INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: Electronics and Communication Engineering

Subject Code: ECC-505 **Course Title:** Linear Algebra and Random Processes

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PCC

Course Outlines:

Vector spaces & subspaces, bases and dimensions, linear dependence and independence, vector products, orthogonal bases, and orthogonal projections, Gram-Schmidt orthonormalization procedure, linear operators and matrices, eigen values and eigen vectors, characteristic polynomial, diagonalization, Hermitian and unitary matrices, singular value decomposition. Discrete and continuous random variables, distribution and density functions, conditional distributions and expectations, functions of random variables, moments, random process, probabilistic structure: mean, autocorrelation and auto-covariance functions, strict-sense and wide-sense stationary processes, power spectral density; LTI systems with WSS process as the input; Examples of random processes

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-507 **Course Title:** Essentials Concepts in THz Communication

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Introduction to terahertz communication, signal design and its representation, linear and nonlinear modulation, wave propagation and channel characterization, error analysis; multiplexing and diversity techniques, multi-antenna and multi-carrier technologies; fiber channels, dispersion, link budget analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: Electronics and Communication Engineering

Subject Code: ECC-511 **Course Title:** Digital Signal Processing and Communication Techniques

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outline:

Discrete time Fourier transform, Discrete Fourier transform, Fast Fourier transform, Design of finite impulse response filters, Design of infinite impulse response filters, Multirate signal processing, Lowpass equivalent of bandpass signals, Linear and nonlinear modulation techniques, Signal design for band-limited channels, Channel equalization techniques

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: Electronics and Communication Engineering

Subject Code: ECC-513 **Course Title:** Principles of Wireless Communication

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PCC

Course Outline:

Wired (AWGN) Channel and its BER analysis; Wireless channels: physical modeling, input/output model, Rayleigh channel and its BER analysis, channel characteristics: time and frequency, point-to-point communication, diversity techniques, channel uncertainty and estimation, multiple access and interference management, narrow-band and wide-band systems, capacity of wireless channels, MIMO capacity, diversity-multiplexing tradeoff, MIMO receiver design, transmit power allocation, MIMO precoding, Space-time block codes, multi-carrier communication, OFDM and its application to wireless communication, MIMO-OFDM system, peak-to-average power ratio (PAPR), non-orthogonal multiple access, introduction and motivation, system model, successive interference cancellation

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-527 **Course Title:** Introduction to Microwave Measurements

L-T-P: 2-0-4 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Concept of Transmission Lines and S-parameters. Traditional Measurement Techniques: The Power Meter, Transmission Measurement, Reflection Measurement. Basic Vector Measurements, Architecture of the Vector Network Analyzer, Network Analyzer Calibration, Frequency Offset and Mixer Measurement, Time Gating, Material Property Measurement Using the VNA Common Measurements Using the Spectrum Analyzer, Types of Signal Analyzers, Basic Idea behind Spectrum Analyzers, Building Blocks of a Spectrum Analyzer, Features of the Spectrum Analyzer, Dynamic Range and Sensitivity, Component Characterization. Noise Measurement Basics, Special Consideration for Mixers, Phase Noise, Phase Noise Measurement Techniques. Oscillator Circuits: The Crystal Oscillator, Tunable Oscillator, Direct Digital Synthesis, PLL-Based Synthesizers, Fractional N Synthesis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-531 **Course Title:** Digital VLSI Circuit Design

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Review of MOSFET operation, interconnect models & transmission lines, layout & design rules, CMOS inverters – static and dynamic characteristics, Combinational logic design – transistor sizing, logical effort, dynamic logic, pass transistor logic and others, Sequential logic circuits – flipflops, static & dynamic latches, monostable & astable circuits, Timing fundamentals, clock distribution & jitter, Memory & array structures, analysis of SRAM cell – noise margins and stability, programmable logic arrays, Design of adder/subtractor, comparators, counters, shifters, multipliers and other subsystems. Circuit design with PDK, layout, parasitic extraction, and post-layout simulation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-533 **Course Title:** VLSI Technology

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Introduction to VLSI Technology: Device scaling and Moore's law, overview of device fabrication, crystal growth techniques, defects in semiconductors, Oxidation kinematics, and Deal & Grove model of oxidation, Doping – diffusion & ion-implantation, solution of diffusion equation, junction design, rapid thermal processing, Epitaxy and Thin Film Deposition techniques - MOCVD, MBE, CVD, LPCVD, PECVD, PVD, PLD, growth modes & thermodynamics, Wet & Dry etching, etch selectivity, isotropy and bias, plasma etching techniques, metallization & packaging, Schottky and Ohmic contacts, lift-off, Flip-chip and MCM technologies, TSV, 2.5D & 3D packaging & integrations, Lithography, optical lithography, resolution and depth of focus, advanced techniques – immersion, EUV, electron, and X-ray lithography. Advanced processing and characterization techniques, experiments with MOS capacitor fabrication & characterization.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-535 **Course Title:** Foundations of Semiconductor Device Physics

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Physics of semiconductor materials, review of quantum mechanics & energy band theory, carrier statistics – density of states and Fermi-Dirac distribution, Maxwell-Boltzmann approximation, Carrier transport – drift & diffusion, scattering & mobility, quasi-Fermi levels, continuity equation, PN-junction & metal-semiconductor junctions – electrostatics, I-V &, C-V relationships, Analysis of MOS-capacitor - HFCV & LFCV, non-ideal effects, Long channel MOSFET – transfer characteristics & output characteristics, sub-threshold conduction, scaling theory, short channel effects and other non-idealities, advanced MOSFET devices & emerging technologies, Introduction to technology computer aided simulation (TCAD) of semiconductor devices.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-537 **Course Title:** Analog VLSI Circuit Design

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Introduction to analog VLSI design using CMOS, review of single-stage amplifiers with MOSFET and BJT, cascode amplifiers, Differential amplifiers – large & small signal analysis, common-mode rejection, differential amplifiers with active load, Current Mirrors, Current and Voltage References, types of current mirrors, impact of temperature & device mismatch, Review of frequency response techniques, frequency response of single & multi-stage amplifiers, Feedback in amplifiers – gain, linearity, bandwidth & I/O impedances, types of feedback topology, stability in feedback amplifiers, noise in amplifiers, One-stage and two stage OTAs.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-501 **Course Title:** Electromagnetic Field Theory and Scattering

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** PCC

Course Outlines: Maxwell's equations, Poynting vector, wave propagation, plane waves, reflection, and transmission at material interface, surface impedance, Waveguides and transmission lines: TE and TM modes in rectangular and circular metal waveguides, dispersion and wave velocity, Quasi-optical systems and techniques: geometrical optics, Gaussian beams, Bessel beams, Canonical Scattering Problems: Mie coefficients of a homogenous sphere, Rayleigh scattering, Advanced wave-matter interaction and their applications: the concept of double negative metamaterials, evolution of metasurface, Fano resonance, electromagnetic cloaking.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-503 **Course Title**: THz Electronics

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** PCC

Course Outlines: Introduction to Terahertz electronics, Applications in communication and networks. Terahertz wave propagation. Photonic-inspired Terahertz passive and active devices. Terahertz devices using graphene, liquid crystals, and phase-change materials. Terahertz sources and detectors: Terahertz pulse generation using photo-mixing and laser interferometry, Terahertz devices applications and use cases.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-521 **Course Title:** Antenna Theory and Design

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Antenna radiation principle, antenna parameters, Friis transmission equation and radar range equation, potential functions, wire antennas, dipole and loop antennas, near-field and far-field of an antenna, antenna array theory, broadside and end-fire arrays, uniform and non-uniform arrays, array design principle, aperture antenna, horn antenna, frequency independent antennas, log-periodic antennas, microstrip antennas.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-523 **Course Title:** Advanced EMFT

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** PCC

Course Outlines: Maxwell's equations and boundary conditions; Poynting vector; Wave polarization; multiple dielectric interfaces; normal and oblique incidence; Wave functions; Electric and magnetic current sources; Image theory; Auxiliary potentials; Fundamental Theorems; TE, TM, and hybrid modes in rectangular, circular, and Partially filled waveguides; Cavity resonators; Sources of spherical waves; TEM wave propagation in Ferrites; Faraday rotation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electronics and Communication Engineering

Subject Code: ECC-525 **Course Title:** Microwave Engineering

L-T-P: 3-0-0 **Credits:** 3 **Subject Area:** PCC

Course Outlines: Maxwell's equations; TEM mode transmission lines; microstrip lines; coplanar waveguides; Surface waveguides; Microwave Circuit Theory; Z, Y, S, and ABCD parameters; Equivalent circuit representation; Coupling of waveguides; Stub tuners, waveguide reactive elements, quarter-wave transformers, maximally flat and Chebyshev transformers; T-junction; 90° and 180° hybrids; Analysis of periodic structures; filter design; microwave resonators.