Selective Course for Junior Year's Students of Electrical Engineering

Transmission Line Theory and Practice

Lecture 1: Brief Introduction

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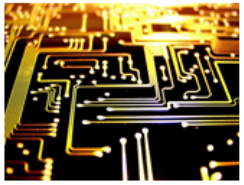
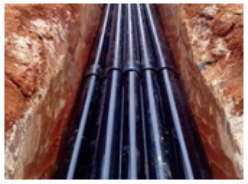
Objective of the course

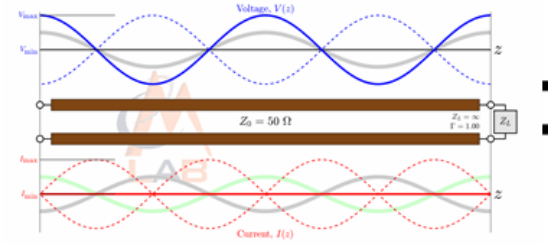
- Based on the fundamental knowledge of ***Electromagnetic fields (or Electrodynamics)*** and ***Circuit theory***, this course is aimed at
  - mastering the basic theory of transmission lines(TLs)
  - setting up TL models in both time and frequency domain
  - establishing the connection between theory and practice
- Improving the ability of students to analyze and solve problems involving ***transmission lines*** in the field of ***electronics*** and ***power industry***.

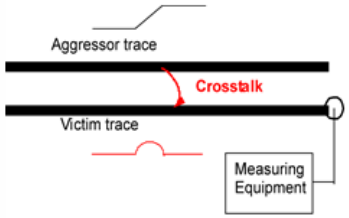




Objective of the course

- In addition to the theoretical contents, there will be several ***demonstrative experiments*** related to transmission line theory, such as wave propagation, crosstalk, mitigation measures, etc.

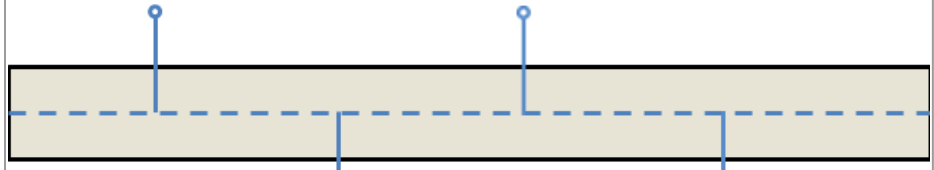




Ref: http://emlab.utep.edu/

1 Teachers and TAs

3 Theoretical Content



2 Textbooks

4 Practice

雨课堂 Rain Classroom

Teachers

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TAs

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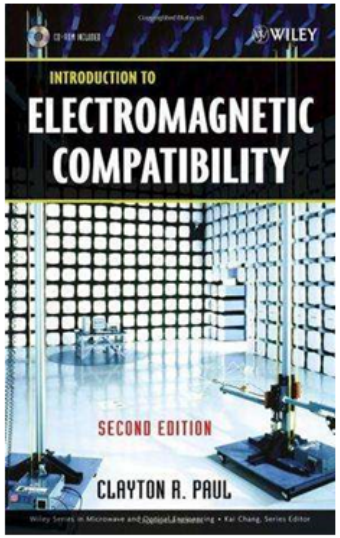
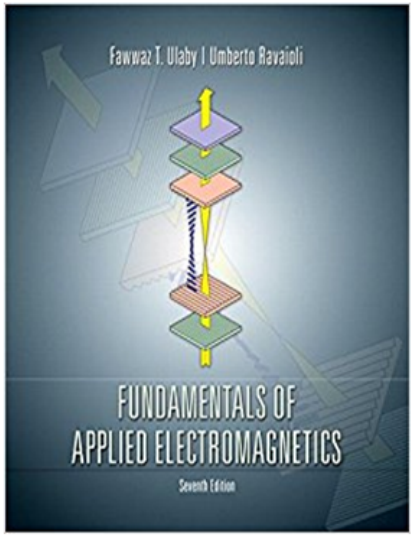
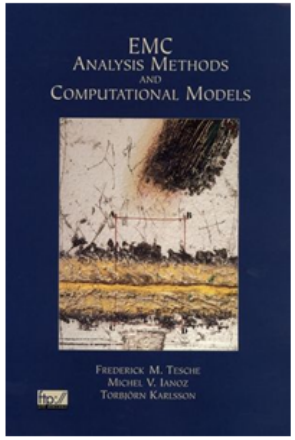
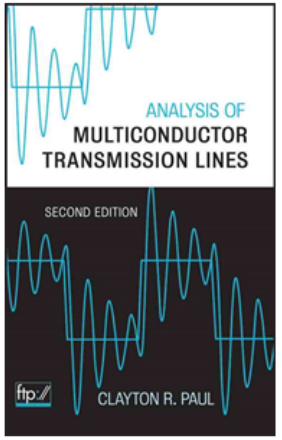
Textbooks

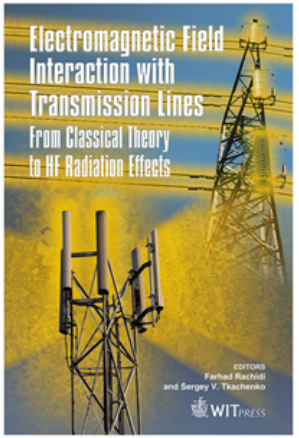


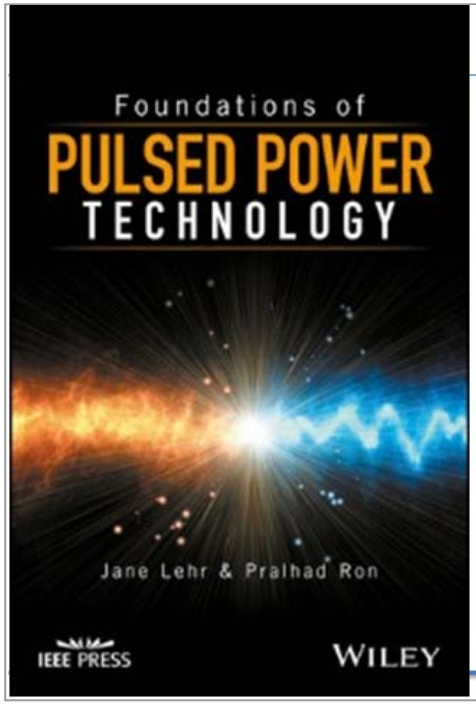


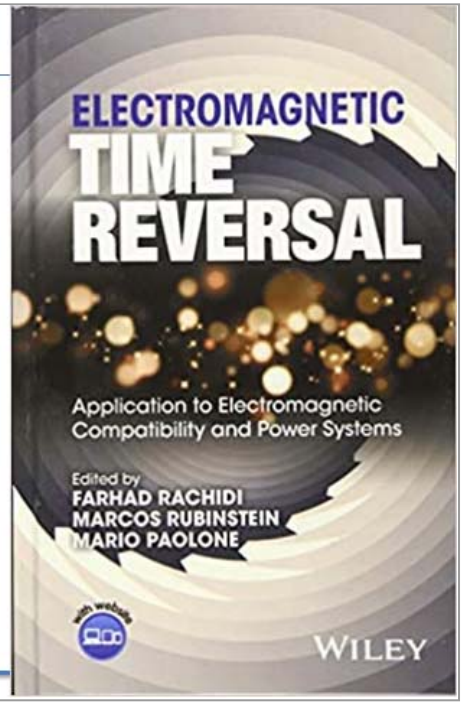
Textbooks











Textbooks

1. C. R. Paul, *Introduction to Electromagnetic Compatibility*[M]. , 2nd Ed., Wiley & Sons Inc., 2006, ISBN-13: 978-0-471-75500-5 Electronic version available at: http://www3.interscience.wiley.com/cgibin/bookhome/110527724
2. Fawwaz T. Ulaby. *Fundamentals of applied electromagnetics.* Prentice hall inc. Seventh Edition.
3. Tesche F M, Ianoz M, Karlsson T. *EMC analysis methods and computational models*[M]. John Wiley & Sons, 1997.
4. Paul C R. *Analysis of multiconductor transmission lines*[M]. John Wiley & Sons, 2008.
5. Rachidi F, Tkachenko S. *Electromagnetic field interaction with transmission lines: from classical theory to HF radiation effects[M]. WIT Press, 2008.*
6. *Foundations of Pulsed Power Technology, Jane Lehr, Pralhad Ron, ISBN: 978-1-118-62839-3 July 2017 Wiley-IEEE Press*

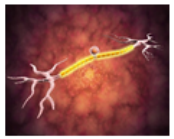
Assignments and grading

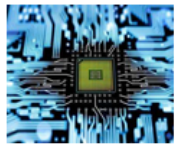
Final score

1. **Attendance: 20%**
2. **Regular Assignments (around 3 times): 30%**
3. **Final examination (open-book examination): 50%**

Scope of the course: the notion of TL

The notion of ***transmission lines (in general sense)*** may encompass all structures and media that serve to transfer energy or information between two points.





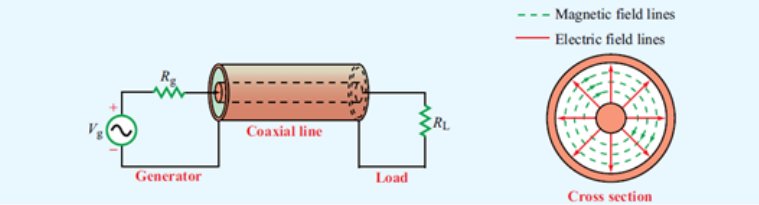
- Nerve fibers in the human body;
- Fluids and solids that support the propagation of mechanical pressure waves;
- Wires that transmit the electrical energy; Energy!
- *Transmission lines (in narrow sense)* that guide *electromagnetic signals*. Information!

Such TLs include ***telephone wires***, ***coaxial cables*** carrying audio and video information to TV sets or digital data to computer monitors, ***microstrips*** printed on microwave circuit boards, and ***optical fibers*** carrying light waves for the transmission of data at very high rates, etc.

Scope of the course: TEM Mode

Transverse electromagnetic (TEM) mode waves on transmission lines:

- Waves propagating along these lines are characterized by electric and magnetic fields that are entirely ***transverse*** to the direction of propagation. Such an orthogonal configuration is called a ***TEM mode***.



- The electric field is in the radial direction between the inner and outer conductors, while the magnetic field circles the inner conductor, and neither has a component along the line axis (the direction of wave propagation).

Scope of the course: Higher-Order Mode

Higher-Order (non-TEM) mode waves on Transmission Lines:

(g) Rectangular waveguide (h) Optical fiber

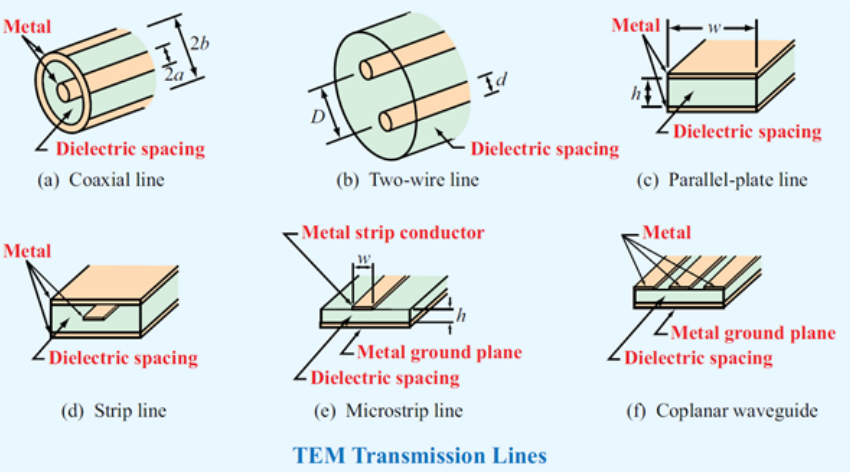
Higher-Order Transmission Lines

These lines have at least ***one significant field component*** in the direction of propagation.

- Hollow conducting waveguides;
- Dielectric rods;
- Optical fibers belong to this class of lines.

Fawwaz T. Ulaby. *Fundamentals of applied electromagnetics*. Prentice hall inc. Seventh Edition.

Scope of the course: Examples of TL

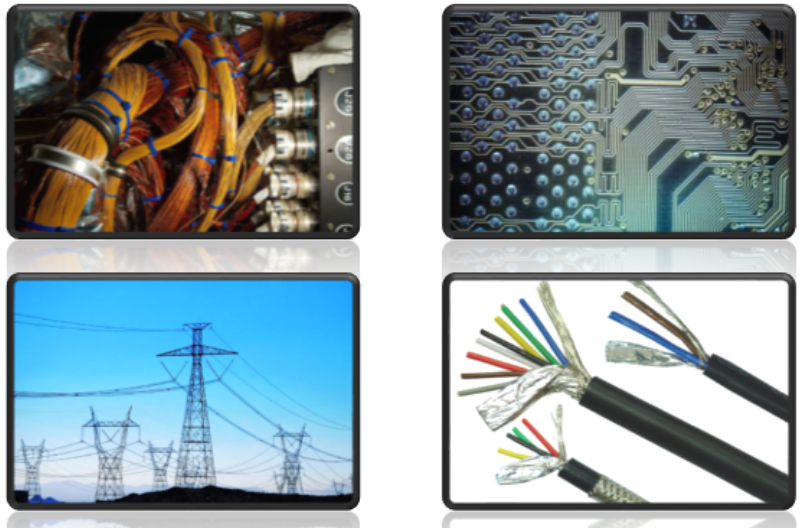


TEM Transmission Lines

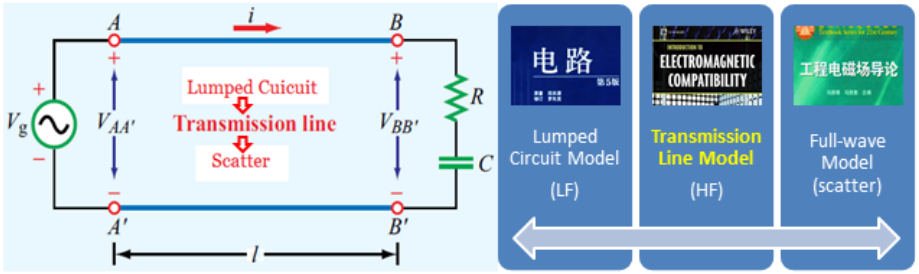
A common feature among TEM lines is that they consist of two parallel conducting surfaces. **Only TEM mode transmission lines are investigated in this course.**

Fawwaz T. Ulaby. *Fundamentals of applied electromagnetics*. Prentice hall inc. Seventh Edition.

Scope of the course: Examples of TL

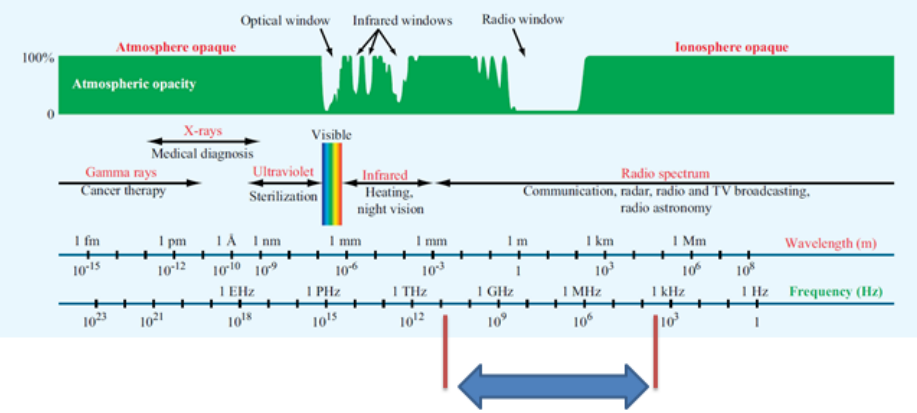


Scope of the course: A bridge between Circuit and EM field



- ***Transmission lines*** may play a **bridge** between ***circuit theory*** and ***electromagnetic theory***.
- By modeling transmission lines in the form of equivalent circuits, we can use ***KVL and KCL*** to develop ***wave equations*** whose solutions provide an understanding of wave propagation, standing waves, and power transfer.
- Vice-versa.

Scope of the course: Electromagnetic Waves



Suggested Syllabi

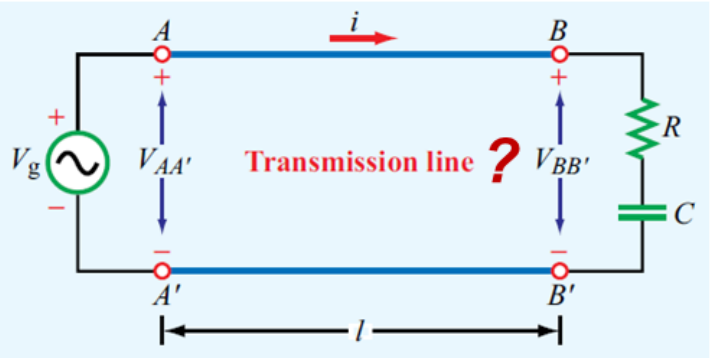
Chapter	Content
1	Introduction
2	Basic theory of two-conductor transmission lines
3	Distributed transmission line models and exact solutions
4	Time-domain analysis of transmission lines
5	Frequency-domain analysis of multi-conductor lines
6	Electromagnetic field interaction with transmission lines
7	***Practice***

Final Objectives

- Basic concepts of TL theory
- Under what sets of circumstances TL theory can be valid?
- Wave propagation and reflections
- Responses excited by lumped source or incoming field
- Crosstalk and interference mitigation measures
- MTL equations in time domain and frequency domain
- ……

Example

Under what set of circumstances should we explicitly treat the pair of wires as a transmission line?



Thank you !