Syllabus for PhD Entrance Exam (Wireless and Optical Communications stream)

	Circuit analysis, Sinusoidal steady state analysis, Phasors, Time and frequency domain analysis of linear circuits, Solution of network equations using Laplace transform, Linear 2-port network parameters
	Continuous-time signals, Fourier series and Fourier transform, sampling theorem and applications, Discrete-time signals, DTFT, DFT, Z-transform, Discrete-time processing of continuous-time signals, LTI systems, causality, stability, Impulse response, convolution, Frequency response, Group delay, Phase delay, Multirate filterbank, Adaptive signal processing Fundamentals Blocks of Multirate Systems, Basic building blocks – Up-sampling, Down-sampling, Aliasing, Interference, Reconstruction, Sampling Rate Change and filtering.
	Random processes, Autocorrelation and power spectral density, Properties of white noise, filtering of random signals through LTI systems, Inter-symbol interference, MAP, ML detection, Matched filter receiver, SNR and BER, Analog modulation and demodulation, AM, FM and PM, Modulation Techniques, Coherent and Non Coherent Detection, Error performance for binary system, and Symbol error performance for M-ary systems, Principle of super heterodyne receiver, Random signals, Noise, Noise temperature and noise figure, Basic concepts of information theory, Error detection and correction, Digital modulation and demodulation, PCM, ASK, FSK, PSK, BPSK, QPSK and QAM, TDM, FDM, Multiple Access techniques, Data Communications, Modems, Codes,
	Review of Electromagnetic Theory, Transmission Lines and Waveguides, Impedance Matching and Tuning, Introduction to different microwave solid state devices; Introduction to strip lines, Microwave filters, amplifiers and oscillators, Review of Antenna Theory.'Electrostatics, Vector calculus, Gauss's Law, Laplace and Poisson's equations, Magnetostatics, Biot Savart's law, Ampere's law and electromagnetic induction, Maxwell's equations and wave equations, Plane wave propagation in free space, Dielectrics and conductors, Poynting theorem, Reflection and refraction, Polarization, Interference, Coherence and diffraction, Line equations, Impedance, Reflections and voltage standing wave ratio, Rectangular waveguides. Antennas, Half wave antenna, Antenna patterns, Radiation intensity, Gain, Effective area and Frii's free space receiver power equation, Phase and group velocity, Skin depth, Characteristic impedance, Impedance transformation. Dipole and monopole antennas, Microwave Sources and Devices, Radar, Frequencies and power used, Radar range equation. Radiation Hazards, Terahertz Communication Overview and Principles, Terahertz Sources & Receivers, Terahertz Optoelectronics.

	Basic control system components, Feedback principle, Transfer function, Block diagram representation, Signal flow graph, Transient and steady-state analysis of LTI systems, Frequency response, Routh-Hurwitz and Nyquist stability criteria, Bode and root-locus plots, Lag, lead and lag-lead compensation, State variable model and solution of state equation of LTI systems.
	Principles of Mobile Communication, Wireless Communication Standards, Characterization of the Wireless Channel, Receiver Techniques for Fading Dispersive Channels, Mobility Management in Wireless Networks, Mobile IP, Mobile Ad hoc Networks, Ad hoc Routing Protocols, Performance Analysis of DSR and CBRP, Cluster Techniques, Incremental Cluster Maintenance Scheme, Space-time Coding for Wireless Communication. Fundamentals of Internet of Things (IoT) for communication. Components of Mobile Communication systems, Operation of cellular system, Trucking Efficiency, Concept of Frequency reuse, Multipath propagation, Short term and Long term fading, Frequency selective fading, Signal Propagation Models, Co-Channel Interference, Techniques for reducing Co-Channel Interference, Diversity Techniques, Other Interferences-Adjacent Channel Interference, Near-End Far-End Interference, Cross talk, Interference between systems, Hand-off Techniques, Antennas. Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain-Beam forming, Diversity-Multiplexing trade-offs, Space-time Modulation and coding.
	Optical Fiber Communication and Optical sources, LED, spontaneous and stimulated emission, Semiconductor Lasers, Detectors, PIN photodiodes, Avalanche photodiodes (APD), Optical fibers, attenuation and dispersion characteristics, Bandwidth, Wavelength division multiplexing. Light propagation in optical fibers, Review of optical fiber Waveguiding concepts, Advanced fiber design, Dispersion issues. Dispersion shifted, Dispersion flattened, Dispersion compensating fibers, Design optimization of single mode fibers. Nonlinear effects in fiber optic links, Concept of self-phase modulation, group velocity dispersion, Transmitter design, Receiver - PIN and APD based designs, noise sensitivity and degradation, Receiver amplifier design, Transceivers for fiber optic communication pre-amplifier type- optical receiver performance calculation - noise effect on system performance receiver modules, Coherent, homodyne and heterodyne keying formats, BER in synchronous- and asynchronous- receivers, sensitivity degradation, system performance, Multichannel, WDM, multiple access networks, WDM Components, TDM, Subcarrier and Code division multiplexing. Semiconductor laser amplifiers, Raman - and Brillouin - fiber amplifiers, Erbium doped fiber amplifiers, pumping phenomenon, LAN and cascaded in-line amplifiers, Limitations, Post- and Pre-compensation techniques, Equalizing filters, fibre-based gratings, Broadband compression. Next Generation Optical Communications: Multi-core MMF based SDM transmission, Optical wireless communications.

Sample Questions

(1) The cut-off wavelength (in μm) of light that can be used for intrinsic excitation of a semiconductor material of bandgap Eg= 1.1 eV is__?

(a) 0.85
(b) 1.125
(c) 1.450
(d) 2.250

(2) If calls arrive at a telephone exchange such that the time of arrival of any call is independent of the time of arrival of earlier or future calls, the probability distribution function of the total number of calls in a fixed time interval will be____?

(a) Poisson
(b) Gaussian
(c) Exponential
(d) Gamma

(3) Which one of the following is not a guided medium of transmission?

(a) Fiber–Optic cable
(b) The atmosphere
(c) Coaxial cable
(d) Twisted-pair cable

(4) The even part of a signal x(t) is?

(a) x(t)+x(-t)
(b) x(t)-x(-t)
(c) (1/2)*(x(t)+x(-t))
(d) (1/2)*(x(t)-x(-t))