Curriculum for M.Tech

Electronics & Communication Engineering with Specialization in RF and Microwave Engineering

From The Academic Year 2025

(Approved in Senate 61)

Indian Institute of Information Technology Design and Manufacturing, Kancheepuram

Chennai-600 127

Semester 1					
Category	**Course Name**	**L**	**T**	**P**	**C**
PCC	Advanced Microwave Engineering	3	1	0	4
PCC	Advanced EMFT	3	1	0	4
PCC	Advanced Microwave Engineering Practice	0	0	4	2
PEC	Program Elective Course 1	3	1	0	4
PEC	Programme Elective Course 2	3	1	0	4
PEC	Programme Elective Course 3	3	1	0	4
					22
Semester 2					
Category	**Course Name**	**L**	**T**	**P**	**C**
PCC	Antenna Theory and Design	3	1	0	4
PCC	RF System Design	3	1	0	4
PCC	Advanced RF-CAD and Circuits Practice	0	0	4	2
PEC	Programme Elective Course 4	3	1	0	4
PEC	Programme Elective Course 5	3	1	0	4
PEC	Programme Elective Course 6	3	1	0	4
					22
Summer					
PCD	M Tech Dissertation (MTD) Phase I	0	0	8	4
					4
Semester 3					
Category	**Course Name**	**L**	**T**	**P**	**C**
PCD	M Tech Dissertation (MTD) Phase II	0	0	24	12
					12
Semester 4					
Category	**Course Name**	**L**	**T**	**P**	**C**
PCD	M Tech Dissertation (MTD) Phase III	0	0	28	14
	Total				**14**

Semester wise Credit Distribution	**Credits**						
Category	**S1**	**S2**	**Summer**	**S3**	**S4**	**Total**	**%**
Program Core Course (PCC)	10	10	0	0	0	20	27.0
Program Elective Course (PEC)	12	12	0	0	0	24	32.4
Professional Career Development (PCD)	0	0	4	12	14	30	40.5
Total	22	22	4	12	14	74	100
Cumulative Credits	**22**	**44**	**48**	**60**	**74**	**74**	

<table>
<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">Advanced Microwave Engineering</td></tr>
<tr><td rowspan="2">Dept./Faculty proposing the course</td><td rowspan="2">ECE</td><td rowspan="2">Structure (LTPC)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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<tr><td rowspan="2">To be offered for</td><td rowspan="2">M.Tech: ECE(RFM)</td><td>Type</td><td colspan="2">Core ☐</td><td colspan="2">Elective ☐</td></tr>
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<tr><td>Pre-requisite</td><td></td><td colspan="2">Submitted for approval</td><td colspan="3">Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">• To introduce the students to the field theory and circuit theory concepts in the analysis and design of microwave guiding structures and passive components.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">At the end of the course, the students are expected to:
Understand the design principles of various passive microwave circuits
Design microwave circuits like Impedance transformers, power dividers, couplers, filters and resonators.</td></tr>
<tr><td>Contents of the course (With approximate break-up of hours for L/T/P)</td><td colspan="6">Transmission Lines and Waveguides: Review of TEM, TE, and TM mode solutions of Maxwell's equations; TEM mode transmission lines: lossless line, line with small losses, power flow in a terminated line; Quasi-TEM mode lines: Fields in microstriplines and striplines, losses in microstrips, microstrip discontinuities, coupled lines, slot lines and coplanar waveguides; Surface waveguides: Surface waves along an impedance plane, dielectric-coated conducting plane, slab waveguide, corrugated plane; Wave velocities. (6L+2T)
Microwave Circuit Theory Principles: Equivalent voltages and currents; Z, Y, S, and ABCD parameters; Equivalent circuit representation of microwave junctions; Scattering parameter analysis of microwave junctions; Coupling of waveguides through probes, loops, and apertures. (8L+3T)
Impedance Transformers: Review of single-, double- and triple-stub tuners, waveguide reactive elements, quarter-wave transformers, design of maximally flat and Chebyshev transformers; Introduction to tapered transmission lines. (9L+3T)
Power Dividers and Couplers: Scattering matrix of 3- and 4-port junctions; Design of T-junction and Wilkinson power dividers; Design of 90□ and 180□ hybrids. (7L+3T)
Filters: Analysis of periodic structures, Floquet's theorem, filter design by insertion loss method, maximally flat and Chebyshev designs.(7L+2T)
Resonators: Principles of microwave resonators, loaded, unloaded and external Q, open and shorted TEM lines as resonators, microstrip resonators, dielectric resonators. (5L+1T)</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Pozar, D.M., "Microwave Engineering", 4th Ed., Wiley, (2012), ISBN:9780470631553, 0470631554
2. Collin, R.E., "Foundations for Microwave Engineering", 2nd Ed., Wiley India Pvt. Ltd (2007), ISBN: 9788126515288, 8126515287.</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. Reinhold Ludwig, RF circuit design, 2nd edition, Prentice Hall 2014, ISBN:978-0131471375.
2. Michael Steer, Fundamentals of Microwave and RF Design, 3rd edition, The University of North Carolina Press, 2019, ISBN: 978-1-4696-5688-5.</td></tr>
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<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">Advanced EMFT</td></tr>
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<tr><td>Pre-requisite</td><td></td><td colspan="2">Submitted for approval</td><td colspan="3">Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">• To introduce the students to analytical techniques used in solving electromagnetic field theory problems.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">Upon completion of the course, the students can
• Comprehensive understanding of various electromagnetic analysis.
• Gain proficiency in analysis of various microwave structures like waveguides
• Solve analytically various electromagnetic problems.</td></tr>
<tr><td>Contents of the course (With approximate break-up of hours for L/T/P)</td><td colspan="6">Electromagnetic waves: Coordinate systems; Maxwell's equations for time-varying fields and boundary conditions; Poynting vector; Wave equation; Wave polarization; Wave propagation in perfect and lossy dielectrics; Reflection of waves on a material boundary; Wave functions. (9L+3T)
Fundamental Theorems and Concepts: Electric and magnetic current sources; Duality; Image theory; Equivalence principle; Babinet's principle; Induction theorem; Reciprocity theorem; Auxiliary potentials; Construction of general solutions from wave functions; Radiation fields. (6L+3T)
Plane Wave Functions: Elementary wave functions in rectangular coordinates; TE, TM, and hybrid modes in rectangular waveguides; Partially filled waveguides; Rectangular cavity; Modal expansion of fields in a waveguide; Apertures in conducting screens. (7L+2T)
Cylindrical Wave Functions: Elementary wave functions in cylindrical coordinates; Homogeneously filled and partially filled circular waveguides; Radial waveguides; Cylindrical cavities; Sources of cylindrical waves. (7L+2T)
Spherical Wave Functions: Elementary wave functions in spherical coordinates; Spherical resonator; Sources of spherical waves. (7L+2T)
Wave Propagation in Anisotropic Media: Plane wave propagation in anisotropic and uniaxial crystals; TEM wave propagation in Ferrites; Faraday rotation. (6L+2T)</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Balanis, C.A., "Advanced Engineering Electromagnetics", 2nd Ed., Wiley, (2012), ISBN:9780470589489, 0470589485.
2. Harrington, R.F., "Time-harmonic Electromagnetic Fields", Wiley-IEEE Press (2001), ISBN: 978-0471208068</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. Ramo, S., Whinnery, J.R., and Van Duzer, T., "Fields and Waves in Communication Electronics", 3rd Ed., John Wiley &Sons (1994), ISBN: 978-0471585510.
2. Collin, R.E., "Foundations for Microwave Engineering", 2nd Ed., John Wiley &Sons (2000), ISBN: 978-0780360310</td></tr>
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<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">Advanced Microwave Engineering Practice</td></tr>
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<tr><td>Pre-requisite</td><td></td><td colspan="2">Submitted for approval</td><td colspan="3">Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">• To learn about the microwave test bench, waveguide components and various microwave measurements</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">• Learn how to use microwave test bench and other microwave components
• Learn how to handle microwave measuring equipment like Vector Network Analyzer, Anechoic Chamber, etc.</td></tr>
<tr><td>Contents of the course (With approximate break-up of hours for L/T/P)</td><td colspan="6">1. To measure frequency of a microwave source and demonstrate relationship among guide dimensions, free space wavelength and guided wavelength.
2. To study isolation & coupling coefficient of E-plane Tee, H-plane Tee and Magic Tee.
3. To study coupling, directivity and isolation of a Directional coupler.
4. To measure attenuation of a fixed and variable attenuator.
5. To measure isolation and insertion loss of a three-port circulator and isolator.
6. To measure SWR and reflection coefficient in a microwave transmission line.
7. To measure impedance of an unknown load.
8. Measurement of Qs of a cavity resonator.
9. To determine the dielectric constant of a material.
10. To study the phase shifter.
11. Study and measurement of transmission line characteristics.
12. Study of Spectrum Analyzer / Vector Network Analyzer.</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Pozar, D.M., “Microwave Engineering”, 4th Ed., Wiley, (2012), ISBN:9780470631553, 0470631554
2. Collin, R.E., “Foundations for Microwave Engineering”, 2 nd Ed., Wiley India Pvt. Ltd (2007), ISBN: 9788126515288, 8126515287.</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. Edwards, T.C. and Steer M.B., “Foundations for Interconnects and Microstrip Design”, 3rd Ed., John Wiley & Sons (2000), ISBN: 978-8126545759.
2. Ludwig, R. and Bretchko, P., “RF Circuit Design”, 2nd Ed., Pearson Education (2009), ISBN: 978-0131471375.</td></tr>
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<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">Antenna Theory & Design</td></tr>
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<tr><td>Pre-requisite</td><td></td><td colspan="2">Submitted for approval</td><td colspan="3">Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">• To provide an in-depth understanding of modern antenna concepts, practical antenna design for various applications, and perform the design of antennas.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">After the completion of this course students can
• Understand the various design aspects and performance parameters of antennas.
• Understand the working principle and analysis of conventional antennas, such as wired antennas, Aperture Antennas, Horn Antennas and microstrip antennas.
• Design the various antennas as per the target specifications.
• Understand design techniques involved in the development of array antennas.
• Understand the working principle and analysis of advanced antennas like MIMO antennas and smart antennas</td></tr>
<tr><td>Contents of the course (With approximate break-up of hours for L/T/P)</td><td colspan="6">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. (7L+3T)
Radiation from Wires and Loops: Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop. (5L+2T)
Aperture Antennas: Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Fourier transform method in aperture antenna theory. (7L+2T)
Horn and Reflector Antennas: Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas. (5L+1T)
Microstrip Antennas: Basic characteristics, feeding methods, methods of analysis, design of rectangular and circular patch antennas. (4L+1T)
Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, synthesis of antenna arrays using Schelkunoff polynomial method, Fourier transform method, and Woodward-Lawson method. (7L+3T)
MIMO Antennas: MIMO Antennas: Spatial diversity, spatial multiplexing, two-port and multi-port antennas, MIMO parameters, isolation enhancement techniques. (7L+2T)</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Balanis, C.A., "Antenna Theory: Analysis and Design", 4th Ed., Wiley (2015), ISBN:9781119178996, 1119178991
2. Stutzman, W.L. and Thiele, H.A., "Antenna Theory and Design", 3rd Ed., John Wiley & Sons (2012), ISBN: 9780470576649.</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. Garg, R., Bhartia, P., Bahl, I. and Ittipiboon, A., "Microstrip Antenna Design Handbook". Artech House (2001), ISBN: 9780890065136.
2. Mohammad S. Sharawi, Printed MIMO Antenna Engineering, Artech House (2014), ISBN: 9781608076819.
3. Jordan, E.C. and Balmain, K.G., "Electromagnetic Waves and Radiation Systems", 2nd Ed., Prentice-Hall of India (1993)
4. Elliot, R.S., "Antenna Theory and Design", Revised edition, Wiley - IEEE Press (2003).
5. A R Harish, M. Sachidananda "Antennas and Wave Propagation", Oxford University Press, 2007, ISBN:9781628708455, 162870845X</td></tr>
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<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">RF System Design</td></tr>
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<tr><td>Pre-requisite</td><td></td><td colspan="2">Submitted for approval</td><td colspan="3">Senate 62</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">• To provide a cohesive overview of the fundamental concepts required for the design and analysis of RF stages of a modern wireless system and perform RF circuit design.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">After the completion of this course students can
• Understand various RF front end modules in the modern wireless systems and design specifications of the various RF systems to support modern wireless systems.
• Understand the design principles of active RF circuits like power amplifier, LNA, Mixers, Switches and Oscillators.</td></tr>
<tr><td>Contents of the course (With approximate break-up of hours for L/T/P)</td><td colspan="6">Introduction to Wireless Systems: Classification of wireless systems; Design and performance issues: Choice of operating frequency, multiple access and duplexing, circuit switching versus packet switching, propagation, radiated power and safety; Cellular telephone systems and standards. (4L+1T)
Noise in RF integrated Systems: Basic threshold detection, noise temperature and noise figure, noise figure of a lossy transmission line; Noise figure of cascade systems: Noise figure of passive networks, two-port networks, Noise in Active components: CMOS/ BiCMOS. Distortion in Receiver Design: Linearity, Intermodulation, Dynamic Range, Sensitivity of the receiver, Spurious Free Dynamic Range (SFDR). (4 L+ 1T)
Receiver Architecture such as heterodyne, homodyne, Hartley, Weaver, advanced receiver architecture etc.,Active Device: Comparison of active devices such as BJT, MOSFET, MESFET, HEMT, and HBT; Circuit models for FETs and BJTs; Basic parameters of active devices such as ft/fmax, transconductance, capacitance, resistance, etc.Passive Components and Impedance Matching: On-chip Inductor, capacitor, resistor, resonant circuit and its application in RF IC. Various impedance matching techniques. (8L+3T)
Amplifier Design: Transistor Theory, Transistor S-parameters, gain & Stability, Unilateral and bilateral design, low noise amplifier (LNA Design), Various LNA topologies: CS/CE stage with inductive load, CS/CE stage with resistive feedbac, CG/CB topologies, noise cancellation techniques, differential LNA, Broad band amplifier design, Biasing in RF & microwave circuits (8L+3T)
Mixers: Mixer characteristics: Image frequency, conversion loss, noise figure; Devices for mixers: p-n junctions, Schottky barrier diode, FETs; Diode mixers: Small-signal characteristics of diode, single-ended mixer, large-signal model, switching model; FET Mixers: Single-ended mixer, other FET mixers; Balanced mixers; Image reject mixers.(6L+2T)
Switches: Devices for microwave switches: PIN diode, BJT, FET; Device models; Types of switches; Switch configurations; Basic theory of switches; Multi-port, broad-band and isolation switches. (4L+2T)
Oscillators and Frequency Synthesizers: General analysis of RF oscillators, transistor oscillators, voltage-controlled oscillators, dielectric resonator oscillators, frequency synthesis methods, analysis of first and second order phase-locked loop, oscillator noise and its effect on receiver performance. (8L+2T)</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Pozar, D.M. “Microwave and RF Design of Wireless Systems”, John Wiley & Sons. (2001), ISBN: 978-0471322825.
2. Gonzalez, G., “Microwave Transistor Amplifiers: Analysis and Design”, 2nd Ed., Pearson Education Taiwan(2008), ISBN: 9789861546940, 9861546944 .</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. Michael Steer, “Microwave and RF Design: A Systems Approach”, SciTech Publications, 2013, ISBN: 9781613530214, 1613530218
2. Behzad Razavi, “RF Microelectronics”, 2nd Ed., Prentice Hall (2011), ISBN: 978-0137134731.
3. Rohde, U.L. and Newkirk, D.P., “RF/Microwave Circuit Design for Wireless Applications”, John Wiley & Sons, 2012, ISBN:9780470901816, 0470901810
4. Chang, K., Bahl, I. and Nair, V., “RF and Microwave Circuit and Component Design for Wireless Systems”, Wiley Interscience (2002), ISBN: 978-0471197737
5. Larson, L.E., “RF and Microwave Circuit Design for Wireless Applications”, Artech House (1996), ISBN-978-0890068182.
6. Egan, W. F., “Practical RF Circuit Design”, Wiley -IEEE Press (2004), ISBN: 978-0471654087.</td></tr>
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<tr><td>Course Code</td><td></td><td>Course Title</td><td colspan="4">Advanced RF-CAD and Circuits Practice</td></tr>
<tr><td rowspan="2">Dept./Faculty proposing the course</td><td rowspan="2">ECE</td><td rowspan="2">Structure (LTPC)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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<tr><td>Learning Objectives</td><td colspan="6">• To introduce the basic topics of RF-CAD design using commercial software packages and design the RF components like Antennas, Frequency Selective Surfaces, Microwave Absorbers, Quasi-Optical Launcher Systems, Non-Linear Tapers, MIMO Antennas, Mirror Systems</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">After the completion of this course students can
• Use RF CAD software to model various RF Components
• Design RF components like Antennas, Frequency Selective Surfaces, Microwave Absorbers, Quasi-Optical Launcher Systems, Non-Linear Tapers, MIMO Antennas, Mirror Systems.</td></tr>
<tr><td>Contents of the course
(With approximate break-up of hours for L/T/P)</td><td colspan="6">1. Introduction to the software: HFSS, CST, and ADS/AWR.
2. Design and analysis of microstrip line, strip-line, and coplanar waveguide using HFSS and AWR.
3. Design of rectangular and circular waveguides using HFSS/CST.
4. Design of quarter wave transformer using AWR and HFSS.
5. Design of single and double stub matching using AWR and HFSS.
6. Design of Wilkinson power divider using AWR and HFSS.
7. Design of attenuator and directional coupler using AWR and HFSS.
8. Design of filter using insertion loss method.
9. Design of frequency-selective surface using HFSS and CST.
10. Design of Metamaterial Absorber using HFSS and CST.
11. Measurement of antenna parameters using network analyzer and anechoic chamber.
12. To study the waveguide launcher system using LOT/SURF3D</td></tr>
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