

BPE609	Electromagnetic waves	3L:0T:0P	3 credits
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Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Analyse transmission lines and estimate voltage and current at any point in transmission line for different load conditions.
- Provide solution to real life plane wave problems for various boundary conditions.
- Analyse the field equations for the wave propagation in special cases such as lossy and low loss dielectric media.
- Visualize TE and TM mode patterns of field distributions in a rectangular wave-guide.
- Understand and analyse radiation by antennas.

Module 1: Transmission Lines (6 hours)

Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module 2: Maxwell's Equations (6 hours)

Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction, Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.

Module 3: Uniform Plane Wave (7 hours)

Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting

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Effective from session 2020-21

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medium, Phase velocity of a wave, Power flow and Poynting vector.

### Module 4: Plane Waves at Media Interface (7 hours)

Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

### Module 5: Waveguides (7 hours)

Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic(TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode. Analysis of waveguide-general approach, Rectangular waveguides.

### Module 6: Antennas (7 hours)

Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

### Text/Reference Books

1. R. K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill, 2005.
2. D. K. Cheng, "Field and Wave Electromagnetics", Addison-Wesley, 1989.
3. M. N.O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 2007.
4. C. A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.
5. C. A. Balanis, "Antenna Theory: Analysis and Design", John Wiley & Sons, 2005.