Department of Electrical Engineering

Deep Learning for Computer Vision stream:

Linear Algebra, Probability & Random Variables: Matrix Algebra, Systems of linear equations, Eigen values and Eigen vectors; Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Normal and Binomial distribution, Correlation and Independence, Transformation of random variables.

Signals and Systems & Digital Signal Processing: Continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT: Definitions and properties of Laplace transform, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Deterministic & Random (a-periodic & Periodic) Signal transmission through LTI systems. FIR & IIR Filter design. Basics of Multi-rate signal processing.

[1] A. V. Oppenheim, R. W. Schafer and J. R. Buck, Discrete Signal Processing, Prentice-Hall Inc., 2009.
[2] A. V. Oppenheim and A. S. Willsky, Signals and Systems, Pearson Education, 2013.
[3] K. Hoffman and R. Kunze, Linear Algebra, Prentice-Hall Inc., 2005.
[4] R. Sheldon, A first course in probability. Pearson Education India, 2002.

Wireless Communication and Networking: (Syllabus for interview):

Linear Algebra, Probability & Random Variables: Matrix Algebra, Systems of linear equations, Eigen values and Eigen vectors;, Random variables, Discrete and continuous distributions, Normal and Binomial distribution, Correlation and Independence, Transformation of random variables, expectation and variance of random variables, Conditional probability and distributions, random processes.

Signals and Systems & Digital Signal Processing: Continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT: Definitions and properties of Laplace transform, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, frequency response, group delay, phase delay.

Communication Systems:
Basic analog and digital communication systems, Digital modulation techniques, basics of wireless communication

[1] A. V. Oppenheim, R. W. Schafer and J. R. Buck, Discrete Signal Processing, Prentice-Hall Inc., 2009.
[2] A. V. Oppenheim and A. S. Willsky, Signals and Systems, Pearson Education, 2013.
[3] Gilbert Strang, Linear Algebra and its applications, Cengage Learning India; 4th edition.
[4] R. Sheldon, A first course in probability. Pearson Education India, 2002.
[5] U. Madhow, Introduction to Communication Systems, Cambridge University Press, 2014.

For Semiconductor devices (Syllabus for the written exam):

Engineering Mathematics

Linear Algebra, Differential and Integral Calculus, Plotting functions, Finding Maxima & Minima

Networks, Signals and Systems Circuit analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Sinusoidal steady state analysis: phasors, complex power, maximum power transfer. Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform. Linear 2-port network parameters, wye-delta transformation. Continuous-time signals: Fourier series and Fourier transform. Laplace transform

Analog and Digital Electronics: Diode circuits: clipping, clamping, rectifiers; Amplifiers: biasing, small-signal equivalent circuit or incremental circuit, basic amplifier topologies, constant current biasing, frequency response; oscillators and feedback amplifiers; operational amplifiers: characteristics and applications; Active filters.

Digital logic, Combinatorial and sequential logic circuits, multiplexers, demultiplexers, Schmitt triggers, sample and hold circuits.

Semiconductor Devices: Crystals and Electronic grade materials; Formation of energy bands in solids; Concept of holes, Density of states and Fermi level; Intrinsic and extrinsic semiconductors; Equilibrium carrier concentration; Direct and indirect semiconductors; Recombination and generation of carriers, carrier transport; Drift and Diffusion; Equations of state; Continuity and Poisson equation; generation-recombination mechanism; pn junction; energy band diagram, static and dynamic characteristics; physics and characteristics of MOS capacitors; Energy band diagram of MOS capacitor; MOSFET-physics, characteristics and modelling; small-signal equivalent circuits of PN junction and MOSFET; light-matter interactions; photo detectors; solar cells.

Power Engineering & Smart Grids, Power Electronics & Drives:

Basic Engineering Mathematics: Linear Algebra, Differential and Integral Calculus, Plotting functions, Finding Maxima & Minima, Numerical methods (Gauss Seidel, Newton Raphson, Runge Kutta method, Trapezoidal rule of integration), Optimization Techniques.

Power Systems: Structure of power systems, three phase synchronous generators, transformers, induction machines, transmission line parameters, transmission line modeling for steady state operation, network modeling, power flow solution methods, symmetrical faults, symmetrical components, unsymmetrical faults, power system protection, economic operation of power system, power system stability and control, Basic knowledge on Smart Gids, Phasor Measurement Units

Control Systems: Mathematical modelling and representation of systems, Feedback principle, Transfer function, Block diagrams and Signal flow graphs, Transient and Steady -state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis in Time and Frequency domain, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space models, State transition matrix; Linear Systems, Eigen values/vectors, Basics of non-linear systems and Lyapunov stability Analysis.

Power Electronics and Drives: Basic circuit analysis, DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of uncontrolled rectifiers; Bidirectional ac to dc voltage source converters; Power factor and Distortion Factor of ac to dc converters; Single-phase and three-phase voltage and current source inverters, Modelling and control of power converters, Steady state analysis of electric machines.

Reference books:

1. J. J. Grainger, W. D. Stevenson, *Power system analysis*, McGraw-Hill
2. C. L. Wadhwa, *Electrical power systems*, New Age International,
3. H. Saadat, *Power system analysis*, Tata McGraw-Hill,
4. DP Kothari, IJ Nagrath, *Electric Machines*, McGrawHill
5. Norman S Nise, *Control Systems Engineering*, Wiley
6. Robert Erickson and Dragon Maksimovic, *Fundamentals of Power Electronics*

RF and Microwave:

Electromagnetic Theory: Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics,conductors- skin depth – Poynting vector – Plane wave reflection and refraction**.**Review of rectangular and circular metallic waveguides– TE and TM modes, guide wavelength, cut-off, mode excitation, re-entrant cavity, Microwave Resonators .Relation between field theory and circuit
theory – Applications.

Microwave Circuits : Transmission lines-concepts of characteristics impedance, reflection coefficient, standing and propagating waves, equivalent circuit.,Network analysis: Z, ABCD, Y, T, S-parameters.Smith chart, Impedance matching technique Power divider and combiner; Branch-line couple, parallel-coupled lines and directional couplers;

Antenna Theory and Design: 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; Radiation from Wires and Loops: Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.Fourier transform method in aperture antenna theory; Microstrip Antennas: Basic characteristics, feeding methods, Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes,.

Reference Books:

1. Balanis, C.A., “Antenna Theory and Design”, 3rd Ed., John Wiley & Sons, 2005.
2. Pozar, D.M., “Microwave Engineering”, 4th Ed., John Wiley & Sons. 2011.
3. Balanis, C.A., “Advanced Engineering Electromagnetics,” 2nd Edition, John Wiley & Sons, 2012
4. Collin, R. E., “Foundations for Microwave Engineering,” Wiley-IEEE Press, 2001
5. Harrington, R.F., “Time-Harmonic Electromagnetic Fields,”Wiley-IEEE Press, 2001