INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 201** Course Title: **Linear Circuits**

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

3. Examination Duration (Hrs.): **Theory** 0 | 2 **Practical** 0 | 0

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

5. Credits: 0 | 3 6. Semester √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: **MA-102**

8. Subject Area: **DCC**

9. Objective: To acquaint the students with the fundamental concepts of network analysis and synthesis of two-port passive networks.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Review of Kirchoff's laws, nodal and loop analysis, and network theorems; Tellegen's theorem.	4
2.	Nodal and loop analysis using Laplace transform; Circuit applications: Switching in RLC circuits, switched capacitor circuits and conservation of charge; Frequency response, impulse and step response, initial and final value theorems.	5
3.	Time domain circuit response computations, convolution and Laplace transformation, time domain evaluation of the convolution integral for linear time invariant circuits, circuit response computations using convolution.	5
4.	Resonant and band pass circuits, magnetically coupled circuits, analysis of coupled circuits; Two-port networks: Admittance, impedance, hybrid, generalized and transmission parameters.	6
5.	Analysis of interconnected two-port, three-terminal networks, two-port network analysis.	3
6.	Driving point and transfer impedance/admittance functions, synthesis of two-port passive networks using ladder development.	5
	Total	**28**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/
1.	Van Valkenbarg, M.E., "Network Analysis", 3rd Ed., Prentice-Hall.	2007
2.	Van Valkenbarg, M.E., "Network Synthesis", 3rd Ed., Prentice-Hall.	2007
3.	Kuo, F.F., " Network Analysis and Synthesis", 2nd Ed., Wiley India.	2008
4.	Murthy, K.V.V. and Kamath, M.S., "Basic Circuit Analysis", Tata McGraw-Hill.	1989
5.	DeCarlo, R.A. and Lin, P.M., "Linear Circuit Analysis: Time Domain, Phasor and Laplace Transform Approaches", Oxford University Press.	2003
6.	Ramakalyan, A., "Linear Circuit Analysis and Synthesis", Oxford University Press.	2005

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 202** Course Title: **Signals and 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: 0 | 4 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **MA - 102**

8. Subject Area: **DCC**

9. Objective: To provide a thorough understanding of the fundamentals of signals and systems required in the study of signal processing, communication systems and control systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Classification and representation of signals and systems, examples; Impulse response and step response of a system.	6
2.	Review of Fourier series and its exponential representation; Review of Fourier transform and its properties, relationship between Fourier transform and Fourier series; Generalized Fourier transform; Amplitude and phase spectra, energy and power spectral density, signal bandwidth.	6
3.	Relationship of Laplace and Fourier transforms; Transfer function and its block diagram representation, convolution integral and the Fourier transfer function; System properties, linearity and time invariance, bandwidth.	6
4.	Review of z-transform and its properties, geometric evaluation of Fourier transform from pole-zero plot; Discrete time Fourier transform and its properties; Discrete convolution and duality; Discrete Fourier transform and its properties; Computation of discrete time Fourier transform and discrete Fourier transform, approximation of Fourier transform and discrete convolution using discrete Fourier transform.	10
5.	Difference equation, impulse response, convolution sum and transfer function representation of discrete time linear time invariant systems; Transform analysis and networks structures for discrete-time systems.	8
6.	Distortionless transmission, ideal and non-ideal filters, Butterworth and Chebyshev filters; Time and frequency domain analysis of continuous time	6

	LTI systems.	
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Oppenheim, A.V., Willsky, A.S. and Nawab, S.H., "Signals & Systems", 2nd Ed., Prentice-Hall of India.	1997
2.	Haykin, S. and Van Been, B., "Signals and Systems" 2nd Ed., John Wiley & Sons.	2003
3.	Roberts, M.J., "Fundamentals of Signals & Systems", Tata McGraw-Hill.	2007
4.	Ziemer, R.E., Tranter, W.H. and Fannin, D.R., "Signals and Systems: Continuous and Discrete", 4th Ed., Pearson Education.	2001
5.	Lathi, B. P., "Linear Systems and Signals", 2nd Ed., Oxford University Press.	2006

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code**: EC - 203** Course Title**: Digital Electronics**

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 – 102**

8. Subject Area**: DCC**

9. Objective: To acquaint the students with the fundamental principles of two-valued logic and various devices used to implement logical operations on variables.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to Boolean algebra, Boolean identities; Basic logic functions, combinational logic, standard forms of logic expressions.	4
2.	K-map representation, simplification of logic expressions, realization of logic expressions using AOI, NOR, NAND and other combinations of logic functions.	4
3.	Transistor as a switch, Schottky transistor; Logic gate characteristics: Propagation delay, speed, noise margin, fan-out and power dissipation.	3
4.	Analysis and characteristics of standard TTL, Schottky TTL, advanced TTL and ECL logic; MOS inverter and gate, CMOS logic, operation and characteristics of MOS and CMOS logic.	6
5.	Comparison of logic families, interfacing of various logic families; Tri-state logic.	3
6.	Multiplexers, demultiplexers and decoders, and their use in logic synthesis; Arithmetic circuits; Seven-segment and alphanumeric display design.	5
7.	Operation and excitation tables of RS, JK, Master Slave, D, and T flip flops; Latch, shift register; Counters: Ripple, synchronous, ring and up-down; Design of counters, design of other sequential circuits.	10
8.	ROM and RAM; PLA, PAL and FPGA; Logic synthesis.	3
9.	Astable and monostable multivibrator circuits using basic logic gates, internal structure of 555 and its applications, clock circuits.	4
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/ Authors	Year of Publication/ Reprint
1.	Mano, M.M. and Ciletti, M.D., "Digital Design", 4th Ed., Prentice-Hall.	2006
2.	Balabanian, N. and Carlson, B., "Digital Logic Design Principles", John Wiley & Sons.	2001
3.	Jain, R.P., "Modern Digital Electronics", 3rd Ed., Tata McGraw-Hill.	2003
4.	Kumar, A.A., "Pulse and Digital Circuits", 2nd Ed., Prentice-Hall of India.	2008
5.	Malvino, A.P. and Leach, D.P., "Digital Principles and Applications", 6th Ed., Tata McGraw-Hill.	2008
6.	Floyd, T.L., " Digital Fundamentals ", 8th Ed., Pearson Education.	2005

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 242** Course Title: **Semiconductor Devices and Technology**

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

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

4. Relative Weight: **CWS** 15 **PRS** 15 **MTE** 30 **ETE** 40 **PRE** 00

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

7. Pre-requisite: **EC-102**

8. Subject Area: **DCC**

9. Objective**:** To impart knowledge about the principles of semiconductor devices and their fabrication processes.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Review of semiconductor materials.	2
2.	Energy band diagrams of metal-semiconductor interface; Rectifying and ohmic contacts.	2
3.	Characteristics and small signal models of MOSFET, MISFET and MESFET; Characteristics of CMOS and BiCMOS; Design of CMOS inverter: Power dissipation characterization, timing issues and noise margins; CMOS based NAND and NOR gates.	11
4.	Energy band diagrams and properties of III-V semiconductors; Principle of operation and V-I characteristics of Gunn diode.	4
5.	Basic charge coupled device (CCD) structure, charge storage mechanism, charge transfer and frequency response, buried channel CCD.	4
6.	Single crystal growth, wafer preparation, epitaxial growth, deposition and characterization of oxide layers, masking, lithography, dopant diffusion, and ion-implantation.	8
7.	Process integration, MOS based silicon microcircuits, BJT based silicon microcircuits, BiCMOS process flow.	6
8.	Dual-in line packaging, flip-chip ball grid array packages, system in package; Testing processes, fault modeling, delay and IDDQ test, design for testability.	5

	Total	**42**
	Laboratory Component: Measurement of conductivity, band-gap, Hall coefficient, junction capacitance, h-parameters of a transistor, and breakdown voltage of a Zener diode. Study of surface preparation for device fabrication. Study of vacuum coating unit.	7×2

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Streetman, B.G. and Banerjee, S.K, "Solid State Electronic Devices", 6th Ed., Pearson Education.	2006
2.	Bhattacharya, P., "Semiconductor Optoelectronic Devices", 2nd Ed., Pearson Education.	1997
3.	Tyagi, M.S., "Introduction to Semiconductor Materials and Devices", John Wiley & Sons.	2000
4.	Chang, C.Y. and Sze, S.M., " ULSI Technology", McGraw-Hill	2002
5.	Plummer, J.D., Deal, M.D. and Griffin, P.B., "Silicon VLSI Technology: Fundamentals, Practice and Modeling", Prentice-Hall.	2000

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 251** Course Title: **Data Structures**

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

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

4. Relative Weight: **CWS** 15 **PRS** 15 **MTE** 30 **ETE** 40 **PRE** 00

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

7. Pre-requisite: **EC - 101A / EC - 101B**

8. Subject Area: **DCC**

9. Objective: To provide basic data structure concepts in an object-oriented setting for design, implementation, testing and maintenance of software systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Complexity Analysis:** Time and Space complexity of algorithms, asymptotic analysis, big O and other notations, importance of efficient algorithms, program performance measurement, data structures and algorithms.	3
2.	**Linear Lists:** Abstract data type, sequential and linked representations, comparison of insertion, deletion and search operations for sequential and linked lists, list and chain classes, exception and iterator classes for lists, doubly linked lists, circular lists, linked lists through simulated pointers, lists in STL, skip lists, applications of lists in bin sort, radix sort, sparse tables.	8
3.	**Stacks and Queues: A**bstract data types, sequential and linked implementations, exception handling in classes, representative applications such as parenthesis matching, towers of Hanoi, wire routing in a circuit, finding path in a maze, simulation of queuing systems, equivalence problem.	6
4.	**Hashing:** Search efficiency in lists and skip lists, hashing as a search structure, hash table, collision avoidance, linear open addressing, chains, uses of hash tables in text compression, LZW algorithm.	4
5.	**Trees:** Binary trees and their properties, terminology, sequential and linked implementations, tree traversal methods and algorithms, heaps as priority queues, heap implementation, insertion and deletion operations, heapsort, heaps in Huffman coding, leftist trees, tournament trees, use of winner trees in mergesort as an external sorting algorithm, bin packing.	8

6.	**Search Trees**: Binary search trees, search efficiency, insertion and deletion operations, importance of balancing, AVL trees, searching insertion and deletions in AVL trees, red-black trees, comparison with AVL trees, search insert and delete operations.	4
7.	**Multiway Trees:** Issues in large dictionaries, m-way search trees, B-trees, search insert and delete operations, height of B-tree, 2-3 trees, sets and multisets in STL.	5
8.	**Graphs:** Definition, terminology, directed and undirected graphs, properties, connectivity in graphs, applications, implementation – adjacency matrix and linked adjacency chains, graph traversal – breadth first and depth first, spanning trees.	4
	Total	**42**
	Laboratory component (a) Programming of various data structures and applications in C++ and Java. (b) Data structure programming using STL.	**14x2**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Sahni, S., "Data Structures, Algorithms, and Applications in C++", WCB/McGraw-Hill.	2001
2.	Sahni, S., "Data Structures, Algorithms, and Applications in Java", WCB/McGraw-Hill.	2001
3.	Drozdek, A., "Data Structures and Algorithms in C++", Vikas Publishing House.	2002
4.	Wirth, N., "Algorithms and Data Structures", Prentice-Hall of India.	1985
5.	Lafore, R., "Data Structures and Algorithms in Java", 2nd Ed., Dorling Kindersley.	2007

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 252** Course Title: **Computer Architecture and Microprocessors**

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: **DCC**

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.	CPU structure and functions, processor organization, ALU, data paths, internal registers, status flags; System bus structure: Data, address and control buses.	5
2.	Processor control, micro-operations, instruction fetch, hardwired control, microprogrammed control, microinstruction sequencing and execution.	6
3.	Instruction set principles, machine instructions, types of operations and operands, encoding an instruction set, assembly language programming, addressing modes and formats.	8
4.	Memory system, internal and external memory, memory hierarchy, cache memory and its working, virtual memory concept.	5
5.	I/O organization; I/O techniques: interrupts, polling, DMA; Synchronous vs. asynchronous I/O.	4
6.	8085 microprocessor architecture; Instruction set, instruction types and formats; Instruction execution, instruction cycles, different types of machine cycles and timing diagram.	8
7.	16-bit microprocessors, 8086 architecture, registers, memory segmentation and addressing, 32-bit/64-bit microprocessor families.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Mano, M.M., "Computer System Architecture" 3rd Ed., Prentice-Hall of India.	2004
2.	Rajaraman, V. and Radhakrishnan, T., "Computer Organization and Architecture", Prentice-Hall of India.	2007
3.	Govindrajalu, B., "Computer Architecture and Organization", Tata McGraw-Hill.	2004
4.	Stallings, W., "Computer Organization and Architecture", 5th Ed., Pearson Education.	2001
5.	Hall, D.V., "Microprocessors and Interfacing", 2nd Ed., Tata McGraw-Hill.	2006
6.	Brey, B.B., "The Intel Microprocessors", 6th Ed., Pearson Education.	2003

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 253** Course Title: **System Software**

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

3. Examination Duration (Hrs.): **Theory** 0 | 2 **Practical** 0 | 0

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

5. Credits: 0 | 3 6. Semester √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: **EC - 101A / EC - 101B**

8. Subject Area: **DCC**

9. Objective: The objective of the course is to familiarize students with the design and functioning of computer software.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to system software, machine architecture, machine level representation of programs, assembly language programming and optimizing program performance.	6
2.	Assemblers, basic function, machine dependent and independent assembler features, assembler design options.	4
3.	Two-pass, one-pass and multi-pass assembler design.	6
4.	Macro-processors, basic functions, machine independent features, nested definitions and calls, design options.	4
5.	General purpose macro-processor design, macro-processing within language translators.	2
6.	Loaders and linkers, basic functions, machine dependent and independent features, linkers, loaders and editors, design options.	3
7.	Relocating loaders and dynamic linking loader designs.	3
	Total	**28**

11. Suggested Books:

Sl.	Name of Authors / Books / Publishers	Year of

No.		Publication/ Reprint
1.	Beck, L.L., "System Software", 3rd Ed., Addison Wesley.	1997
2.	Dhamdhere, D.M., "System Programming & Operating Systems", 2nd Ed., Tata McGraw-Hill.	1999
3.	Abel, P. "IBM PC Assembly Language and Programming", 3rd Ed., Prentice-Hall of India.	2000
4.	Bryant, R.E. and O'Hallaron, D.R., "Computer Systems: A Programmer's Perspective", Prentice-Hall of India.	2001

NAME OF DEPT/CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 254** Course Title: **Discrete Structures**

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: **NIL**

8. Subject Area: **DCC**

9. Objective: To introduce to the students the fundamental discrete structures used in computer science.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Sets:** Properties, relations, functions, finite and infinite sets, lattice.	6
2.	**Graphs:** Directed, undirected, directed acyclic, and bipartite graphs; Connected components, Eulerian graphs, Hamiltonian cycles; Some fundamental theorems, applications.	10
3.	**Logic:** Propositional and predicate logic; Syntax, semantics, resolution principle, soundness, completeness, unification, inferencing; Applications.	10
4.	**Abstract Algebra:** Groups, rings, fields, Galois field, Euler's phi function, Fermat's theorem, discrete logarithm, applications.	10
5.	**Introduction to Number Theory:** Remainder theorem, gcd, factorization theorem.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint

1.	Herstein, I., “Abstract Algebra”, Pearson Education.	2005
2.	Harary, F., “Graph Theory”, Narosa Publishing House.	2001
3.	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 DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 262** Course Title: **Digital Hardware Lab**

2. Contact Hours: **L: 0** **T: 0** **P: 4**

3. Examination Duration (Hrs.): **Theory** 0 | 0 **Practical** 0 | 2

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

5. Credits: 0 | 2 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

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

8. Subject Area: **DCC**

9. Objective: To provide hands-on experience on the various building blocks of digital circuits.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
	Truth table verification of basic TTL and CMOS gates, and multiplexers and demultiplexers. Realization of switching functions with gates and multiplexers. Study and operation of 7-segment display, and decoder-driver. Design of binary and BCD adders. Design and testing of switch debouncers. Study of RS, JK master-slave, and D and T flip-flops. Operation of BCD, decade, mod-N, and up-down counters. Study of shift registers, and design of ring counters. Design of TTL- and 555-based multivibrators, timers and clock circuits. Study of ALU and RAM. ***Basic programming of 8085 microprocessor.*** ***Simple I/O exercises using 8255.***	14 x 4
	Total	**56**

11. Suggested Books:

Sl. No	Name of Books/ Authors	Year of Publication/ Reprint

1.	Mano, M.M. and Ciletti, M.D., "Digital Design", 4th Ed., Prentice-Hall.	2006
2.	Jain, R.P., "Modern Digital Electronics", 3rd Ed., Tata McGraw-Hill.	2003
3.	Gaonkar, R.S., "Microprocessor Architecture, Programming and Applications", 5th Ed., Penram International.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 301** Course Title: **Analog Electronics**

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

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

4. Relative Weight**:** **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits**:** 0 | 3 6. Semester √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite**: EC-242**

8. Subject Area**: DCC**

9. Objective: To acquaint students with the basic building blocks of analog circuits, their functioning and various applications in analog systems.

10. Details of the course:

Sl. No.	Contents	Contact Hours
1.	Introduction to analog electronics.	1
2.	CMOS based single stage amplifier, common source, common-gate and cascode stage.	2
3.	High frequency models of BJT and FET, hybrid-π model, Gummel Poon model, generalized high frequency response.	5
4.	Differential amplifier, passive and active current mirror circuits, frequency response, differential amplifier as a building block for operational amplifier; Operational amplifier: Characteristics, specification, limitations, linear applications.	8
5.	Concept of feedback; Topologies: Voltage-voltage, current-voltage, voltage-current, current-current; Stability and compensation.	5
6.	Operational amplifier based Schmitt trigger, half and full wave rectifiers, square wave and triangular wave generators, voltage to frequency converters, function generators, log and antilog amplifiers, and multipliers.	8
7.	Filter specifications, design of low pass, high pass, band pass and band reject filters using operational amplifiers; Design of Butterworth and Chebyshev filters, higher order filters; State variable filters.	6
8.	Operational amplifier based comparators, A/D and D/A converters, analog switches, multiplexers, voltage regulators, three terminal regulators, and switching regulators.	7

	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication
1.	Razavi, B., "Design of Analog CMOS Integrated Circuits", Tata McGraw-Hill.	2002
2.	Gregorian, R., "Introduction to CMOS Op-Amp and Comparators", John Wiley & Sons.	1999
3.	Gray, P.R., Hurst, P.T., Lewis, S.H. and Meyer, R.G., "Analysis and Design of Analog Integrated Circuits", 4th Ed., John Wiley & Sons.	2001
4.	Gayakwad, R., "Op-amp and Linear Integrated Circuits", 4th Ed., Pearson Education.	2005
5.	Coughline, R.F. and Driscoll, F.F., "Operational Amplifier and Linear Integrated Circuits", 6th Ed., Prentice-Hall of India.	2002
6.	Stanley, W.D., "Operational Amplifier with Linear Integrated Circuits", 3rd Ed., Merril.	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 311** Course Title: **Principles of Digital Communication**

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 - 202**

8. Subject Area: **DCC**

9. Objective: The objective of this course is to provide a detailed treatment of the techniques used in digital communication. The course will also introduce the students to the basics of information theory and coding techniques.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Digital communication system model, modulation process, analog vs. digital communication; Fundamental limitations of communication systems.	3
2.	Concept of probability, random variable and its characterization, probability density functions, transformations of random variables, statistical averages.	6
3.	Sampling theorem for low-pass and band-pass signals, practical difficulties in signal reconstruction; Instantaneous, natural and flat-top sampling; PAM and TDM; Uniform quantization and its noise analysis, non-uniform quantization, A-law, μ-law; PCM, DM, and DPCM, performance comparison; Adaptive quantization and prediction, low bit rate coding and compression standards for speech signals; Emerging digital communication techniques including video compression and HDTV.	12
4.	Baseband transmission; Matched filter; Nyquist rate and wave shaping techniques; ISI and adaptive equalization.	6
5.	Passband transmission; Coherent and non-coherent detection of signals in noise; Generation and detection of PSK, DPSK, QPSK, OOK, FSK, QAM and MSK; Probability of error analysis of digital modulation techniques.	10
6.	Measure of information, entropy; Channel capacity and Shannon's theorems; Introduction to source coding and channel coding techniques.	5
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/ Authors	Year of Publication/ Reprint
1.	Haykin, S., "Communication Systems", 4th Ed., John Wiley & Sons.	2001
2.	Lathi, B.P., "Modern Digital and Analog Communication Systems", 3rd Ed., Oxford University Press.	1998
3.	Roden, M.S., "Analog and Digital Communication Systems", 5th Ed., Discovery Press.	2005
4.	Couch II, L.W., "Modern Communication Systems: Principles and Applications", Prentice-Hall.	1998
5.	Carlson, A.B., Crilly, P.B. and Rutledge, J.C., "Communication Systems: An Introduction to Signals and Noise in Electrical Communication", 4th Ed., McGraw-Hill.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 312** Course Title: **Communication Systems and Techniques**

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 - 311**

8. Subject Area: **DCC**

9. Objective: To provide a detailed treatment of techniques used for implementation and performance analysis of transceivers for general communication applications, HDTV and satellite communication systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to modern communication systems and frequency band allocation.	2
2.	Random process, correlation and power spectrum of random signals, random signals through linear systems, Gaussian random process and white noise; Shot noise and thermal noise; Noise figure and noise temperature of a two-port network, system noise calculations.	8
3.	Characteristics of AM and FM; Generation and detection techniques for AM-FC, AM-DSB, SSB, NBFM, WBFM and PM; PLL and its applications in carrier acquisition and FM demodulation; Effect of noise on AM and FM systems, evaluation of SNR at detector output.	12
4.	Super heterodyne receivers and their characteristics; Different receiver architectures; RF and IF amplifiers, mixers.	8
5.	Image characteristics; Interlaced scanning, horizontal and vertical resolution, video bandwidth; Luminance and chrominance signals, composite video signal; Digital TV and video compression; TV camera; Transceiver architecture for TV; HDTV.	6
6.	Introduction to satellite systems; Orbital period and velocity; Coverage angle and slant range; Satellite link design; Multiple access techniques used in satellite systems.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Books/ Authors	Year of Publication/ Reprint
1.	Smith, J.R., "Modern Communication Circuits", 2nd Ed., McGraw-Hill.	1997
2.	Haykin, S., "Communication Systems", 4th Ed., John Wiley & Sons.	2001
3.	Lathi, B.P., "Analog and Digital Communications", 3rd Ed., Oxford University Press.	1998
4.	Proakias, J.G., and Salehi, M., "Communication Systems Engineering", 2nd Ed., Pearson Education.	2002
5.	Carlson, A.B., Crilly, P.B. and Rutledge, J.C., "Communication Systems: An Introduction to Signals and Noise in Electrical Communication", 4th Ed., McGraw-Hill.	2002
6.	Roddy, D. and Coolen, V., "Electronic Communications", 4th Ed., Prentice-Hall of India.	1997

1. Subject Code: **EC - 321** Course Title: **Automatic Control Systems**

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

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

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

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

7. Pre-requisite: **EC-202**

8. Subject Area: **DCC**

9. Objective: To introduce the concepts of modeling, analysis and design of simple linear and non-linear dynamic systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Control System Concepts and Classification:** Open loop, closed loop, continuous, discrete, linear and non-linear control systems.	2
2.	**Mathematical Models of Systems:** Impulse response and transfer function, block-diagram model and signal flow graphs.	4
3.	**Time Domain Analysis:** Transient and steady state responses of first and second order systems, steady state errors, control of transient response; Basic control actions and their effects on transient and steady state responses.	7
4.	**Root Locus Technique:** Root loci, properties and construction of root loci, effects of adding and moving poles and zeros, root locus of conditionally stable systems, generalized root contour.	7
5.	**Frequency Domain Analysis:** Routh Hurwitz criterion, Bode and Nyquist diagrams, gain magnitude and phase shift plots, frequency domain specifications, peak resonance and resonant frequency of a second order system, gain margin and phase margin, conditionally stable system.	6
6.	**Compensation Design in s and ω Planes:** Introduction, phase lead compensation, phase lag compensation; Design of phase-lead and phase-lag compensation by Bode plot and root locus methods.	6
7.	**State Variable Technique:** Derivation of state model of LTI continuous time systems, state equations, state transition matrix, solution of state equations.	5
8.	**Basic Non-linear Analysis:** Linearization, describing function and phase plane methods, stability concepts and Lyapunov functions.	5

	Total	42

11. Suggested Books:

Sl. No.	Name of books/ Authors	Year of Publication/ Reprint
1.	Gopal, M., "Control Systems: Principle and Design", 2nd Ed., Tata McGraw-Hill.	2002
2.	Kuo, B.C., "Automatic Control Systems", 8th Ed., Wiley India.	2008
3.	Ogata, K., "Modern Control Engineering", 4th Ed., Pearson Education.	2008
4.	Dorf, R.C. and Bishop, R.H., "Modern Control Systems", 11th Ed., Prentice-Hall of India.	2007
5.	Nise, N. S., "Control Systems Engineering", 4th Ed., Wiley India.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 331** Course Title: **Engineering Electromagnetics**

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**: PH - 101**

8. Subject Area**: DCC**

9. Objective: To introduce to the students the theory of electromagnetic wave propagation in free space and in various types of guiding structures.

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10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Fundamental Concepts:** Scalar and vector fields; Physical interpretation of gradient, divergence and curl; Coordinate systems; Review of static fields; Current continuity equation; Displacement current; Maxwell's equations.	6
2.	**Plane Waves:** Wave equation in an isotropic homogeneous medium and its solution, phasor notation, polarization of waves, reflection and refraction of plane waves at plane boundaries, Poynting vector.	10
3.	**Multi-conductor Transmission Lines:** Time-domain analysis of transmission lines; Bounce diagrams; Frequency-domain analysis of transmission lines; Standing waves; Smith chart; Transmission line matching: Single and double-stub matching, quarter-wave transformers.	10
4.	**Waveguides:** Electromagnetic fields in parallel-plate, rectangular, and circular waveguides, TE and TM modes, wave impedance, wave velocities, attenuation in waveguides.	10
5.	**Planar Transmission Lines:** Electromagnetic fields in striplines, microstriplines, and co-planar waveguides.	4
6.	**Cavity Resonators:** Elecromagnetic fields in rectangular and cylindrical resonators, degeneracy of modes, quality factor.	2
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Narayana Rao, N., "Elements of Engineering Electromagnetics", 5th Ed., Prentice-Hall of India.	2002

2.	Sadiku, M.N.O., "Elements of Electromagnetics", 3rd Ed., Oxford University Press.	2001
3.	Jordan, E.C. and Balmain, K.G., "Electromagnetic Waves and Radiating Systems", 2nd Ed., Prentice-Hall of India.	1993
4.	Hayt, W.H. and Buck, J.A., "Engineering Electromagnetics", 7th Ed., Tata McGraw-Hill.	2006
5.	Kraus, J.D. and Fleisch, D.A., "Electromagnetics with Applications", McGraw-Hill.	1999
6.	Ramo, S.A., Whinnery, J.R. and Van Duzer, T., "Fields and Waves in Communication Electronics", 3rd Ed., John Wiley & Sons.	1994

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE**:** **Department of Electronics and Computer Engg.**

1. Subject Code**: EC - 332** Course Title**: Microwave Techniques**

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

0	**3**	**0**	**0**

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

4. Relative Weight**:** **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits**:** 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite**: EC - 331**

8. Subject Area**: DCC**

9. Objective: To provide a comprehensive introduction to various devices and passive components used at microwave frequencies.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Microwave Tubes:** Design considerations for microwave tubes, current status of microwave tubes, principle of operation of multi-cavity and reflex klystron, magnetron and traveling wave tube.	8
2.	**Microwave Network Analysis**: Equivalent voltages and currents, concept of impedance, impedance and admittance matrices of microwave junctions, scattering matrix representation of microwave networks, ABCD parameters, excitation techniques for waveguides.	10
3.	**Power Dividers and Couplers:** Scattering matrix of 3- and 4-port junctions, T-junction power divider, Wilkinson power divider, qualitative description of two-hole and multi-hole waveguide couplers, hybrid junctions.	8
4.	**Ferrimagnetic Components:** Permeability tensor of ferrites, plane wave propagation in ferrites, Faraday rotation, ferrite circulators, isolators and phase shifters.	6
5.	**Microwave Semiconductor Devices:** Operation and circuit applications of Gunn diode, IMPATT diode, PIN Diode, and Schottky barrier diode; Microwave BJT, MESFET, HEMT and their applications.	10
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Sons.	2004
2.	Liao, S.Y., "Microwave Devices and Circuits", Prentice-Hall of India.	1991
3.	Collin, R.E., "Foundations for Microwave Engineering", 2nd Ed., John Wiley & Sons.	2000

4.	Streetman, B.G. and Banerjee, S.K., "Solid-state Electronic Devices", 6th Ed., Prentice-Hall of India.	2006
5.	Sze, S.M. and Ng, K.K., "Physics of Semiconductor Devices", 3rd Ed., John Wiley & Sons.	2006
6.	Bahl, I. and Bhartia, P., "Microwave Solid State Circuit Design", 2nd Ed., John Wiley & Sons.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE**:** **Department of Electronics and Computer Engg.**

1. Subject Code**: EC - 334** Course Title**:** **Antennas and Wave Propagation**

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

0	**3**

0	**0**

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 331**

8. Subject Area: **DCC**

9. Objective: To explain the theory of different types of antennas used in communication systems, and different mechanisms of wave propagation in free space.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Fundamental Concepts:** Physical concept of radiation, retarded potentials, Hertzian dipole; Antenna parameters: Radiation pattern, gain, directivity, effective aperture, and reciprocity; Radiation from dipoles of arbitrary length.	8
2.	**Antenna Arrays:** Arrays of point sources, endfire and broadside arrays, pattern multiplication, synthesis of binomial and Dolph-Chebyshev arrays.	8
3.	**Broadband Antennas:** Log-periodic and Yagi antennas, frequency-independent antennas, broadcast antennas.	6
4.	**Aperture and Reflector Antennas:** Huygens' principle, radiation from apertures in an infinite ground plane, slot and horn antennas, parabolic reflector antennas.	8
5.	**Printed Antennas:** Radiation from rectangular and circular patches, feeding techniques.	2
6.	**Wave Propagation:** Ground wave, surface wave, and space wave propagation; Tropospheric and duct propagation; Structure of ionosphere and ionospheric propagation; Multipath fading, ray bending and other propagation phenomena; Indoor propagation.	10
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Balanis, C.A., "Antenna Theory and Design", 3rd Ed., John Wiley & Sons.	2005
2.	Kraus, J.D. and Fleisch, D.A., "Electromagnetics with Applications", McGraw-Hill.	1999

3.	Jordan, E.C. and Balmain, K.G., "Electromagnetic Waves and Radiating Systems", 2nd Ed., Prentice-Hall of India.	1993
4.	Stutzman, W.L. and Thiele, H.A., "Antenna Theory and Design", 2nd Ed., John Wiley & Sons.	1998
5.	Elliot, R.S., "Antenna Theory and Design", Revised edition, Wiley-IEEE Press.	2003
6.	Collin, R.E., "Antennas and Radio Wave Propagation", McGraw-Hill.	1985

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 351** Course Title: **Design and Analysis of Algorithms**

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: **EC - 251**

8. Subject Area: **DCC**

9. Objective: To familiarize students with the design strategies and bounds on the performance of different computer algorithms.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Review of Data Structures**.	2
2.	**Program Performance**: Time and space complexity, asymptotic notation, complexity analysis, recurrence equations and their solution.	4
3.	**Algorithmic Techniques**: Algorithm design strategies, divide and	14

	conquer, merge sort, quick sort and its performance analysis, randomized quick sort, Strassen's matrix multiplication; Greedy method and its applications, knapsack problem; Dynamic programming and its performance analysis, optimal binary search trees, 0/1 knapsack problem; Traveling salesman problem; Back-tracking, n-queens problem, graph coloring, Hamiltonian cycles, knapsack problem; Branch and bound examples, 15-puzzle problem, 0/1 knapsack, traveling salesman.	
4.	**Graph Algorithms**: DFS and BFS, spanning trees, biconnectivity; Minimum cost spanning trees: Kruskal's, Prim's and Sollin's algorithms; Path finding and shortest path algorithms; Topological sorting; Bipartite graphs.	6
5.	**Infeasibility**: P and NP-classes, NP-hard problems, reduction.	4
6.	**Parallel Algorithms**: Data and control parallelism, embedding of problem graphs into processor graphs, parallel algorithms for matrix multiplication.	6
7.	**Other Algorithms**: Number theoretic algorithms, string matching algorithms, approximation algorithms, randomized algorithms.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Sahni, S., "Data Structures, Algorithms and Applications in C++", WCB/McGraw-Hill.	2001
2.	Mchugh, J.A., "Algorithmic Graph Theory", Prentice-Hall.	1990
3.	Quinn, M.J., "Parallel Computing Theory & Practice", McGraw-Hill.	1994
4.	Cormen, T.H., Leiserson, C.E., Rivest, R.L. and Stein, C., "Introduction to Algorithms", 2nd Ed., Prentice-Hall of India.	2002
5.	Dasgupta, S., Papadimitriou, C. and Vazirani, U., "Algorithms", Tata McGraw-Hill.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 352** Course Title: **Principles of Programming Languages**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 355**

8. Subject Area: **DCC**

9. Objective: To introduce the semantics of programming languages and develop skills in describing, analyzing, and using the features of programming languages.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Lambda Calculus and Turing Machines:** Equivalence of Lambda calculus and Turing machines, free and bound variables, substitutions.	6
2.	**Sequential Programming Languages:** Constructs, programs as state transformers, denotational semantics.	6
3.	**Object-oriented Programming Languages:** Constructs, mathematical	4

	structures, implementation, constraint matching.	
4.	**Type Theory:** Operational semantics, basic type systems and type soundness, advanced type systems.	6
5.	**Nondeterminism:** Predicate transformers, guarded command language, algebraic specification.	6
6.	**Program Correctness:** Program termination, well-foundedness, logics of programs, correctness proof.	6
7.	**Program Verification:** Hoare logic, model checking, model checkers, algorithmic versus deductive approaches.	8
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Sethi, R., "Programming Languages: Concepts and Constructs", Pearson Education.	2004
2.	Tucker, A. and Noonan, R., "Programming Languages: Principles and Paradigms", Tata McGraw-Hill.	2007
3.	Van Roy, P. and Haridi, S., "Concepts, Techniques and Models of Computer Programming", Prentice-Hall of India.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 353** Course Title: **Operating Systems**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 15 **MTE** 30 **ETE** 40 **PRE** 00

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

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

8. Subject Area: **DCC**

9. Objective: To provide an understanding of the functions and modules of an operating system and study the concepts underlying its design and implementation.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Fundamental Concepts of Operating System:** Operating system functions and characteristics, historical evolution of operating systems, issuess in operating system design.	5
2.	**Process Management:** Process abstraction, process address space, process management, system calls, threads, process hierarchy.	6
3.	**CPU Scheduling:** Levels of scheduling, comparative study of scheduling algorithms, multiple processor scheduling.	4

4.	**Deadlocks:** Characterization, prevention and avoidance, deadlock detection and recovery.	4
5.	**Concurrent Processes:** Critical section problem, semaphores, monitors, inter-process communication, message passing mechanisms.	5
6.	**Memory Management:** Storage allocation methods, virtual memory concept, demand paging, page replacement algorithms, segmentation, thrashing.	5
7.	**File Systems:** Functions, file access and allocation methods, directory system, file protection mechanisms, implementation issues, file system hierarchy.	5
8.	**Device Management:** Hardware organization, device scheduling policies, device drivers.	5
9.	**Case Studies:** Windows, Unix, Linux.	3
	Total	**42**
	Laboratory component Creating processes in Unix with commands like Fork and Exec; Pipes and process communication; Performance study of various CPU scheduling algorithms; Process synchronization using semaphores, and threading.	**14x2**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Silberscharz, A. and Galvin, P.B., "Operating System Concepts", 7th Ed., Addison-Wesley.	2006
2.	Tanenbaum, A., "Modern Operating Systems", Prentice-Hall of India.	2004
3.	Nutt, G., "Operating Systems", Addison-Wesley.	2004
4.	Joshi, R. C. and Tapaswi, S., "Operating Systems", Wiley Dreamtech.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 354** Course Title: **Compiler Design**

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: **EC - 355**

8. Subject Area: **DCC**

9. Objective: To introduce students to the techniques used in designing and writing compilers.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to the translation process, phases of the compiler, compiler tools.	3
2.	Role of lexical analyzer, specification and recognition of tokens, automatic generation of lexical analyzer.	6
3.	Top down parsing methods, elimination of left recursion, recursive descent and predictive parsers; Bottom up parsing, shift-reduce parsing, precedence parsing, LR parsers, SLR (1) table construction, limitations of SLR parsing, non-SLR (1) grammars; Introduction to canonical and LALR parsing.	8

4.	Type checking, type systems, type expressions, type conversion and overloading.	3
5.	Run time environments, storage organization and allocation strategies, parameter passing, symbol tables.	4
6.	Intermediate code generation, interpreters, intermediate languages, syntax trees, postfix code, triples and indirect triples, syntax directed translation of simple statements.	6
7.	Issues in code generation, basic blocks and flow graphs, next use information, register allocation and assignment, simple code generation.	6
8.	Sources of optimization, optimization of basic blocks, data flow analysis, code improving transformations.	6
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Aho, A.V., Lam, M., Sethi, R. and Ullman, J.D., "Compilers: Principles, Techniques and Tools", 2nd Ed., Pearson Education.	2007
2.	Tremblay, J.P. and Sorenson, P.G., "Theory and Practice of Compiler Writing", SR Publications.	2005
3.	Cooper, K.D. and Torczon, L., "Engineering a Compiler", Morgan Kaufmann.	2004
4.	Louden, K.C., "Compiler Construction: Principles and Practice", Course Technology.	1997
5.	Tremblay, J.P. and Sorenson, P.G., "Parsing Techniques: A Practical Guide", Ellis Horwood.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC-355** Course Title: **Theory of Computation**

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: **EC-254**

8. Subject Area: **DCC**

9. Objective: To provide an understanding of the theoretical development of computer science, particularly for finite representations of languages and machines.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Abstract machines and computation, formal languages and grammars.	3
2.	Regular languages, finite state machines, deterministic and non-deterministic finite state machines, regular grammars, regular expressions, equivalence of the three models, state equivalence and minimization.	9
3.	Properties of finite state languages, closure, decidability, pumping lemma.	5

4.	Context-free language models, context-free grammars, simplification of content-free grammars, Chomsky normal form, Greibach normal form.	5
5.	Pushdown automata, deterministic and non-deterministic pushdown automata and their equivalence with context free languages, parsing.	7
6.	Closure properties of context-free languages.	3
7.	Turing machines, computable languages and functions, modifications of Turing machines, restricted Turing machines, Church's hypothesis.	6
8.	Recursive, and recursively enumerable languages; Undecidability, notion of reduction.	4
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Hopcropt, J.E., Motwani, R. and Ullman, J.D., "Introduction to Automata Theory, Languages and Computation", Pearson Education.	2001
2.	Lewis, H.R. and Papadimitriou, C.H., "Elements of the Theory of Computation", 2nd Ed., Prentice-Hall.	1998
3.	Linz, P., "An Introduction to Formal Languages and Automata", Narosa Publishing House.	1998
4.	Cohen, D.I.A., "Introduction to Computer Theory", John Wiley & Sons.	1991
5.	Denning, P.J., Dennis, J.B., and Qualitz, J.E., "Machines, Languages and Computation", Prentice-Hall.	1978

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 356** Course Title: **Computer Networks**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

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

8. Subject Area: **DCC**

9. Objective: To familiarize students with the layered design and protocols of computer networks, including the Internet.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Introduction:** Use of computer networks, network hardware and software; Layering, reference models and their comparison.	7
2.	**Physical Layer:** Theoretical basis for data communication, transmission media and impairments, switching systems.	6
3.	**Data Link Layer:** Design issues, framing, error detection and correction, elementary and sliding window protocols, examples of data link layer protocols.	6
4.	**Medium Access Control Sub Layer:** Channel allocation problem, multiple access protocols, Ethernet, data link layer switching.	6

5.	**Network Layer:** Design issues, routing algorithms, congestion control, QOS, internetworking, IP and IP addressing.	6
6.	**Transport Layer:** Transport service, elements of transport protocols, TCP and UDP.	6
7.	**Application Layer Overview:** Email, DNS, WWW.	5
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Tanenbaum, A.S, "Computer Networks", 4th Ed., Pearson Education.	2003
2.	Forouzan, B.A., "Data Communication and Networking", 4th Ed., Tata McGraw-Hill.	2006
3.	Stallings W., "Data and Computer Communication", 8th Ed., Prentice-Hall.	2007
4.	Kurose, J.F. and Ross, K.W., "Computer Networking: A Top-Down Approach Featuring the Internet", 3rd Ed., Addison Wesley.	2004
5.	Comer, D.E. and Droms, R.E., "Computer Networks and Internets", 4th Ed., Prentice-Hall.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 357** Course Title: **Software Engineering**

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

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

4. Relative Weightage: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: **EC-251**

8. Subject Area: **DCC**

9. Objective: To introduce the concepts of software development, design and implementation.

10. Details of Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to software and software engineering, various software process modules, capability, maturity, module and KPAs.	6
2.	Project planning, project introduction, team organization, scheduling and management, constructive cost model.	6
3.	Software measures, indicators and metrics, software risk analysis and management.	5
4.	Software requirement analysis and specifications, applicability to small, medium, and large-scale systems.	4
5.	Software design, technical design, objectives of design, design metrics, modularity, module coupling and cohesion, relation between cohesion and coupling; Design strategies: Bottom up design, top down design, hybrid	8

	design, functional oriented design, object oriented design; IEEE recommended practice for software design description	
6.	Software testing, testability, testing process, structural testing, unit testing and integrated testing, debugging, testing tools, software maintenance, maintenance process, maintenance cost, reverse engineering and re-engineering.	7
7.	Configuration management, assessing and controlling software quality.	3
8.	CASE tools and workbenches.	3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Pressman R., "Software Engineering", 7th Ed., McGraw-Hill.	2000
2.	Sommerville, I., "Software Engineering", 6th Ed., Pearson Education.	2007
3.	Dfleeger, S. L., "Software Engineering", Pearson Education.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC- 361** Course Title: **Linear IC Applications Lab.**

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

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

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

5. Credits: 0 2 6. Semester √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: **EC-102**

8. Subject Area: **DCC**

9. Objective: To familiarize the students with design, assembly, and testing of analog electronic circuits using linear integrated circuit chips.

10. Details of the Course:

Sl. No.	Contents	Contact Hours

	Study of offset voltage/current and slew rate characteristics of 741. Design of inverting and non-inverting amplifiers. Design of clipper, clamper, peak detector and precision rectifiers using 741. Design of low voltage and high voltage regulators using 723, and fixed voltage regulators using 78xx and 79xx. Log and antilog amplifier design using 741, design of multiplier circuit. Design of Schmitt trigger using 741. Assembly and test of a sample-and-hold circuit using 398. Design and test comparator circuits including window comparator using 741 and 311. Design and test of Wein Bridge oscillator. Generation of different waveforms using VCOs 566 and 8038. Generation of square and triangular waveforms using 741. Operation of D/A converter 0800. Operation of A/D converter 0809 and demonstration of continuous conversion, cascading of A/D and D/A converter.	14 x 3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books/ Authors**	**Year of Publication/ Reprint**
1.	Gayakwad, R.A., "OP-Amps and Linear Integrated Circuits", 4th Ed., Pearson Education.	2005
2.	Choudhury, D.R. and Jain, S.B., "Linear Integrated Circuits", New Age International.	2007
3.	Tietze, U., Schenk, C. and Gamm, E., "Electronic Circuits: Handbook for Design and Application", 2nd Ed., Springer.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 362** Course Title: **Communication Systems Lab**

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

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

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

5. Credits: 0 | 2 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 312**

8. Subject Area: **DCC**

9.Objective: To expose students to the techniques of communication hardware design through fabrication and testing of simple communication subsystems.

10. Details of Course:

Sl. No.	Contents	Contact Hours

	Design and fabrication of Full- and suppressed-carrier AM DSB modulator using 633. Demodulator for full-carrier AM DSB signal. ASK and PSK modulator using 633. Integrate and dump filter. PCM system using LM 398, ADC 0809 and DAC 0800. Encoder and decoder for Hamming code. Delta modulator and demodulator. Frequency modulator using 8038. FM demodulator using 565. Frequency multiplier by a given factor N and demonstrate carrier recovery using 565. FSK generator using 566 and FSK demodulator using 565. PPM and PWM circuits.	14 x 3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books/ Authors**	**Year of Publication/ Reprint**
1.	Gayakwad, R.A., "Op-Amps and Linear Integrated Circuits", 3rd Ed., Prentice-Hall of India.	2002
2.	Lathi, B.P., "Modern Digital and Analog Communication Systems", 3rd Ed., Oxford University Press.	1998
3.	Soclof, S., "Applications of Analog Integrated Circuits", Prentice-Hall of India.	1990
4.	Smith, J.R., "Modern Communication Circuits", McGraw-Hill.	1998
5.	Roddy, D. and Coolen, V., "Electronic Communications", 4th Ed., Prentice-Hall of India.	1997

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 363** Course Title: **Control Systems Lab**

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

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

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

5. Credits: 0 2 6. Semester √ **Autumn** **Spring** **Both**

7. Pre-requisite: **EC-202**

8. Subject Area: **DCC**

9. Objective: The laboratory course is designed to expose the students to control systems and their dynamic characteristics.

10. Details of the Course:

Sl. No.	Contents	Contact Hours

	Experiments on: **1. Control System Components** Potentiometer and error detection. Synchro as a. c. position sensor. D.C. motor transfer function. 2-phase a. c. servomotor transfer function. Optically coded disc as angular position sensor. Lag, lead, lag-lead and twin-T networks. **2. Closed Loop Systems** D.C. position control system. D.C. speed control system. Temperature control system. Response study of simulated system. PID control system. Design and evaluation of compensation networks. A case study servo voltage stabilizer. **3. Advanced Systems** Stepper motor control system through microprocessor kit/ PC. Digital control through microprocessor kit/ PC.	14 x 3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books/ Authors**	**Year of Publication/ Reprint**
1.	Gopal, M., "Control Systems: Principle and Design", 2nd Ed., Tata McGraw-Hill.	2007
2.	Kuo, B.C., "Automatic Control Systems", 8th Ed., Wiley India.	2008
3.	Roy Choudhury, D., " Modern Control Engineering", Prentice-Hall of India.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 364** Course Title: **VLSI Lab**

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

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

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

5. Credits: 0 | 2 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC – 242**

8. Subject Area: **DCC**

9. Objective: To provide exposure to the students on basic VLSI design - from device level to sub-system level.

10. Details of the Course:

Sl. No.	Contents	Contact Hours

	Study of CMOS process technology. Determination of threshold voltage, and sub-threshold slope; Study of effect of variation of channel length on threshold voltage and DIBL effects. Determination of static characteristics of CMOS inverter with power supply and temperature variations. Study of dynamic behavior of CMOS inverter with power supply variation. Implementation of Boolean logic using S-Edit for static logic. Implementation of Boolean logic using L-Edit for static logic, generation of layout and extraction. Simulation and synthesis of logic circuits using VHDL/Verilog. Study of process and device simulator ATLAS/ATHENA.	14 x 3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Rabaey, J.M., Chandrakasan A. and Nikolic B., "Digital Integrated Circuits: A Design Perspective", 2nd Ed., Prentice-Hall of India.	2006
2.	Kang, S. and Leblebici, Y., "CMOS Digital Integrated Circuits: Analysis and Design", Tata McGraw-Hill.	2003
3.	Bhasker, J., "A VHDL Primer," Pearson Education.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 372** Course Title: **Compiler Lab**

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

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

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

5. Credits: 0 | 2 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 355**.

8. Subject Area: **DCC**

9. Objective: To give the students practice in writing various phases of a compiler and to familiarize them with various compiler writing tools.

10. Details of the Course:

Sl. No.	Contents	Contact Hours

	Design and coding of lexical analyzer manually. Use of LEX, LEX specification for tokens and construction of lexical analyzer, programming problems with LEX. Parser construction, producing simple desk calculator with YACC, generating postfix code with YACC. Machine code generation.	14 x 3
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Aho, A.V., Lam, M., Sethi, R. and Ullman, J.D., "Compilers: Principles, Techniques and Tools", 2nd Ed., Pearson Education.	2007
2.	Das, V.V., "Compiler Design using FLEX and YACC", Prentice-Hall of India.	2007
3.	Tremblay, J.P. and Sorenson, P.G., "Parsing Techniques: A Practical Guide", Ellis Horwood.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE**:** **Department of Electronics and Computer Engg.**

1. Subject Code**: EC - 382** Course Title**: Artificial Intelligence**

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

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

4. Relative Weight**:** **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits**:** 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite**: EC - 251**

8. Subject Area**: DEC**

9. Objective: To acquaint the students with the theoretical and computational techniques in Artificial Intelligence.

10. Details of the Course:

Sl. No.	Contents	Contact Hours

1.	**Fundamental Concepts:** Agents, environments, general model; Problem solving techniques.	4
2.	**Search Techniques:** Uninformed search, heuristic search, adversarial search and game trees; Solution of constraint satisfaction problems using search.	6
3.	**Knowledge Representation:** Propositional and predicate calculus, semantics for predicate calculus, inference rules, unification, semantic networks, conceptual graphs, structured representation, frames, scripts.	8
4.	**Prolog:** Basic constructs, answer extraction.	4
5.	**Bayesian Reasoning:** Bayesian networks, dynamic Bayesian networks.	4
6.	**Planning:** State-space search, planning graphs.	4
7.	**Learning:** Inductive learning, decision tree learning.	4
8.	**Advanced Topics:** Role of knowledge in language understanding, stages of language analysis, parsing using context free grammars, transition network parser, Chomsky hierarchy and context sensitive grammars, rule based expert systems, neural networks, genetic algorithms.	8
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication
1.	Russell, S. and Norvig, P., "Artificial Intelligence: A Modern Approach", Pearson Education.	2006
2.	Rich, E. and Knight, K., "Artificial Intelligence", Tata McGraw-Hill.	2006
3.	Nilsson, N. J., "Artificial Intelligence: A New Synthesis", Morgan Kaufmann.	1998
4.	Bratko, I., "Prolog Programming for Artificial Intelligence", 3rd Ed., Pearson Education.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 384** Course Title: **Digital Image Processing**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester: [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 202**

8. Subject Area: **DEC**

9. Objective: To acquaint the students with the fundamental concepts of digital image processing and its applications.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Digital Image Fundamentals:** Simple image model, sampling and quantization, imaging geometry, digital geometry, different types of	3

	digital images.	
2.	**Bilevel Image Processing:** Digital distance, distance transform, medial axis transform, component labeling, thinning, morphological processing, extension to grey scale morphology.	4
3.	**Binarization and Segmentation of Grey Level Images:** Histogram of grey level images, optimal thresholding, multilevel thresholding; Segmentation of grey level images, watershed algorithm for segmenting grey level images.	5
4.	**Detection of Edges and Lines in 2D Images:** First order and second order edge operators, multi-scale edge detection, Canny's edge detection algorithm, Hough transform for detecting lines and curves, edge linking.	6
5.	**Image Enhancement:** Point processing, spatial filtering, frequency domain filtering, multi-spectral image enhancement, image restoration.	6
6.	**Color Image Processing:** Color representation, laws of color matching, chromaticity diagram, color enhancement, color image segmentation, color edge detection, color demosaicing.	6
7.	**Image Registration and Depth Estimation:** Registration algorithms, stereo imaging, computation of disparity map.	6
8.	**Image Compression:** Lossy and lossless compression schemes, prediction based compression schemes, vector quantization, sub-band encoding schemes, JPEG compression standard, fractal compression scheme, wavelet compression scheme.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication
1.	Gonzalez, R. C., Woods, R. E. and Eddins, S. L., "Digital image Processing Using MATLAB", 3rd Ed., Prentice-Hall.	2008
2.	Jahne, B., "Digital Image Processing", 5th Ed., Springer.	2003
3.	Pratt, W. L., "Digital Image Processing", 3rd Ed., John Wiley & Sons.	2001
4.	Sonka, M., Hlavac, V. and Boyle, R., "Image Processing, Analysis and Machine Vision", 3rd Ed., PWS Publishing.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 411** Course Title: **Digital Signal Processing**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: **EC - 202**

8. Subject Area: **DCC**

9. Objective: This course aims to provide a detailed treatment of principles and algorithms of Digital Signal Processing (DSP), and implementation and applications of DSP algorithms.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Advantages and typical applications of DSP; Review of discrete-time signal and system analysis.	4

2.	Sampling and discrete-time processing of continuous time signals; Decimation and interpolation.	3
3.	Multirate DSP and its application in sampling rate conversion and high quality A/D and D/A conversion.	4
4.	Design of digital IIR filters: Impulse invariant, and bilinear transformation techniques for Butterworth and Chebyshev filters; Design of FIR filters: Windowing, optimum approximations of FIR filters; Multistage approach to sampling rate conversion**.**	8
5.	Properties and applications of DFT, implementing linear time invariant systems using DFT; Goertzel algorithm; FFT algorithms: Decimation in time, decimation in frequency; Implementation of DFT using convolution; DCT and its applications, audio and video coding, MPEG coding standards; FFT spectral analysis**.**	10
6.	Adaptive Wiener filter and LMS algorithm; Applications of adaptive filtering to echo cancellation and equalization.	3
7.	Filter banks; Polyphase structures; Quadrature-mirror filter bank: Two-channel and L-channel, applications to speech and audio coding.	7
8.	General and special purpose hardware for DSP; Digital signal processor trends, software radio.	3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books/ Authors**	**Year of Publication/ Reprint**
1.	Mitra, S.K., "Digital Signal Processing-A Computer Based Appraoach", 3rd Ed., Tata Mcgraw-Hill.	2005
2.	Oppenheim, A.V. and Schafer, R.W. with Buck, J.R., "Discrete Time Signal Processing", 2nd Ed., Prentice-Hall of India.	2002
3.	Proakis, J.G. and Manolakis, D.G., "Digital Signal Processing: Principles, Algorithm and Applications", 4th Ed., Pearson Education.	2007
4.	Ifeachor, E.C. and Jervis, B.W., "Digital Signal Processing: A Practical Approach", 2nd Ed., Pearson Education.	2002
5.	Jeffrey, H.R., "Software Radio: A Modern Approach to Radio Engineering", Pearson Education.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 413** Course Title: **Telecommunication Switching, Networks and Protocols**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: **EC - 311**

8. Subject Area: **DEC**

9 Objective: This course is designed to provide a detailed treatment of switching principles and control of switching systems, traffic engineering and queuing models, and signaling and transmission protocols for telecommunication networks.

10. Details of Course:

Sl. No.	Contents	Contact Hours
1.	Network configurations; Transmission, switching and signaling; Circuit	2

	and packet switching; Analog, digital and integrated digital networks.	
2.	Transmission media and impairments; 4-wire transmission: Hybrid, echo, stability and crosstalk; Digital transmission and multiplexing, line coding, framing and bit stuffing, plesiochronous digital hierarchies; SONET and SDH: Hierarchical model, frames and justification, virtual tributaries.	5
3.	Space and time division switching; Switching elements and switching matrices; Time division time- and space-switching; Multi-stage switching, internal blocking, distribution and mixing; Evaluation of probability of blocking of switching networks, Lee graph; Call packing, Benes networks and Clos networks.	7
4.	Traffic characteristics, Erlang, random process and Markov chain modeling of traffic; Birth-Death models, differential equations and steady-state solutions, Poisson process; Modeling of arrivals, interarrival times and service times; Grade of service, time and call congestion; Little's theorem, M/M/1 queue, Erlang-B and Erlang-C formulations, M/G/1 queue, prioritized queues; Sequential hunting; Loss system with limited sources.	11
5.	Call processing functions, signal exchange and state transition diagrams; Distributed and common control; Stored programme control; Overload control.	3
6.	Subscriber loop signaling; PCM signaling, channel-associated and common channel signaling; Signaling system No. 7: Protocol architecture, signaling units' format, signaling link and network level; Numbering plan and routing; Concept of intelligent networks.	4
7.	Overview of ISDN, transmission structure, protocol architecture, physical layer, LAPD, basic call control; Overview of ATM, ATM cells, reference model, adaptation layer, cell switching.	4
8.	Introduction to DSL, transmission and reception in ADSL; Overview of xDSL.	3
9.	Overview of VoIP and MPLS.	3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Flood, J.E., "Telecommunication Switching, Traffic and Networks", Pearson Education.	2001
2.	Bertsekas, D. and Gallager, R., "Data Networks", 2nd Ed., Prentice-Hall of India.	1992
3.	Bellamy, J.C., "Digital Telephony", 3rd Ed., John Wiley & Sons	2002
4.	Bear, D., "Principles of Telecommunication Traffic Engineering", 3rd Ed., Peter Peregrinus.	1988
5.	Stallings, W., "ISDN and Broadband ISDN with Frame Relay and ATM", 4th Ed., Pearson Education.	2000
6.	Olivier, H., Gurle, D. and Petit, J.P, "IP Telephony: Packet Based Multimedia Communications Systems", Addison-Wesley Longman.	2000
7.	Black, U., "MPLS and Label Switching Networks", Pearson	2002

	Education.	

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE**:** **Department of Electronics and Computer Engg.**

1. Subject Code**: EC - 451** Course Title**: Database Management Systems**

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**: EC - 251**

8. Subject Area**: DCC**

9. Objective: To introduce the concepts of database management systems and the design of relational databases.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to database management, data abstraction and system structure.	3
2.	Entity relational model, entity set, relationship sets, mapping cardinalities, keys, E-R diagrams.	3
3.	Relational model, database schema, relational algebra, outer join and	6

	manipulation of databases.	
4.	Tuple relational calculus: Example queries, formal definitions and safety of expressions; SQL: Query processing and optimization, set operations, aggregate functions, data definition language and views, comparison of queries in relational algebra, SQL, tuple relation calculus and domain relation calculus.	7
5.	Relational database design, various normal forms, functional dependencies, canonical cover, lossless join, dependency preservation, multi value dependency and higher normal forms, transaction management, ACID property.	6
6.	Serializability and testing for serializability, concurrency control schemes, lock-based protocols, two-phase locking protocols, graph-based protocols, time stamp-based protocols, deadlocks.	5
7.	Recovery systems, log-based recovery, deferred and immediate database modification, object oriented database design.	6
8.	Data warehousing, heterogeneous component systems, data scrubbing.	3
9.	Data mining and knowledge discovery, basic mathematical, numerical and statistical techniques; Applications in information retrieval.	3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Abraham, H. and Sudershan, S., "Database System Concepts", 4th Ed., McGraw-Hill.	2002
2.	Elmasi, R. and Navathe, S.B., "Fundamentals of Database Systems", 4th Ed., Pearson Education.	2005
3.	Date, C. J., "Introduction to Database Systems", Pearson Education.	2002
4.	Ramakrishnan, R. and Gekhre, J., "Database Management Systems", 3rd Ed., McGraw-Hill.	2003
5.	Pang, N. T., Steinbach, M. and Kumar, V., "Introduction to Data Mining", Pearson Education.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC- 461** Course Title: **Microwave Lab**

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

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

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

5. Credits: 0 | 2 6. Semester √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: **EC-332 and EC-334**

8. Subject Area: **DCC**

9.Objective: To introduce the students to various microwave sources, components, and equipments and the measurement of their performance characteristics.

10. Details of the Course:

Sl. No.	Contents	Contact Hours

	Study of microwave sources and components. Study of crystal detector characteristics. Measurement of VSWR, impedance and frequency. Measurement of attenuation and dielectric constant. Measurement of phase shift. Measurement of Q of a cavity resonator. Measurement of directional coupler characteristics. Study of tee junctions. Study and measurement of transmission line characteristics. Measurement of antenna characteristics. Study of Spectrum Analyzer. Study of Network Analyzer.	14x3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Sons.	2004
2.	Collin, R.E., "Foundations for Microwave Engineering", 2nd Ed., John Wiley & Sons.	2000
3.	Laverghetta, T.S., "Microwave Measurements and Techniques", Artech House.	1984
4.	Laverghetta, T.S., "Practical Microwaves", H.W. Sams & Co.	1984

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 473** Course Title: **Computer Networks Lab**

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

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

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

5. Credits: 0 | 2 6. Semester √ **Autumn** **Spring** **Both**

7. Pre-requisite: **EC - 356**

8. Subject Area: **DCC**

9. Objective: To design program and configure various hardware and software components of computer networks, including protocols.

10. Details of the Course:

Sl.	Contents	Contact

No.		Hours
	Socket programming using RPC and RMI. Cryptography algorithms, DES, RSA, and digital signatures. Implementation of various LAN protocols and configurations. Network simulation using the NS2 package. Network simulation using the Qualnet software. Configuration of PC as router and switch.	14 x 3
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Tanenbaum, A.S., "Computer Networks", 4th Ed., Pearson Education.	2003
2.	Forouzan, B.A., "Data Communication and Networking", 4th Ed., Tata McGraw-Hill.	2006
3.	Stallings, W., "Cryptography and Network Security: Principles and Practice", 4th Ed., Prentice-Hall of India.	2006
4.	Stallings, W., "Data and Computer Communication", 8th Ed., Prentice-Hall of India.	2007
5.	Stevens, W. R., "Unix Network Programming: Vol. II", 2nd Ed., Pearson Education	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 512N** Course Title: **Information and Communication Theory**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [√] **Autumn** [ ] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 312 or equivalent**

8. Subject Area: **MSC**

9. Objective: To provide the essential concepts of information and communication theory and their applications.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to detection and estimation problem in communication.	2
2.	The meaning and axioms of probability; Random variables; Examples of commonly used random variables and their density and distribution functions; Moments and characteristic functions.	6
3.	Bivariate distributions and functions of two random variables, joint moments and characteristic functions, conditional distributions and expected values.	4
4.	Binary hypothesis testing: Bayes, Neyman-Pearson, maximum likelihood, MAP and minimum probability of error criteria; Bayes, ML and MAP estimation.	6
5.	Information, entropy, source coding theorem, Markov sources; Channel capacity theorems for discrete and continuous ensembles; Introduction to rate distortion function.	8
6.	Correlation matrix and characteristic functions of sequences of random variables, jointly normal random variables; Mean square estimation, stochastic convergence and limit theorems; Random number generation.	6
7.	Random processes, correlation function and power spectrum, random process	10

	through linear systems, KLT, ergodicity; Spectral factorization and innovation; Optimum linear filters and mean square estimation.	
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books/Author**	**Year of Publication/ Reprint**
1.	Papoulis, A. and Pillai, S.U., "Probability, Random Variables and Stochastic Processes", Tata McGraw-Hill.	2002
2.	Cover, T.M. and Thomas, J.A., "Elements of Information Theory", 2nd Ed., Wiley Interscience.	2006
3.	Van Trees, H.L., "Detection, Estimation and Modulation Theory", Part I, Wiley Interscience.	2001
4.	Bose, R., "Information Theory, Coding and Cryptography", Tata McGraw-Hill.	2003
5.	Sayood, K., "Data Compression", Harcourt India.	2000
6.	Lafrance, P., "Fundamental Concepts in Communication", Prentice-Hall of India.	1992

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 513N** Course Title: **Telecommunication Networks**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC – 311 / Background of probability and random variables.**

8. Subject Area: **MSC**

9. Objective: This course is designed to provide an in - depth study of communication networks with emphasis on development of analytical tools and quantitative performance evaluation.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to communication networks, network topologies, internetworking, circuit and packet switching; Layered architecture and protocols, OSI reference model and functions of various layers, overview of TCP / IP, ISDN and SS – 7 protocol architectures.	3
2.	Brief characterization of communication channels and fundamental limits in digital transmission; Line codes and modems; Transmission media and transmission impairments; Synchronous and asynchronous time division multiplexing, SONET and SDH.	3
3.	Error detection: Parity check, polynomial representation, cyclic redundancy checks and their capabilities; Error control: Stop and wait, go - back n and selective repeat ARQ strategies, correctness and throughput analysis; Framing and optimum frame size; HDLC and LAPB protocols, throughput analysis of HDLC.	6
4.	Introduction to queuing models, modeling of arrivals, interarrival times	15

	and service times, Poisson process; Little's theorem, proof and examples; Continuous–time discrete event process and Markov chain, Birth-Death process; Analysis and applications of M/M/1, M/M/m, M/M/m/m, M/M/m/K and M/M/∞ queues; M/G/1 queue, vacation, reservation, polling, and priority; G/G/1 queue; Network of queues, Kleinrock's independence assumption, Burke's and Jackson's theorems.	
5.	Classification and performance measures of MAC protocols; Pure-ALOHA and slotted-ALOHA, Markov chain modeling, stability, BEB and other stabilization techniques; Splitting algorithms; Non-persistent, 1-persistent and p-persistent CSMA, performance evaluation; CSMA/CD and CSMA/CA; Polling, reservation and token ring protocols; Overview of IEEE 802 standards and frame structures of 802.3 and 802.5.	8
6.	Main issues in routing, virtual circuit and datagram routing; Classification of routing algorithms; Shortest path algorithms: Bellman-Ford, Dijkstra and Floyd-Warshall; Distributed asynchronous Bellman-Ford algorithm.	4
7.	Objectives and means of flow and congestion control, End-to-end and node by node windows, performance analysis and simplified queuing models; Rate control schemes: Time window, modeling and performance of leaky bucket algorithm.	3
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Bertsekas, D. and Gallager, R., "Data Networks", 2nd Ed., Prentice-Hall of India.	1992
2.	Kumar, A., Manjunath, D. and Kuri, J., "Communication Networking: An Analytical Approach", Morgan Kaufmann.	2004
3.	Schwartz, M., "Telecommunication Networks: Protocols, Modeling and Analysis", Pearson Education.	1987
4.	Stallings, W., "Data and Computer Communication", 8th Ed., Pearson Education.	2007
5.	Walrand, J., "Communication Networks", 2nd Ed., McGraw-Hill.	2009
6.	Kleinrock, L., "Queuing Systems: Theory", 2nd Ed., Wiley Blackwell.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 515N** Course Title: **Coding Theory and Applications**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC 311 or equivalent**

8. Subject Area: **MSC**

9. Objective: To provide an in-depth study of the design of good forward error correction codes and their efficient decoding.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Introduction to forward error correction and reliable information transmission; Discrete communication channels and Shannon's theorems revisited.	2
2.	Introduction to groups, rings and fields; Finite fields based on integer and polynomial rings; Binary field arithmetic, construction and properties of GF (2^m); Vector spaces and linear algebra; Logic circuits for finite field arithmetic.	6
3.	Structure of Linear Block Codes, encoding, minimum distance, error detection and correction capabilities, syndrome; Standard array and decoding of block codes; Probability of undetected error over binary symmetric channel; Examples of block codes: Hamming, SEC-DED, Reed-Muller, Golay.	6
4.	Polynomial and matrix description of Cyclic Codes, encoding, decoding; Hamming code and Golay code; Shortened and quasi-cyclic codes; Error trapping decoding.	6
5.	Binary primitive BCH codes, Berlekamp's iterative algorithm for BCH decoding, decoder implementation; Non-binary BCH and Reed-Solomon	8

	(R-S) codes, decoding of R-S codes by Berlekamp's algorithm; Frequency domain representation and decoding of R-S codes.	
6.	Convolutional codes, encoding, trellis description, structural and distance properties; Viterbi algorithm (VA), implementation and performance of VA; SOVA and BCJR algorithms.	8
7.	Introduction to Turbo and LDPC codes; Iterative decoding of Turbo codes; Trellis coded modulation.	4
8.	Burst-error correction, interleaving and concatenation.	2
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books/ Authors**	**Year of Publication/ Reprint**
1.	Lin, S. and Costello Jr., D.J., "Error Control Coding", 2nd Ed., Pearson Prentice-Hall.	2004
2.	Blahut, R.E., "Algebraic Codes for Data Transmission", 2nd Ed., Cambridge University Press.	2003
3.	Vucetic, B. and Yuan, J., "Turbo Codes: Principles and Applications", Springer.	2000
4.	McEliece, R., "Theory of Information and Coding", 2nd Ed., Cambridge University Press.	2002
5.	Huffman, W.C. and Pless, V., "Fundamentals of Error Correcting Codes", Cambridge University Press.	2003
6.	Moon, T.K., "Error Correction Coding: Mathematical Methods and Algorithms", Wiley Interscience.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 516N** Course Title: **Advanced Digital Communication Techniques**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 312 or equivalent**

8. Subject Area: **MSC**

9. Objective: To expose the students to advanced topics in digital communication with emphasis on source coding, signal design and optimum receiver structures.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Vector quantization; Sub-band coding of speech, audio and video signals; Linear predictive coding of speech, CELP coders; MPEG standards for audio and video.	6
2.	Characterization of bandpass signals and systems, orthonormal expansion of signals, representation of digitally modulated signals; Non-linear modulation methods with memory.	6
3.	Optimum demodulation of known signals in additive white Gaussian noise; Probability of error for binary and M-ary signaling, and DPSK demodulator.	6
4.	Carrier and symbol synchronization techniques.	4
5.	Characterization of band-limited channels and ISI, signal design for zero ISI and controlled ISI.	4
6.	Optimum demodulator for ISI and AWGN; Linear equalization and decision feedback equalization, adaptive equalizers.	6
7.	Characterisation of fading dispersive channel, tapped delay line model, optimum demodulation for binary signaling, Rake receiver.	5
8.	Direct sequence spread spectrum and CDMA systems, DSSS performance in AWGN and fading channel.	5

	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Books/ Authors**	**Year of Publication/ Reprint**
1.	Proakis, J.G., "Digital Communications", 4th Ed., McGraw-Hill.	2001
2.	Barry, J.R., Lee, E.A. and Messerschmitt, D.G., "Digital Communication", 3rd Ed., Kluwer.	2004
3.	Benedetto, S. and Biglieri, E., "Principles of Digital Transmission: Wireless Applications", Springer.	1999
4.	Sayood, K., "Introduction to Data Compression", 3rd Ed., Morgan Kaufman.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC - 517N** Course Title: **Optical Communication Systems**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 311 / Digital Communication course at UG level.**

8. Subject Area: **MSC**

9. Objective: To provide in-depth knowledge of modern optical communication systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Optical communication system evolution, Generic optical system, wireless optical systems, applications and design challenges.	3
2.	Wave propagation in optical fiber, analysis of optical waveguide using ray theory; Physical and electrical characteristics of fiber; Fiber nonlinearities; Polarization effects; Passive optical components.	6
3.	Modes in a planar waveguide structure, ray optic approach to optical mode theory, channel and strip loaded wave guides, losses, input/output couplers, coupling between wave guides; Optical modulators: Internal and external modulation techniques, Mack-Zehnder and electro absorption modulators; Optical amplifiers: Semiconductor, EDFA, Raman and hybrid amplifiers; Noise characteristics and applications of amplifiers.	12
4.	Basic concepts of optical sources, semiconductor lasers, distributed feedback lasers, frequency chirping, LED; Optical detectors: Principles of photo detector, PIN and avalanche photo diode, phototransistor, NEP.	5
5.	Optical transceivers; Direct detection and coherent receivers, noise in detection process, BER; System design, power budgeting, rise time budgeting; Maximum transmission distance due to attenuation and dispersion, attenuation and dispersion limits.	8

6.	Binary, magnitude, phase and real valued spatial filters, spatial carrier frequency filters, interferometric methods for constructing filters, multiplexed filters; Optical signal processor and filter generator; Methods for handling non-uniform noise spectral density; Effect of small displacements of spatial filters.	8
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Senior, J.M., "Optical Fiber Communications", 2nd Ed., Prentice-Hall of India.	1999
2.	Keiser, G., "Optical Fiber Communications", 3rd Ed., McGraw-Hill.	2000
3.	Papannareddy, R., "Lightwave Communication Systems: A Practical Perspective", Penram International.	2004
4.	Razavi, B., "Design of Integrated Circuits for Optical Communications", McGraw-Hill.	2002
5.	Vanderlugt, A., "Optical Signal Processing", John Wiley & Sons.	2005
6.	Yariv, A., "Optical Electronics in Modern Communications", Oxford University Press.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 518N** Course Title: **Speech and Audio Processing**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 311 and EC - 411 or equivalent**

8. Subject Area: **MSC**

9. Objective: To acquaint the students with the concepts in speech and audio processing, and their applications in communication systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Digital speech processing and its applications, production and classification of speech sounds, lossless tube models, digital models for speech signals; Analysis and synthesis of pole-zero speech models, Levinson recursion, lattice synthesis filter.	7
2.	Time dependent processing of speech, pitch period estimation, frequency domain pitch estimation; Discrete-time short-time Fourier transform and its application, phase vocoder, channel vocoder.	6
3.	Homomorphic speech processing, waveform coders, hybrid coders and vector quantization of speech; Model based coding: Linear predictive, RELP, MELP, CELP; Speech synthesis.	9
4.	Principles of speech recognition, spectral distance measures, dynamic time warping, word recognition using phoneme units, hidden Markov models and word recognition, speech recognition systems, speaker recognition.	7
5.	Ear physiology, psychoacoustics, perception model and auditory system as filter bank; Filter bank design and modified discrete cosine transform algorithm for audio compression in MP3 and AAC coders; Standards for high-fidelity audio coding.	7

6.	Tree-structured filter banks, multicomplementary filter banks; Properties of wavelets and scaling functions, wavelet transform; Filter banks and wavelets, applications of wavelet signal processing in audio and speech coding.	6
	Total	**42**

11. Suggested Books:

Sl. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Rabiner, L.R. and Schafer, R.W., "Digital Processing of Speech Signals", Pearson Education.	2006
2.	Quatieri, T.F., "Discrete-Time Speech Signal Processing: Principles and Practice", Pearson Education.	2002
3.	Furui, S., "Digital Speech Processing, Synthesis and Recognition", 2nd Ed., CRC Press.	2000
4.	Fliege, N.J., "Multi Rate Digital Signal Processing", John Wiley & Sons.	1999
5.	Spanias, A., Painter, T. and Venkatraman, A., "Audio Signal Processing and Coding", John Wiley & Sons.	2007
6.	Gold, B. and Morgan, N., "Speech and Audio Signal Processing", John Wiley & Sons.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT/CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 519N** Course Title: **Selected Topics in Communication**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 411 and EC – 612N or equivalent**

8. Subject Area: **MSC**

9. Objective: To introduce the students to advanced topics in communication with sufficient mathematical/analytical and technological details.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Software defined radio; Cognitive radio: Definition, spectrum management, computational intelligence, architecture and radio resource management.	8
2.	Review of third generation cellular systems and standards, multicarrier modulation and multiple access techniques; Broadband wireless access, OFDMA and mobile WiMAX.	6
3.	Space-time wireless communications, linear diversity techniques, space-time coding; MIMO detection and channel estimation, iterative detection and decoding, MIMO-OFDM; Smart antennas; Ultra wideband communication.	12
4.	Advanced physical and MAC layer alternatives for wireless PAN, LAN, MAN and cellular networks; Mobile ad hoc and wireless sensor networks, adaptive link, MAC and network layer, energy efficiency and cross-layer design.	10
5.	Wireless capacity and channel state estimation, network capacity, information theory and network architecture, capacity of ad hoc networks; Wireline and wireless cooperation strategies, multiantenna relaying, cooperative diversity, cooperative physical layer architecture.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Fette, B., "Cognitive Radio Technology", Elsevier.	2006
2.	Mitola III, J., "Cognitive Radio Architecture: The Engineering Foundation of Radio XML", Wiley- Interscience.	2006
3.	Giannakis, G.B., Hua, Y., Stoica, P. and Tong, L., "Signal Processing Advances in Wireless and Mobile Communications", Vol.1 and Vol. 2, Prentice- Hall.	2001
4.	Pietrzyk, S., "OFDMA for Broadband Wireless Access", Artech House.	2006
5.	Siwiak, K. and McKeown, D., "Ultra-wideband Radio", John Wiley & Sons.	2004
6.	Paulraj, A., Nabar, R. and Gore, G., "Introduction to Space-Time Wireless Communications", Cambridge University Press.	2003
7.	Gilsic, S.G., "Advanced Wireless Networks: 4G Technology", John Wiley & Sons.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE**:** **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 531N** Course Title: **Microwave Engineering**

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

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

4. Relative Weight**:** **CWS** | 15 | **PRS** | 00 | **MTE** | 35 | **ETE** | 50 | **PRE** | 00 |

5. Credits**:** | 0 | 3 | 6. Semester | √ | **Autumn** | | **Spring** | | **Both** |

7. Pre-requisite**: EC-331 and EC-332 or equivalent**

8. Subject Area**: MSC**

9. Objective: To introduce the students to the field theory and circuit theory concepts in the analysis and design of microwave guiding structures and passive components.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Transmission Lines and Waveguides:** Review of TEM, TE, and TM mode solutions of Maxwell's equations; TEM mode transmission lines: lossless line, line with small losses, power flow in a terminated line; Quasi-TEM mode lines: Fields in microstriplines and striplines, losses in microstrips, microstrip discontinuities, coupled lines, slot lines and coplanar waveguides; Surface waveguides: Surface waves along an impedance plane, dielectric-coated conducting plane, slab waveguide, corrugated plane; Wave velocities.	10
2.	**Microwave Circuit Theory Principles:** Equivalent voltages and currents; Z, Y, S, and ABCD parameters; Equivalent circuit representation of microwave junctions; Scattering parameter analysis of microwave junctions; Coupling of waveguides through probes, loops, and apertures.	8
3.	**Impedance Transformers:** Review of single-, double- and triple-stub tuners, waveguide reactive elements, quarter-wave transformers, design of maximally flat and Chebyshev transformers; Introduction to tapered transmission lines.	6
4.	**Power Dividers and Couplers:** Scattering matrix of 3- and 4-port junctions; Design of T-junction and Wilkinson power dividers; Design of 90° and 180° hybrids.	6
5.	**Filters:** Analysis of periodic structures, Floquet's theorem, filter design by insertion loss method, maximally flat and Chebyshev designs.	6
6.	**Resonators:** Principles of microwave resonators, loaded, unloaded and external Q, open and shorted TEM lines as resonators, microstrip resonators, dielectric resonators**.**	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Collin, R.E., "Foundations for Microwave Engineering", 2nd Ed., John Wiley & Sons.	2000
2.	Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Sons.	2004
3.	Edwards, T.C. and Steer M.B., "Foundations for Interconnects and Microstrip Design", 3rd Ed., John Wiley & Sons.	2001
4.	Ludwig, R. and Bretchko, P., "RF Circuit Design", Pearson Education.	2000
5.	Hunter, I., "Theory and Design of Microwave Filters", IEE Press.	2001
6.	Misra, D.K., "Radio-frequency and Microwave Communication Circuits", John Wiley & Sons.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC– 534N** Course Title: **Antenna Theory and Design**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC-334 or equivalent**

8. Subject Area: **MSC**

9. Objective: The objective of this course is to provide an in-depth understanding of modern antenna concepts, and practical antenna design for various applications.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Fundamental Concepts:** Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.	6
2.	**Radiation from Wires and Loops:** Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.	6
3.	**Aperture Antennas:** Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Fourier transform method in aperture antenna theory.	8
4.	**Horn and Reflector Antennas:** Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas.	6
5.	**Microstrip Antennas:** Basic characteristics, feeding methods, methods of analysis, design of rectangular and circular patch antennas.	6
6.	**Antenna Arrays:** Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Fourier transform method, and Woodward-Lawson method.	10
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Balanis, C.A., "Antenna Theory and Design", 3rd Ed., John Wiley & Sons.	2005
2.	Jordan, E.C. and Balmain, K.G., "Electromagnetic Waves and Radiating Systems", 2nd Ed., Prentice-Hall of India.	1993
3.	Stutzman, W.L. and Thiele, H.A., "Antenna Theory and Design", 2nd Ed., John Wiley & Sons.	1998
4.	Elliot, R.S., "Antenna Theory and Design", Revised edition, Wiley-IEEE Press.	2003
5.	Garg, R., Bhartia, P., Bahl, I. and Ittipiboon, A., "Microstrip Antenna Design Handbook", Artech House.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 552N** Course Title: **Network Programming in UNIX**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester: √ **Autumn** ☐ **Spring** ☐ **Both**

7. Pre-requisite: **EC – 353 and EC - 356**

8. Subject Area: **MSC**

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, half duplex and full duplex pipes, FIFOs, properties of pipes and FIFOs, POSIX message queues, system V message queues, semaphores, shared memory, mmap function and its use, RPC, authentication, timeout and retransmission, call semantics, XDR.	10
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
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
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: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 554N** Course Title: **Network Security**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: | 0 | 3 |

6. Semester | √ Autumn | | Spring | | Both |

7. Pre-requisite: **EC - 356**

8. Subject Area: **MSC**

9. Objective: To introduce the students to the security aspects of computer networks and electronic transactions

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Security model, security objectives and types of attacks.	3
2.	Symmetric key cryptography, DES, Triple DES, AES, and other symmetric ciphers, block cipher modes of operation.	6
3.	Public-key cryptography principles; Number theory: prime numbers, Chinese remainder theorem, discrete logarithms; RSA and other public key algorithms, key management and PKI; Authentication requirements, message authentication functions and hash algorithms.	9
4.	Digital signature requirements, direct and arbitrated signatures, authentication with symmetric and public key encryption, Kerberos, X.509 authentication service.	8
5.	Security issues in electronic mail, PGP, S/MIME.	4
6.	IP Security issues and architecture, Web security, transport layer security and Secure Socket Layer, secure electronic transaction.	6
7.	Intruders and intrusion detection, password management; Malicious software, viruses, worms and related threats; Firewalls and their design principles, trusted systems.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Stallings, W., "Cryptography and Network Security: Principles and Practice", 4th Ed., Prentice-Hall.	2006
2.	Forouzan, B.A., "Cryptography and Network Security", Tata McGraw-Hill.	2007
3.	Schneier, B., "Applied Cryptography", 2nd Ed., Wiley & Sons.	2002
4.	Kaufman, C., Perlman, R. and Speciner, M., "Network Security", Prentice-Hall.	2002
5.	Bishop, M., "Computer Security: Art and Science", Pearson.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 555N** Course Title: **Advanced Computer Networks**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: | 0 | 3 | 6. Semester [ ] Autumn [√] Spring [ ] Both

7. Pre-requisite: **EC - 356**

8. Subject Area: **MSC**

9. Objective: To provide to the students an in-depth understanding of networking.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Review:** Computer networks and layered architecture.	2
2.	**Asynchronous Transfer Mode:** ATM layered model, switching and switching fabrics, network layer in ATM, QOS, LAN emulation.	4
3.	**Transport Layer:** Elements of transport protocols; Internet transport protocols: TCP and UDP, TCP connection management, congestion control.	6
4.	**Application Layer:** Network application architectures: Client-server, P2P and hybrid; Application layer protocols: DNS, FTP, TFTP, TELNET, HTTP and WWW, SMTP and electronic mail; Network management and SNMP	8
5.	**Wireless and Mobile Networks:** Wireless links and network characteristics, 802.11 wireless LANs, mobility management, addressing and routing, mobile IP, WAP, mobility in cellular networks.	8
6.	**Multimedia Networking:** Streaming audio and video, RTSP, jitter removal and recovery from lost packets; Protocols for real-time interactive applications: RTP, RTCP, SIP, H.323; Content distribution networks; Integrated and differentiated services, RSVP.	8
7.	**Introduction to Network Security:** Cryptography, symmetric and public-key algorithms, digital signatures, communication security, authentication protocols, E-mail security, PGP and PEM.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Tanenbaum, A. S., "Computer Networks", 4th Ed., Pearson Education.	2003
2.	Forouzan, B. A., "Data Communication and Networking", 3rd Ed., Tata McGraw-Hill	2004
3.	Kurose, J. F. and Ross, R.W., "Computer Networking", 3rd Ed., Pearson Education	2005
4.	Stallings, W., "Network Security and Cryptography", 4th Ed., Prentice-Hall of India.	2006
5.	Comer, D.E. and Droms, R.E., "Computer Networks and Internets", 4th Ed., Prentice-Hall.	2004

6.	Stevens, W.R., "TCP/IP Illustrated, Volume 1", Pearson	2000
7.	Walrand, J. and Varaiya, P., "High Performance Communication Networks", 2nd Ed., Morgan Kaufmann.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 556N** Course Title: **Advanced Computer Architecture**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 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, 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.	Vector processing characteristics and requirements, pipelined vector processing, vectorization methods, examples of vector processing.	4
6.	Array processing, SIMD array processors, communication between PEs, SIMD interconnection networks, algorithms for array processing.	4
7.	Data and control parallelism, concurrency, scalability, speedup and Amdahl's law, PRAM model of parallel computation, parallel algorithms.	4
8.	Multiprocessors and multi-computers; Processor organizations: mesh, binary tree, hypercube; Shared memory and message passing systems; Mapping and Scheduling: Embedding of task graphs in processor graphs, dilation and loading, load balancing, models for static and dynamic scheduling.	6
9.	Overview of parallel programming using MPI and Open MP.	2
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	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	2007

	Architecture: A Design Space Approach", Pearson Education.	
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: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 558N** Course Title: **Mobile Computing**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester: [ ] [√] [ ]

Autumn Spring Both

7. Pre-requisite**: EC - 252, EC - 356**

8. Subject Area**: MSC**

9. Objective: To impart knowledge of mobile and wireless computing systems and techniques.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Mobility:** Issues, challenges, and benefits; Review of mobile and cellular communication technology; Review of distributed/network operating systems, ubiquitous computing.	4
2.	**Network Programming:** Process communication techniques, remote login, ftp, socket programming, RPC, RMI, client-server programming.	4
3.	**Process Migration:** Steps, advantages, application taxonomy, alternatives, case study of DEMOS/MP.	3
4.	**Mobile Computing:** Physical mobility, challenges, limits and connectivity, mobile IP and cellular IP in mobile computing, case study of CODA.	6
5.	**Wireless LANs:** Introduction to IEEE 802.11, Bluetooth and IrDA technologies and standards.	4
6.	**Mobile Adhoc Networks:** Hidden and exposed terminal problems; Routing protocols: DSDV, DSR, AODV.	6
7.	**Wireless Sensor Networks:** Motes, smart dust, TinyOS, routing protocols.	4
8.	**Handheld Devices and OS:** Palm, HP; PalmOS, WindowsCE, Windows Mobile.	4
9.	**Mobile Internet and WAP:** WWW programming model, WAP programming model, gateways.	4
10.	**Mobile agents:** Aglets, Tcl, PMADE.	3
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Tanenbaum, A. S., "Computer Networks", 4th Ed., Pearson Education.	2003
2.	Milojicic, D., Douglis, F. and Wheeler R., (ed.), "Mobility Processes, Computers and Agents", Addison Wesley.	2000
3.	Lange, D. B. and Oshima, M., "Programming and Deploying Java Mobile Agents with Aglets", Addison Wesley.	1998
5.	Schildt, H., "The Complete Reference Java2", 5th Ed., McGraw-Hill.	2002
6.	Stevens, W. R., "UNIX Network Programming", Prentice-Hall of	1998

	India.	
7.	Hansman, U. and Merck, L., "Principles of Mobile Computing", 2nd Ed., Springer.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 562N** Course Title: **Wireless Communication Lab**

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

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

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

5. Credits: 0 | 2 6. Semester [ ] [√] [ ]

Autumn Spring Both

7. Pre-requisite**: EC-332 and EC-334**

8. Subject Area**: MSC**

9. Objective: To provide a hands-on experience to students on the use of various e.m. solvers for the design of rf circuits and components used in wireless communication.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
	It will be a project-based laboratory where the students will be required to study various e.m. circuit design and analysis softwares like ADS, HFSS, IE3D, CST Microwave Studio and use them in the design of sub-systems. The designs will be implemented and tested in the laboratory.	14x3
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Sons.	2004
2.	Pozar, D. M., "Microwave and RF Design of Wireless Systems", John Wiley & Sons.	2001
3.	Gonzalez, G., "Microwave Transistor Amplifiers: Analysis and Design", 2nd Ed., Prentice-Hall.	1997
4.	Bahl, I. and Bhartia, P., "Microwave Solid State Circuit Design", John Wiley & Sons.	1988
5.	Chang, K., Bahl, I. and Nair, V., "RF and Microwave Circuit and Component Design for Wireless Systems", Wiley Interscience.	2002
6.	Larson, L.E., "RF and Microwave Circuit Design for Wireless Applications", Artech House.	1996

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code**: EC – 612N** Course Title**: Wireless Networks**

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

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

4. Relative Weight**:** **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

0 | 3		√	

5. Credits**:** 6. Semester

Autumn Spring Both

7. Pre-requisite**: EC - 413 or EC - 513 or equivalent**

8. Subject Area**: MSC**

9. Objective: To acquaint the students with the concepts and the issues involved in the design of wireless networks.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Wireless network topologies, infrastructure and ad-hoc networks, different generations of wireless networks; The cellular concept and design fundamentals, coverage and capacity expansion techniques.	5
2.	Large scale path loss modeling and shadow fading, indoor and outdoor propagation models; Multipath and Doppler, impulse response model of multipath channel, types of small scale fading, Rayleigh and Ricean fading, simulation model.	5
3.	Constant envelope modulation techniques, GMSK; OQPSK and $\pi/4$ QPSK; Spread spectrum modulation and RAKE receiver; OFDM; Performance in fading and multipath channels.	5
4	Fixed assignment and random access; Capacity and performance of FDMA, TDMA, DS/CDMA and FH/CDMA; WCDMA and OFDMA; Access techniques for WLAN, Bluetooth and mobile data networks; Quality of service enabled wireless access, access methods for integrated services.	6
5.	Location and handoff management, classification of handoffs and handoff algorithms, mobile IP; Power control, and techniques of power control, power saving mechanisms, energy efficient designs; Security in wireless networks.	6
6.	GSM: Reference architecture, registration, call establishment, handoff mechanisms, communication in the infrastructure, GPRS; IS-95: reference architecture, physical layer, radio resource and mobility management; IMT 2000: Physical layer, handoff, power control; Introduction to cordless systems and wireless local loop technologies.	5
7.	Reference and layered architecture of IEEE 802.11 WLANs, physical layer alternatives, MAC scheme and frame format, handoff and power management; Protocol architecture, physical and MAC layer of Hiperlan-1 and Hiperlan-2; IP telephony using WLANs.	5
8.	Wireless home networking; HomeRF; Bluetooth: Protocol stack, physical and MAC layer.	3
9.	Broadband wireless access and IEEE 802.16; Next generation broadband wireless networks and navigational services.	2
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication / Reprint
1.	Pahalvan, K. and Krishnamurthy, P., "Principles of Wireless Networks: A Unified Approach", Pearson Education.	2002
2.	Stallings, W., "Wireless Communications and Networking", Pearson Education.	2002
3.	Rappaport, T.S., "Wireless Communications: Principles and Practice", 2nd Ed., Pearson Education.	2002
4.	Prasad, R. and Munoz, L., "WLANs and WPANs: Towards 4G Wireless", Artech House.	2003
5.	Haykin, S. and Moher, M., "Modern Wireless Communication", Pearson Education.	2005
6.	Pandya, R., "Mobile and Personal Communication Systems and Services", Prentice-Hall of India.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 614N** Course Title: **Adaptive Signal Processing Techniques**

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

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

15	00	35	50	00

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

5. Credits: | **0** | **3** | 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 411 and EC – 512N**

Subject Area: **MSC**

9. Objective: To acquaint the students with the concepts, algorithms and applications of adaptive signal processing in wireless communication systems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Linear optimum filtering and adaptive filtering, linear filter structures, adaptive equalization, noise cancellation and beam forming.	3
2.	Optimum linear combiner and Wiener-Hopf equations, orthogonality principle, minimum mean square error and error performance surface; Steepest – descent algorithm and its stability.	5
3.	LMS algorithm and its applications, learning characteristics and convergence behaviour, misadjustment; Normalized LMS and affine projection adaptive filters; Frequency domain block LMS algorithm.	10
4.	Least squares estimation problem and normal equations, projection operator, exponentially weighted RLS algorithm, convergence properties of RLS algorithm; Kalman filter as the basis for RLS filter; Square-root adaptive filtering and QR- RLS algorithm; Systolic-array implementation of QR – RLS algorithm.	10
5.	Forward and backward linear prediction; Levinson-Durbin algorithm; Lattice predictors, gradient-adaptive lattice filtering, least-squares lattice predictor, QR-decomposition based least-squares lattice filters.	10
6.	Adaptive coding of speech; Adaptive equalization of wireless channels; Antenna array processing.	4
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Haykin, S., “Adaptive Filter Theory”, Pearson Education.	2002
2.	Widrow, B. and Stearns, S.D., “Adaptive Signal Processing”, Pearson Education.	1985
3.	Manolakis, D.G., Ingle, V.K. and Kogon, M.S., “Statistical and Adaptive Signal Processing”, Artech House.	2005
4.	Sayed Ali, H., “Fundamentals of Adaptive Filtering”, John Wiley & Sons.	2003
5.	Diniz, P.S.R., “Adaptive Filtering: Algorithms and Practical	1997

	Implementation", Kluwer.	
6.	Sayeed, Ali, H., "Adaptive Filters", Wiley-IEEE Press.	2008
7.	Scharf, L.L., "Statistical Signal Processing: Detection, Estimation, and Time Series Analysis", Addison-Wesley.	1991

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE**:** **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 631N** Course Title: **RF Receiver Design for Wireless Applications**

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

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

4. Relative Weight**:** **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: | 0 | 3 |

6. Semester | √ Autumn | | Spring | | Both |

7. Pre-requisite: **EC-332 or equivalent**

8. Subject Area: **MSC**

9. Objective: To present to the students a cohesive overview of the fundamental concepts required for the design and analysis of RF stages of a modern wireless system.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Introduction to Wireless Systems**: Classification of wireless systems; Design and performance issues: Choice of operating frequency, multiple access and duplexing, circuit switching versus packet switching, propagation, radiated power and safety; Cellular telephone systems and standards.	4
2.	**Noise and Distortion in Microwave Systems:** Basic threshold detection, noise temperature and noise figure, noise figure of a lossy transmission line; Noise figure of cascade systems: Noise figure of passive networks, two-port networks, mismatched transmission lines and Wilkinson power dividers; Dynamic range and inter-modulation distortion.	6
3.	**Microwave Amplifier Design**: Comparison of active devices such as BJT, MOSFET, MESFET, HEMT, and HBT; Circuit models for FETs and BJTs; Two-port power gains; Stability of transistor amplifier circuits; Amplifier design using S-parameters: Design for maximum gain, maximum stable gain, design for specified gain, low-noise amplifier design, design of class-A power amplifiers.	12
4.	**Mixers:** Mixer characteristics: Image frequency, conversion loss, noise figure; Devices for mixers: p-n junctions, Schottky barrier diode, FETs; Diode mixers: Small-signal characteristics of diode, single-ended mixer, large-signal model, switching model; FET Mixers: Single-ended mixer, other FET mixers; Balanced mixers; Image reject mixers.	8
5.	**Switches:** Devices for microwave switches: PIN diode, BJT, FET; Device models; Types of switches; Switch configurations; Basic theory of switches; Multi-port, broad-band and isolation switches.	4
6.	**Oscillators and Frequency Synthesizers:** General analysis of RF oscillators, transistor oscillators, voltage-controlled oscillators, dielectric resonator oscillators, frequency synthesis methods, analysis of first and second order phase-locked loop, oscillator noise and its effect on receiver performance.	8
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Pozar, D.M. "Microwave and RF Design of Wireless Systems", John Wiley & Sons.	2001
2.	Gonzalez, G., "Microwave Transistor Amplifiers: Analysis and Design", 2nd Ed., Prentice-Hall.	1997
3.	Bahl, I. and Bhartia, P., "Microwave Solid State Circuit Design", 2nd Ed., John Wiley & Sons.	2003
4.	Chang, K., Bahl, I. and Nair, V., "RF and Microwave Circuit and Component Design for Wireless Systems", Wiley Interscience.	2002
5.	Rohde, U.L. and Newkirk, D.P., "RF/Microwave Circuit Design for Wireless Applications", John Wiley & Sons.	2000
6.	Larson, L.E., "RF and Microwave Circuit Design for Wireless Applications", Artech House.	1996
7.	Egan, W. F., "Practical RF Circuit Design", John Wiley & Sons.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 633N** Course Title: **Computational Methods for Electromagnetics**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC-331 or equivalent and a course on complex variables.**

8. Subject Area: **MSC**

9. Objective: The objective of this course is to introduce the students to advanced computational techniques for the solution of partial differential equations and integral equations encountered in electromagnetic boundary value problems.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Fundamental Concepts:** Review of Maxwell's equations and boundary conditions, integral equations versus differential equations, radiation and edge conditions, modal representation of fields in bounded and unbounded media.	6
2.	**Green's Functions:** Green's function technique for the solution of partial differential equations, classification of Green's functions, various methods for	12

	the determination of Green's functions including Fourier transform technique and Ohm-Rayleigh technique, dyadic Green's functions, determination of Green's functions for free space, transmission lines, waveguides, and microstrips.	
3.	**Integral Equations:** Formulation of typical problems in terms of integral equations: wire antennas, scattering, apertures in conducting screens and waveguides, discontinuities in waveguides and microstriplines; Solution of Integral equations: General Method of Moments (MoM) for the solution of integro-differential equations, choice of expansion and weighting functions, application of MoM to typical electromagnetic problems.	12
4.	**Finite Element Method:** Typical finite elements, Solution of two-dimensional Laplace and Poisson's equations, solution of scalar Helmholtz equation.	6
5.	**Finite-difference Time-domain Method:** Finite differences, finite difference representation of Maxwell's equations and wave equation, numerical dispersion, Yee's finite difference algorithm, stability conditions, programming aspects, absorbing boundary conditions.	6
	Total	**42**

11. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Collin, R.E., "Field Theory of Guided Waves", 2nd Ed., Wiley-IEEE Press.	1991
2.	Peterson, A.F, Ray, S.L. and Mittra, R., "Computational Methods for Electromagnetics", Wiley-IEEE Press.	1998
3.	Harrington, R.F., "Field Computation by Moment Methods", Wiley-IEEE Press.	1993
4.	Sadiku, M.N.O., "Numerical Techniques in Electromagnetics", 2nd Ed., CRC Press.	2001
5.	Stutzman, W.L. and Thiele, H.A., "Antenna Theory and Design", 2nd Ed., John Wiley & Sons.	1998
6.	Volakis, J.L., Chatterjee, A. and Kempel, L.C., "Finite Method for Electromagnetics", Wiley-IEEE Press.	1998
7.	Taflov, A. and Hagness, S.C., "Computational Electrodynamics", 3rd Ed., Artech House.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 654N** Course Title: **Multimedia Techniques**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC – 202 or Equivalent**

8. Subject Area: **MSC**

9. Objective: To expose students to the concepts and issues of multimedia data acquisition, communication and presentation technologies.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	**Introduction to Multimedia Systems:** Architecture and components, multimedia distributed processing model, synchronization, orchestration and quality of service architecture.	5
2.	**Audio and Speech:** Data acquisition, sampling and quantization, human speech production mechanism, digital model of speech production, analysis and synthesis, psycho-acoustics, low bit rate speech compression, MPEG audio compression.	7
3.	**Images and Video:** Image acquisition and representation, composite video signal, NTSC, PAL and SECAM video standards; Bilevel image compression standards, JPEG and MPEG.	6
4.	**Multimedia Communication:** Fundamentals of data communication and networking, bandwidth requirements of different media; Real time constraints: Audio latency, video data rate; Multimedia over LAN and WAN, multimedia conferencing.	8
5.	**Hypermedia Presentation:** Authoring and publishing, linear and non-linear presentation, structuring information, different approaches of authoring hypermedia documents, hypermedia data models and standards.	8
6.	**Multimedia Information Systems:** Operating system support for continuous media applications, limitations of OS, new OS support, media stream protocol, file system support for continuous media, data	8

	models for multimedia and hypermedia information, content based retrieval of unstructured data.	
	Total	**42**

12. Suggested Books:

Sl. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Li, Z.N. and Drew, M.S., "Fundamentals of Multimedia", Pearson Education.	2004
2.	Hillman, D., "Multimedia Technology and Application", Galgotia Publication.	1998
3.	Steinmetz, R., "Multimedia Computing, Communication and Applications", Pearson Education.	2001
4.	Buford, J., "Multimedia Systems", Addison Wesley.	1996

NAME OF DEPT./CENTRE: **Department of Electronics and Computer Engg.**

1. Subject Code: **EC – 656N** Course Title: **Intrusion Detection Systems**

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

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

4. Relative Weight: **CWS** 15 **PRS** 00 **MTE** 35 **ETE** 50 **PRE** 00

5. Credits: 0 | 3 6. Semester: [ ] **Autumn** [√] **Spring** [ ] **Both**

7. Pre-requisite: **EC - 351**

8. Subject Area: **MSC**

9. Objective: To introduce the elements of intrusion detection systems and its models.

10. Details of the Course:

Sl. No.	Contents	Contact Hours
1.	Intruder types, intrusion methods, processes and detection, message integrity and authentication, honey pots.	8
2.	General IDS model, data mining based IDS, Denning model, data mining framework for constructing features and models for intrusion detection systems.	6
3.	Unsupervised anomaly detection, CV5 clustering, SVM, probabilistic and statistical modeling, general IDS model and taxonomy, evaluation of IDS, cost sensitive IDS.	8
4.	NBAD, specification based and rate based DDOS, scans/probes, predicting attacks, network based anomaly detection, stealthy surveillance detection; Defending against DOS attacks in scout: signature-based solutions, snort rules.	6
5.	Host-based anomaly detection, taxonomy of security flaws in software, self-modeling system calls for intrusion detection with dynamic window size.	6
6.	Secure intrusion detection systems, network security, secure intrusion detection environment, secure policy manager, secure IDS sensor, alarm management, intrusion detection system signatures, sensor configuration, signature and intrusion detection configuration, IP blocking configuration, intrusion detection system architecture.	8
	Total	**42**

11. Suggested Books:

Sl.	Name of Authors / Books / Publishers	Year of

No.		Publication/ Reprint
1.	Endorf, C., Schultz E. and Mellander J., "Intrusion Detection and Prevention," McGraw-Hill.	2003
2.	Bhatnagar, K., "Cisco Security", Course Technology.	2002
3.	Marchette, D. J., "Computer Intrusion Detection and Network Monitoring: A Statistical Viewpoint", Springer.	2001
4.	Rash, M., Orebaugh, A. and Clark, G., "Intrusion Prevention and Active Response: Deploying Network and Host IPS", Syngress.	2005
5.	Cooper, M., Northcutt, S., Fearnow, M. and Frederick, K., "Intrusion Signatures and Analysis", Sams.	2001