

## 3/4 B.Tech - FIFTH SEMESTER

EC5T2

Transmission Lines and Waveguides

Credits: 3

Lecture: 3 periods/week

Internal assessment: 30 marks

Tutorial: 1 period /week

Semester end examination: 70 marks

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**Prerequisites:** Electromagnetic Fields and Waves (EC4T4)

### Course Objectives:

- To understand the basic transmission modes of EM waves
- To learn the usage of smith chart to solve various transmission line problems
- To study the characteristics of EM wave propagation in rectangular, circular and cavity resonators

### Course Outcomes:

Student will be able to

- Understand the propagation characteristics of EM waves in transmission lines and waveguides.
- Analyze and design various transmission line components and circuits.
- Compute various transmission line parameters using Smith chart

### UNIT – I

**Basics of Transmission Lines:** Concept and definition, Different kinds of transmission lines, Applications, Equivalent circuit, Primary constants- R, L, C and G, Secondary constants – Propagation constant and Characteristic Impedance, General transmission line equations. Attenuation and phase constant. Wavelength, phase velocity and group velocity. Time domain transmission line equations. The lossless transmission line, The infinite long transmission line, The distortion less transmission line and condition for distortionlessness and minimum attenuation, The low resistance transmission line. Loading, Types of loading, Losses.

### UNIT-II

**Finite Transmission Lines:** The load reflection coefficient, Standing Wave Ratio, Line impedance, Generalized reflection coefficient, The lossless terminated transmission line, The lossless matched transmission line, The lossless shorted transmission line, The lossless open transmission line, The lossless resistively loaded transmission line. Power relations on a general transmission line.

### UNIT-III

**UHF Lines:** UHF lines as circuit elements:  $\lambda/4$ ,  $\lambda/2$ ,  $\lambda/8$  lines, **Smith Chart:** Construction of smith chart, Smith chart as impedance chart, smith chart as admittance chart, Problems using smith chart. Impedance matching- Single stub with applications, Quarter wave transformer.

## UNIT-IV

**Guided waves:** Review of Maxwell's equations for time varying and time-harmonic fields, Wave equations and boundary conditions.

**Rectangular Waveguides:** Transverse Electric (TE) and Transverse Magnetic (TM) mode analysis – Field expressions, Characteristic equation, Cut-off frequency, Phase velocity, Group velocity, Attenuation and Phase constants, Wavelength and Impedance. Filter characteristics, Dominant and degenerate modes, Mode dispersion, Power transmission and Power loss expressions.

## UNIT-V

**Circular Waveguides:** Transverse Electric (TE) and Transverse Magnetic (TM) mode analysis – Field Expressions, Characteristic equation, Cut-off frequency, Phase velocity, Group velocity, Phase constant, Wavelength and Impedance.

**Cavity Resonators:** Rectangular and Cylindrical cavities, Dominant modes and Resonant Frequencies, Q factor, Types of coupling and Coupling coefficients.

Introduction to strip lines and microstrip lines

### Learning Resources

#### Text Books:

1. Engineering Electromagnetics, Nathan Ida, Springer International, 2nd Edition 2008.
2. Electromagnetic Waves and Radiating Systems, E.C. Jordan and K.G. Balmain, PHI, 2nd Edition, 2009

#### References:

1. Microwave Devices and Circuits – Samuel Y. Liao, Pearson Education, 3rd Edition, 2003.
2. Foundations for Microwave Engineering – R.E. Collins, Wiley student Edition, 2nd Edition, 2007.
3. Microwave Engineering- David M Pozar, Wiley student Edition, 3rd Edition, 2007.
4. Annapurna Das, Sisir K Das, “Microwave Engineering”, 2nd edition, 2006, Tata McGraw Hill.

#### Web Resources:

1. <http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/em/index.htm>
2. <http://nptel.iitm.ac.in/video.php?subjectId=117101056>
3. <http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Transmission%20Lines%20and%20EM%20Waves/TOC.htm>
4. <http://www.mike-willis.com/Tutorial/PF2.htm>