Major topics covered

REVIEW OF ECED4301 ELECTROMAGNETIC WAVES AND PROPAGATION

Major Topics

- This course: introduction of basic concepts and applications of electromagnetic waves and propagation as well as transmission line theory

Maxwell's Equations

Plane Waves

Transmission Line Theory

Maxwell's Equations (1/2)

- Governing equations for behaviors of electromagnetic fields.
- Foundation for electrical and electronic engineering
- Circuit theory and others are simplified models of Maxwell's equations
- Lecture Notes; topics
- Chapter 9 of the textbook; examples, review questions and problems
- Assignments/tutorials/in-class examples

Time-domain Maxwell's Equations: differential and integral forms

Time varying: electric and magnetic fields are coupled: propagation

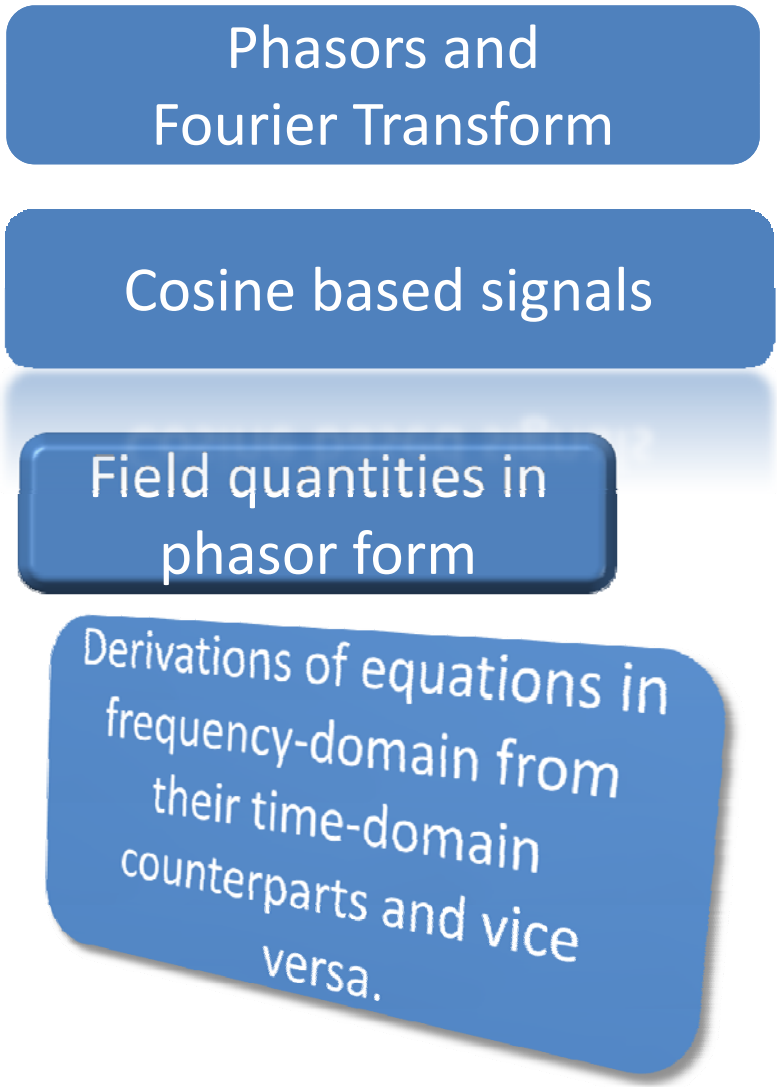
Boundary conditions: Maxwell's equations at the boundary or interface

Electromagnetic Induction: electric power generation

Magnetic vector potential and electric potential: wave equations; retarded or delayed waves

Maxwell's Equations (2/2)

- Maxwell's equations in vector phasor form or frequency domain
- Conversion between vector phasors and instantaneous expressions
- Electromagnetic spectrum
- Lecture notes; topics.
- Chapter 9 of the textbook; examples, review questions and problems
- Assignments/tutorials/in-class examples



Plane Waves (1/2)

- A special case of electromagnetic propagation
- Concepts and ideas applicable to realistic situations
- Lecture notes; topics.
- Chapter 10 of the textbook; examples, review questions and problems
- Assignments/tutorials/in-class examples

- Vector field quantities: no variation on a plane perpendicular to the propagation direction.
- Electric, magnetic fields and propagation direction: mutually perpendicular to each other.
- Forward wave and backward wave.
- Doppler shift.
- Phase velocity; group velocity; wavelength; wave impedance.
- Polarization
- Lossy media: complex permittivity

Plane Waves (2/2)

- Normal incidence
- Oblique incidence
- Normal incidence as the special case of oblique incidence
- Poynting vector: applicable to both plane and non-plane wave cases
- Average power density and field quantities in phasor forms
- Lecture notes; topics.
- Chapter 10 of the textbook; examples, review questions and problems
- Assignments/in-class examples and tutorials

- Incidence, reflection and transmission.
- Oblique incidence: Snell's Law for both lossless and lossy media; critical angle;
- Parallel polarization: reflection and transmission coefficients; Brewster's angles
- Perpendicular polarization: reflection and transmission coefficients; Brewster's angle.
- Poynting vector: surface power density and flowing direction

Transmission Lines (1/2)

- **Function: to guide electromagnetic waves to propagate effectively from one spatial point to another point.**
- **Two conducting structures with substrate in between.**
- **Matching networks to transform impedance to the desired values**

- TL theory: line or device dimension larger than 5% or 10% of wavelength; Incidence, reflection and transmission.
- Solutions for voltages and currents: Forward and backward voltage and current waves.
- R,L,G,C parameters.
- Characteristic impedance; propagation constant; attenuation and phase shift constants.
- Reflection coefficient and impedance: change with locations
- Standing waves: VSWR; voltage/current maximum/minimum; impedance maximum and minimum.
- Short-end and open-end TL: inductor or capacitor

Transmission Lines (2/2)

- **Lecture notes; topics.**
- **Chapter 11 of the text except Sections 11.7, 11.8; examples, review questions and problems**
- **Assignments/in-class examples/tutorials**

- Smith Chart: graphical solutions of transmission problems: normalized impedance; const.-$|\Gamma|$ circle; const.-r circle; cont.-x circle; const.-g circle; const.-b circle; electrical length; angle; wavelength towards generators; wavelength towards load; impedance Smith Chart v.s. admittance Smith Chart; locations of voltage/current maxima, voltage/current minima and pure resistances; VSWR;
- Impedance or admittance matching networks: lossless; intersections of two circles: normally two solutions;
- Other matching networks: e.g. quarter-wavelength transformer; open/short-ended lines.

Final Exam and Final Grade (1/1)

Mark 1 = highest of (i) 40% Midterm + 60% Final (ii) 100% Final

Mark 2 = 85% Mark 1 + 15% Assignments when Mark 1>=40%

Final grade = highest of Mark 1 and Mark 2

Don’t forget to bring a ruler, a compass and a pencil to your final examination!

Your own Smith Charts have to be initialized before you use them

Good Luck!