Circuits II

Topics covered:
• Fundamental analysis techniques for LTI circuits
  – Phasor Modeling
  – Laplace Transform
  – Fourier Series/Transform
• Components and circuits
  – Magnetically coupled circuits
  – Polyphase systems

Prerequisite topics: (ECE201)
• Circuit analysis
  – KVL, KCL, nodal/mesh analysis, superposition, ...
• Components and circuits
  – RLC circuits, op-amps
• Math (through Calc 2 & DE)

Contact Information

• Instructor: Daniel Costinett
  • Office: MK504
  • OH: T 2:30-4:00, W 3:30-5:00, by appointment
  • E-mail: Daniel.Costinett@utk.edu
  • Please use [ECE 202] in the subject line
  • Email questions will be answered within 24 hours (excluding weekends)
Textbook and Materials

Textbook
  - ISBN: 0073545511
  - required
• Course covers Chapters 10-17

Course Website
• [http://web.eecs.utk.edu/~dcostine/ECE202](http://web.eecs.utk.edu/~dcostine/ECE202)

Software
• MATLAB
• LTSpice

Course Website
Grading

- **Homework: 20%**
  - Weekly, due on Fridays *before* the start of lecture
  - The one lowest homework grade will be dropped
- **Quizzes: 10%**
  - In-class, open-book, open-note & calculator
- **Labs: 15%**
  - Completed outside of class (by scheduling with TA)
- **Midterms: 30%**
- **Final: 25%**
  - All open-book, open-note & calculator

Assignments

- **Submission**
  - Homeworks and Labs should be submitted by uploading a pdf to canvas
    - Physical copy submitted prior to the due date/time loses 5% credit
    - [https://libanswers.utk.edu/faq/103187](https://libanswers.utk.edu/faq/103187)
Course Policy

• No late work will be accepted except in cases of documented medical emergency
• Collaboration encouraged on Labs and Homework
  – Must submit your own work on all assignments
  – Adhere to Student Code of Conduct
• Attendance is required in all lectures and scheduled lab time

How to Succeed in ECE202

• Attend all lectures
• Read associated sections in the book, as listed on the course schedule
• Work collaboratively to understand homework assignments
  – Complete your own work
  – Review any incorrect answers
• Actively participate in lab sessions
• Review material in advance of quizzes and tests
• Ask questions in lecture / office hours / e-mail after having made an attempt at the material on your own
INTRODUCTION TO ECE202

End of ECE201

\[ L \frac{d^2 i}{dt^2} + R \frac{di}{dt} + \frac{1}{C} i = 0 \]

\[ v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t} \]

\[ s_1, s_2 = -\frac{R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}} \]
Example Application: Wireless Power Transfer

Wireless Power Transfer (WPT)

 transmitter coil
(Tx coil)

 sinusoidal voltage supply

 Commercial

 Samsung
 Fast charging wireless stand 2018
 And wireless charger duo
Wireless Power Transfer (WPT)

\[ \Phi = kN i_x \]

\[ V_{ax} = N \left( -\frac{d\Phi}{dx} \right) \]

\[ V_{ax} = N i_x \frac{d^2 i_x}{dx^2} \]

\[ i_x \]

Wireless Power Transfer (WPT)
Wireless Power Transfer (WPT)
Wireless Power Transfer (WPT)

WPT System Design

Example design:

- Phone has 5Ah battery @ 4V → Need a 5Ah, 20W supply to charge a phone in 1 hour

Say:

\[ i_{tx} = I_{pk} \sin(\omega t) \]

\[ \omega = 2\pi \times 100kHz \]

\[ L = 100\mu H \]

\[ n_{tx} = L \frac{di_{tx}}{dt} = L I_{pk} \omega \cos(\omega t) \]

\[ = 150\pi \cos(\omega t) \]

\[ \geq 471 \cos(\omega t) \]

\[ \downarrow \]

471V is way too high for this!
WPT System Design

Add a series capacitor:

\[ V_{tx} = V_C + L \frac{di_w}{dt} = \frac{1}{C_r} \int_0^t i_{tx} dt + L \frac{di_w}{dt} \]

\[ = \frac{I_{pl}}{wC_r} (-\cos(wt)) + \omega L I_{pl} \cos(wt) \]

\[ V_{tx} = I_{pl} (\omega L - \frac{1}{wC_r}) \cos(wt) \]

one option: set \( \omega L = \frac{1}{wC_r} \rightarrow \omega = \frac{1}{\sqrt{LC_r}} \)

\[ C_r = 11.25 \mu F \]

Receiver Side

4 DEs

too much math?
A Slightly More Complicated System

Course Content

• Magnetically Coupled Circuits (Ch 13)
• Sinusoidal Steady-State Analysis (Ch 10)
• AC Circuit Power Analysis (Ch 11)
• Circuit An Analysis in the s-Domain (Ch 14)
• Frequency Response (Ch 15)
• Two-Port Networks (Ch 16)
• Fourier Circuit Analysis (Ch 17)
• Polyphase Circuits (Ch 12)