भारतीय प्रौद्योगिकी संस्थान तिरुपति
INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
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Syllabus for M.S.(R) & Ph.D. Written test/ Interview – January 2026 semester

Department of Electrical Engineering - Advanced Antenna Systems and Base Station, RF and Microwave Components, Metamaterials and RF Sensing

M.S.(R):

Electromagnetics: Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector. Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth. Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart. Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

Reference Books:

1. Sadiku M N and Kulkarni S V, "Elements of Electromagnetics", 5th Edition, Oxford (2015).
2. Ulaby F T, Fundamentals of Applied Electromagnetics, 5th Edition, Prentice-Hall (2014).
3. Cheng D K, Field and Wave Electromagnetics, 2nd Edition, Pearson (2014).
4. Hayt W H, Buck J A, Engineering Electromagnetics, 5th Edition, McGraw Hill (2018).

Ph.D.:

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.

RF & mm wave Integrated Circuit Design: Fundamentals of RF circuits and systems, Passive and active components for CMOS RFIC: Review of MOSFET, RF transistor layout, CMOS process, Capacitors, Varactors, Resistors, Inductors, Transformers, Transmission lines, Low Noise Amplifiers, Power Amplifiers, Mixers, and oscillators.

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. Robert E. Collin, “Foundations for Microwave Engineering”, 2nd Ed., WileyIEEE Press, 2001
4. Balanis, C.A, Advanced Engineering Electromagnetics, 2nd Edition, John Wiley& Sons, 2012.
5. B. Razavi, "RF Microelectronics", 2nd Ed., Pearson, 2012.
6. Thomas H. Lee, "The design of CMOS radio-frequency integrated circuits", 2ndEd., Cambridge University Press, 2004.