Syllabus for PhD Entrance Exam (Electronics and Communication Stream)

	Review of Electromagnetic Theory, Vector calculus, Gauss's Law, Laplace and Poisson's equations, Magnetostatics, Biot Savert'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.
	Analysis of microwave networks and components based on different parameters of two-port networks, Microwave linear beam and crossed field tubes, Introduction to different microwave solid state devices; Introduction to strip lines, Microwave filters, amplifiers, and oscillators, Microwave Sources and Devices, Reflex Klystron, Magnetron, TWT, Gunn diode, IMPATT diode, Crystal Detector and PIN diode, Radar, Block diagram of Radar, Frequencies and power used, Radar range equation, EMI-EMC definitions and Units of parameters, Sources and victim of EMI, Conducted and Radiated EMI Emission and Susceptibility, Transient EMI, ESD, Radiation Hazards, Terahertz Overview and Principles, Terahertz Sources & Receivers.
	Analysis and Design, Antennas, Retarded potential, and Hertzian dipole, Half wave antenna, Antenna patterns, Radiation intensity, Gain, Effective area and Frii's free space receiver power equation, Plane waves and properties, Reflection and refraction, Polarization, Phase and group velocity, Propagation through various media, Skin depth, Transmission lines equations, Characteristic impedance, Impedance transformation, S- parameters, Smith chart. Classification of EM problems, Analytical methods-separation of variables, Finite difference methods, and Variation methods.
	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 a binary system, and Symbol error performance for M-ary systems, Principle of the 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, 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 the cellular system,1G,2G,3G,4G and 5G, 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, Introduction to Satellite Communication, Transponders, Telemetry tracking command and Monitoring, Applications.
	Electrons and holes in an intrinsic semiconductor, Donor and acceptor impurities, charge densities in a semiconductor, Current components in diode, Zener diode and applications. Bipolar Junction Transistor, Current components in transistor, transistor construction, The transistor as an Amplifier, various configurations (CE, CB. CC) and characteristics
	Introduction signal and systems, Types, 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, Definition and properties, causality, stability, impulse response, convolution, poles and zeroes, Frequency response, Group delay, Phase delay, FIR filter, IIR Filter, 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, Fractional sampling rate alteration, Different Applications.

Sample Questions

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

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

Q. (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

Q. (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

Q. (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))

Q. (5) For an antenna radiating in free space, the electric field at a distance of 1 km is found to be 12mV/m. Given that intrinsic impedance of the free space is 120 ohm, the magnitude of average power density due to this antenna at a distance of 2 km fromthe antenna (in nW/m^2) is _____

(a) 50.7
(b) 48.7
(c) 45.7
(d) 47.7

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

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

Syllabus for PhD Entrance Exam (VLSI Stream)

Basic Semiconductor Physics and Devices:
p-n junction and metal-semiconductor junction: Zener diode, Diode circuits, BJT, MOSFETs and Advanced VLSI technology,
MEMS Sensors and Actuators: mechanics including elasticity, beam bending theory, membranes/plates. Materials for MEMS. Micro-sensors/actuators based on various principles, electrostatic, thermal, piezoresistive piezoelectric, magnetic, and its applications

BJT and MOSFET amplifiers:
biasing, ac coupling, small-signal analysis, frequency response. Current mirrors and differential amplifiers, Two stage Op-amp, Stability and Frequency compensation. Op-amp circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers, and oscillators.

CMOS Inverter:
Timing, switching, and power analysis

Combinational Circuits:
Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates, arithmetic circuits, code converters, multiplexers, decoders. complex gates, Pass Transistor logic, Transmission gate, Dynamic MOS design: pseudo NMOS logic, clocked CMOS (C2 MOS) logic, domino logic, NORA,

Logical Effort:
Logical Effort of Different Digital Circuit Design, Input capacitance, Logical and Electrical effort, parasitic delay.
Sequential MOS Logic and Memory Design: latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay. Static latches SRAM and DRAM.

Data converters:
sample and hold circuits, ADCs, and DACs.
Computer organization: Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

Model Questions:

1) A transistor is a …… operated device
a) current
b) voltage
c) both voltage and current
d) none of the above

2) Switching threshold voltage of an ideal CMOS inverter is defined as
a) Vth = VDD/3
b) Vth = VDD/2
c) Vth = VDD
d) Vth = VDD/4

3) Which design allows the reuse of the software and the hardware components?
a) Memory Design
b) Input design
c) Platform-based design
d) Peripheral design

4) Reverse recovery time affect the switching operation of
(a) BJT (b) FET
(b) MOSFET (d) All of the above

Syllabus for PhD Entrance Exam (Embedded Systems Stream)

Note: Part-A and Part-B would contain total questions in the ratio of 2:1

Part-A

Electronics circuits & systems:
Introduction to diodes, Current components in diode, Zener diode and applications. Half -wave and full -wave rectifiers & their analysis, comparison of bridge and center -tap rectifier, various types of RLC filters, clipping & clamping circuits; transistor configuration & amplifiers, oscillators & feedback principles;

Operational Amplifiers:
Inverting Configuration, Non inverting Configuration, Applications of Op Amps, Circuits. loop gain and Bandwidth, Large signal Operation of Op Amps, Practical operational Amplifier parameters; Phase locked loop(PLL): Block diagram, working and its various applications.

Operating systems:
Computer System Structures, Operating System Structures, Process, Deadlock, CPU Scheduling, Process Synchronization, Memory Management

Programming in C/Python/VHDL/Verilog:
C/Python: Variable and Data Types, Operators: arithmetic and logical, Conditional Statements: If, If- else, Nested if-else, Looping: For, While Control Statements: Break, Continue, Basic String Operations, Functions
VHDL/Verilog: Basics of VHDL/Verilog, modeling digital systems.

Data Structures & Algorithm:
Recursion, Arrays, Stacks, Queues and Linked lists, Sorting and searching; Complexity of algorithms, graph algorithms.

Digital System Design:
Number systems, Fixed point & floating-point representation, Boolean algebra, Combinational circuits design and applications, Sequential circuits design and applications, minimization of functions, minimization of FSM/sequential circuits; logic gates and their static CMOS implementations- CMOS inverter, delay, power; combinational & sequential MOS circuits & sub-systems.

Embedded Systems & IoT:
Difference between Microprocessor & Microcontroller, Classification based on architecture, Memory Classification, applications and purpose of embedded systems. Microprocessors and microcontrollers, RISC and CISC controllers, Big-endian and Little-endian processors, Programmable logic devices, COTS, embedded firmware, other system components, PCB and passive components. Memory organization, co-processors, programming of I/Os.

Internet of Things:
sensors and actuators, communication interface, Basic components, Architecture

Part-B

Artificial Intelligence & Machine Learning:
Knowledge representation, search techniques & dynamic programming; Supervised &

Unsupervised Machine Learning, Clustering: K-Means, Classification & Regression, Classifiers: SVM, KNN, Decision Tree etc.

Artificial Neural Network & Deep Learning:
Perceptron, Hyperparameter Tuning, Multi-layer Neural Network, Gradient Descent, Backpropagation, Convolutional Neural Network, RNN, LSTM, encoders/decoders, transformers.

Image Processing & Computer Vision:
Image processing- transforms, enhancement, image compression & coding, segmentation, texture analysis; Image Filters, Edge detection, Corner detection, histogram equalization, Image features, Feature Matching, Face detection, Object Detection, Image classification, Segmentation