **Practical** **0 0**

4. Relative Weight: **CWS 25 PRS 00 MTE 25 ETE 50 PRE 00**

5. Credits: **4** 6. Semester Spring

7. Pre-requisite: **Nil**

8. Subject Area: **PEC**

9. Objective: To introduce the basic notions used for social network analysis.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Social Network Analysis: Preliminaries and definitions, Erdos Number Project, Centrality measures, Balance and Homophily.	4
2.	Random graph models: Random graphs and alternative models, Models of network growth, Navigation in social Networks	4
3.	Network topology and diffusion, Contagion in Networks, Complex contagion, Percolation and information, Epidemics and information cascades	4
4.	Cohesive subgroups, Multidimensional Scaling, Structural equivalence, roles and positions, Ego networks, Weak ties, Structural holes	6
5.	Small world experiments, small world models, origins of small world, Heavy tails, Small Diameter, Clustering of connectivity	6
6.	The Erdos Renyi Model, Clustering Models, Preferential Attachment	6
7.	Navigation in Networks Revisited, Important vertices and page rank algorithm, towards rational dynamics in networks, basics of game theory	6
8.	Coloring and consensus, biased voting, network formation games, network structure and equilibrium, behavioral experiments, Spatial and agent-based models	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors

1.	S. Wasserman and K. Faust. *Social Network Analysis: Methods and Applications* (Cambridge, Cambridge University Press, 1994).
2.	D. Easley and J. Kleinberg, *Networks, Crowds and Markets: Reasoning about a highly connected world*

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Computer Science and Engineering**

1. Subject Code: **CSN-520** Course Title: **Cloud Computing**

2. Contact Hours: **L: 3 T: 1 P: 0**

3. Examination Duration (Hrs.): **Theory 0 3 Practical 0 0**

4. Relative Weightage: **CWS 25 PRS 00 MTE 25 ETE 50 PRE 00**

5. Credits: **0 4** 6. Semester **Autumn** √ **Spring** **Both**

7. Pre-requisite: **CS - 341**

8. Subject Area: **PEC**

9. Objective: This course will cover the study of various algorithms involved in better implementing the cloud-based systems starting through fundamentals of deployment.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction: Distributed Computing and Enabling Technologies, Cloud Fundamentals: Cloud Definition, Evolution, Architecture, Applications, deployment models, and service models.	3
2.	Virtualization: Issues with virtualization, virtualization technologies and architectures, Internals of virtual machine monitors/hypervisors, virtualization of data centers, and Issues with Multi-tenancy.	5
3.	Implementation: Study of Cloud computing Systems like Amazon EC2 and S3, Google App Engine, and Microsoft Azure, Build Private/Hybrid Cloud using open source tools, Deployment of Web Services from Inside and Outside a Cloud Architecture. MapReduce and its extensions to Cloud Computing, HDFS, and GFS.	7
4.	Interoperability and Service Monitoring: Issues with interoperability, Vendor lock-in, Interoperability approaches. SLA Management, Metering Issues, and Report generation.	5
5.	Resource Management and Load Balancing: Distributed Management of Virtual Infrastructures, Server consolidation, Dynamic provisioning and resource management, Resource Optimization, Resource dynamic reconfiguration, Scheduling Techniques for Advance Reservation, Capacity Management to meet	9

	SLA Requirements, and Load Balancing, various load balancing techniques.	
6.	Migration and Fault Tolerance: Broad Aspects of Migration into Cloud, Migration of virtual Machines and techniques. Fault Tolerance Mechanisms.	3
7.	Security: Vulnerability Issues and Security Threats, Application-level Security, Data level Security, and Virtual Machine level Security, Infrastructure Security, and Multi-tenancy Issues. IDS: host-based and network-based, Security-as-a-Service. Trust Management, Identity Management, and Access Controls Techniques	7
8.	Advances: Grid of Clouds, Green Cloud, Mobile Cloud Computing	3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books / Authors**	**Year of Publication**
1.	Cloud Computing Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej Goscinski, Wiley Publishers	2011
2.	Cloud Computing Bible, Barrie Sosinsky, Wiley Publishers	2010
3.	Cloud Computing : Web-based Applications that change the way you work and collaborate online, Michael Miller, Pearson Education	2008
4.	Mastering Cloud computing, Rajkumar Buyya, Christian Vacchiola, S Thamarai Selvi, McGraw Hill	2013
5.	Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide, David S. Linthicum	2010
6.	Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly	2010
7.	Cloud Computing : A Practical Approach, Toby Velte, Antohy T Velte, Robert Elsenpeter, McGraw Hill	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Computer Science and Engineering**

1. Subject Code: **CSN-521** Course Title: **Mobile and Pervasive Computing**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **0** **3** **Practical** **0** **0**

4. Relative Weight: **CWS 25** **PRS 00** **MTE 25** **ETE 50** **PRE 00**

5. Credits: **0** **4** 6. Semester √
Autumn **Spring** **Both**

7. Pre-requisite: **CS - 221**

8. Subject Area: **PEC**

9. Objective: To familiarize students with the concepts and issues of mobile and pervasive computing technologies.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to mobile computing and pervasive/ubiquitous computing, Pervasive computing systems - HP's Cooltown, Microsoft's EasyLiving	5
2.	Enabling technologies for mobile and pervasive computing: sensor technology and wireless sensor networks, RFID technology, smartphones	10
3.	Mobile and pervasive networking: wireless TCP, Mobile IP, ad-hoc routing; data access and management; pervasive computing middleware: AURA, GAIA, ONE.WORLD, service discovery	10
4.	Context-aware computing: location-aware systems-Active Badge, RADAR, Cricket, GPS; location-aware services; issues and challenges in context-awareness	5
5.	Security and privacy in pervasive and mobile computing environment	5
6.	Applications: Internet of Things, smart homes/offices, intelligent traffic systems, social computing, wearable computing	7
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/Authors
1.	Jochen Burkhardt, Pervasive Computing : Technology and Architecture of Mobile

	Internet Applications 14th Edition, Pearson Education Singapore Pte Ltd 2002.
2.	Stefan Poslad, Ubiquitous Computing: Smart Devices, Environments And Interactions 1st Edition, 2010, Wiley India Pvt Ltd
3.	Laurence T. Yang, Handbook On Mobile And Ubiquitous Computing Status And Perspective, 2012, CRC Press

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

NAME OF THE DEPARTMENT: Computer Science and Engineering

1. **Subject Code: CSN-522 Course Title:** Advanced Graph Theory
2. **Contact Hours:** L: 3; T: 1; P: 0
3. **Examination Duration (Hrs.**): **Theory 03 Practical 00**
4. **Relative Weightage:** CWS 25 PRS 0 MTE 25 ETE 50 PRE 0
5. **Credits: 04** 6. **Semester:**

Spring	Autumn	Both
√		

7. **Pre-requisite:** CS-106
8. **Subject Area: PEC**
9. **Objective of the course:** The objective of this course is to provide the students a detailed understanding of graph theory.

10. **Details of the Course:**

S. No.	Particulars	Contact Hours
1	**Review of basics:** Graphs and digraphs, incidence and adjacency matrices, isomorphism, the automorphism group; Trees: Equivalent definitions of trees and forests, Cayley's formula, the Matrix-Tree theorem, minimum spanning trees. Cut vertices, cut edges, bonds, the cycle space and the bond space, blocks, Menger's theorem; Paths and Cycles: Euler tours, Hamilton paths and cycles, theorems of Dirac, Ore, Bondy and Chvatal, girth, circumference,	04
2	**Matchings:** Matchings: Berge's Theorem, perfect matchings, Hall's theorem, Tutte's theorem, Konig's theorem, Petersen's theorem, algorithms for matching and weighted matching (in both bipartitie and general graphs), factors of graphs (decompositions of the complete graph), Tutte's f-factor theorem;	10
3	**Extremal Problems:**Extremal problems: Independent sets and covering numbers, Turan's theorem, Ramsey theorems; Colorings: Brooks theorem, the greedy algorithm, the Welsh-Powell bound, critical graphs, chromatic polynomials, girth and chromatic number, Vizing's theorem; Graphs on surfaces: Planar graphs, duality, Euler's formula, Kuratowski's theorem, toroidal graphs, 2-cell embeddings, graphs on other surfaces.	10
4	**Directed Graphs :** Tournaments, directed paths and cycles, connectivity and strongly connected digraphs, branching.	06
5	**Networks and flows:** Flow cuts, max flow min cut theorem, perfect square.	06
6	**Random Graphs:**The basic models - use of expectations, simple properties of almost all graphs, almost determined variables – use of variance, Hamiltonian cycles, the phase transition.	06
	Total	**42**

11. Suggested Books:

S.No.	Author(s)/Name of Books/Publishers	Year of Publication
1	Douglas B. West, Introduction to Graph Theory, Prentice Hall of India.	2002
2	Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science. Prentice-Hall.	2004
3	Frank Harary, Graph Theory, Narosa.	2000
4	R. Ahuja, T. Magnanti, and J. Orlin, Network Flows: Theory, Algorithms, and Applications, Prentice-Hall.	
5	Bollobas, Bela, Modern Graph Theory, Springer	
6	Diestel, R. Graph Theory, Springer	

INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE

Name of Department: Computer Science and Engineering

1. **Subject Code: CSN-523** **Course Title:** Computational Geometry
2. **Contact Hours L :** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs) : Theory** 03 **Practical**
4. **Relative Weightage: CWS 25 PRS 0 MTE 25 ETE 50 PRE 0**
5. **Credits** 0 4 6**. Semester** Spring
7. **Pre Requisite: CS212**
8. **Subject Area: PEC**
9. **Objective Of Course:** To introduce geometric algorithms and to give an exposure to algorithms and data structures for geometric problems.
10. **Details Of Course:**

S. No.	Topics	No. of Lectures
1	**Polygon Triangulation:** Triangulation Theory, Area of Polygon, Segment intersection, Segment-triangle intersection. **Polygon Partitioning**: Monotone Partitioning, Trapezoidalization, Partition into Monotone Mountains, Linear-Time Triangulation, Convex Partitioning.	6
2	**Convex Hulls in Two Dimensions:** Definitions of Convexity and Convex Hulls, Naive Algorithms for Extreme Points, Gift Wrapping, QuickHull, Graham's Algorithm, Lower Bound, Incremental Algorithm, Divide and Conquer	5
3	**Convex Hulls in Three Dimensions:** Polyhedra and data structures, Gift wrapping, Preparata-Hong algorithm, Incremental algorithm, Randomized incremental algorithm	6
4	**Voronoi Diagrams:** Definitions and Basic Properties, Delaunay Triangulations, Algorithms, Applications in Detail, Medial Axis, Connection to Convex Hulls, Connection to Arrangements	6
5	**Arrangements:**Combinatorics of Arrangements, Incremental Algorithm, Three and Higher Dimensions, Duality, Higher-Order VoronoiDiagrams,	6

	Applications	
6	**Search and Intersection**: Segment-Segment Intersection, Segment-Triangle Intersection, Point in Polygon, Point in Polyhedron, Intersection of Convex Polygons, Intersection of Segments, Intersection of Non-convex Polygons, Extreme Point of Convex Polygon, Extremal Polytope Queries, Planar Point Location	8
7	**Motion Planning**: Shortest Paths, Moving a Disk, Translating a Convex Polygon, Moving a Ladder, Robot Arm Motion, Separability	5
	Total	42

11. **Books recommended**

S. No	Name of Authors/Books/ Publishers	Year of Publication
1	M. de Berg, M. van Kreveld, M. Overmars, O. Schwarzkopf**, Computational Geometry: Algorithms and Applications (2nd Edition)**, , Springer-Verlag.	2000
2	J. O'Rourke, **Computational Geometry in C**, 2nd ed., Cambridge Univ. Press, 1998.	1998
3	B. Casselman, **Mathematical Illustrations: A Manual of Geometry and PostScript**, Springer-Verlag,. (http://www.math.ubc.ca/~cass/graphics/manual)	2005
4	K. Mulmuley, **Computational Geometry: An Introduction Through Randomized Algorithms**, Prentice Hall.	1994