Contact Information

- **Instructor:** Daniel Costinett

  - Office: MK504

  - OH: **W 4:00-5:00 & R 12:30-2:00**, 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)

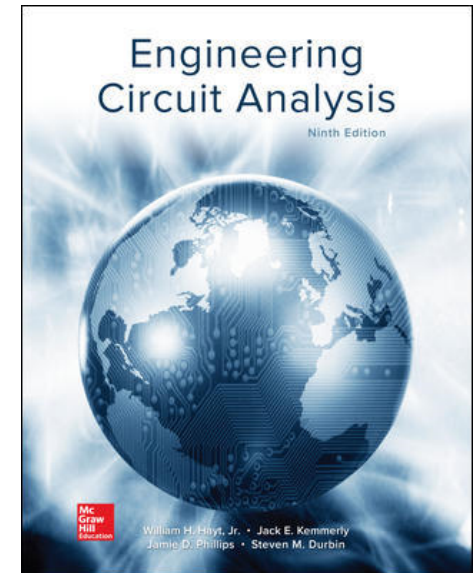# Textbook and Materials

Textbook

- Hayt, Kemmerly, Phillips, and Durbin, *Engineering Circuit Analysis* 9th Edition
  - ISBN: 0073545511
  - required
- Course covers Chapters 10-17

Course Website

- 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
- **Midterms (2): 30%**
- **Final: 25%**
  - All exams open-book, open-note & calculator

Assignments

- Submission
  - Homeworks and Labs should be submitted by uploading a **single pdf** to canvas
    - Physical copy submitted prior to the due date/time loses 5% credit
    - https://www.eecs.utk.edu/resources/it/eecs-it-knowledge-base/using-the-scanner/
    - https://libanswers.utk.edu/faq/103187
    - https://acrobat.adobe.com/us/en/mobile/scanner-app.html : app for Android and iOS

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

Fall 2021: UTK Coronavirus Precautions

utk.edu/coronavirus/guides/requirement-to-wear-face-coverings

- The university is closely following the state of Tennessee's legal challenge to President Biden's Executive Order 14042. The executive order applies to federal contractors, including UT Knoxville, and includes a masking requirement.

- On November 30, 2021, a federal district judge granted the states of Tennessee, Ohio, and Kentucky a preliminary injunction that—for now—prohibits the federal government from enforcing the executive order on federal contractors in those states.

- With the preliminary injunction in place, the university must comply with Tennessee law, which prohibits state institutions like UT Knoxville from requiring the use of masks.

- Faculty, staff, and students are **strongly encouraged to wear masks** in academic and administrative spaces to protect others from the spread of COVID-19.

- The university has **free masks available** including KN95 masks, which are available to campus community members who individually request them.

- Any individual can choose to wear a mask anywhere on campus, even when it is not required.

- The best way to be protected from serious illness is to **get vaccinated and boosted when eligible**. Vaccines are safe, free, effective, and easily available on campus. The CDC has noted that when infections occur among vaccinated people, they tend to be mild.

How to Succeed in ECE202

- Attend all lectures
- Read associated sections in the book, as listed on the course schedule
- Work collaboratively (in person or through Slack, etc.) to understand homework assignments
  - Complete your own work
  - Self-assess solution process
  - 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

ECE 201 Review

- KCL, KVL, Series/Parallel Circuits (Chapter 3)

- Nodal and Mesh Analysis (Chapter 4)

- Linearity/Superposition, Source Transform (Chapter 5)

- Ideal Op-amps (Chapter 6)

- Capacitors and Inductors (Chapter 7)

- RLC Circuits, Resonance, Damping (Chapter 8-9)

  - Differential Equations approach

End of ECE201

$-$ v_C $+$

Series
RLC
circuit

R C L v_L

KVL/KCL
element
eqs
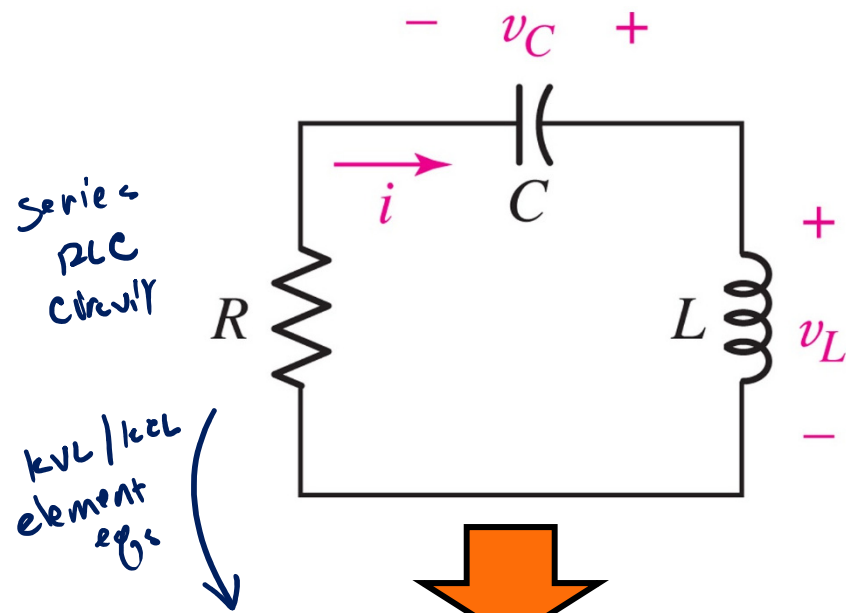
(1) Is this circuit useful?

(2) More complex circuits?
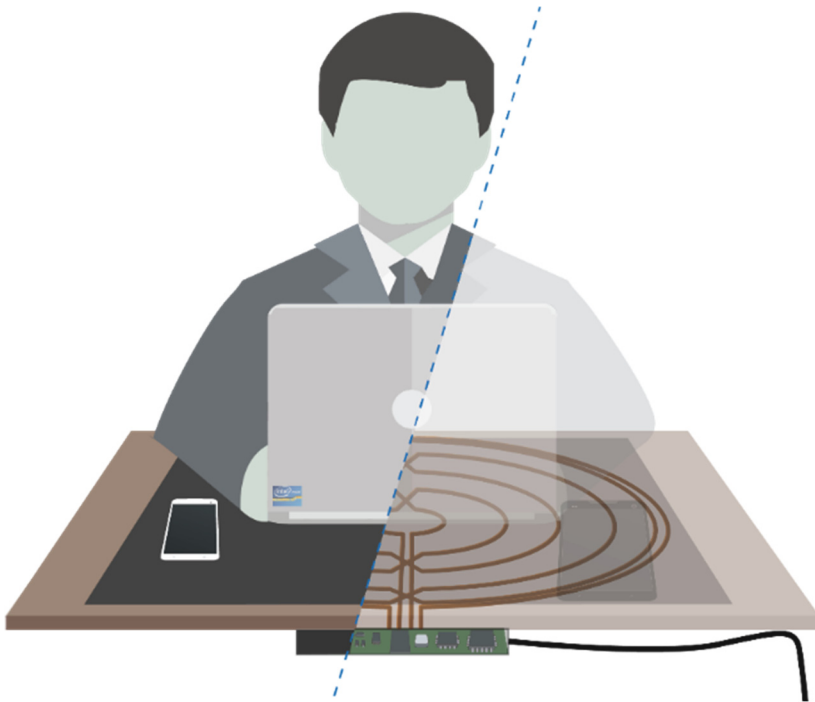
$$L\frac{d^2 i}{dt^2} + R\frac{di}{dt} + \frac{1}{C}i = 0$$

solve
using
DE

$$v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

$$s_1, s_2 = -\frac{R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$$

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Example Application: Wireless Power Transfer

Commercial

Research

Samsung
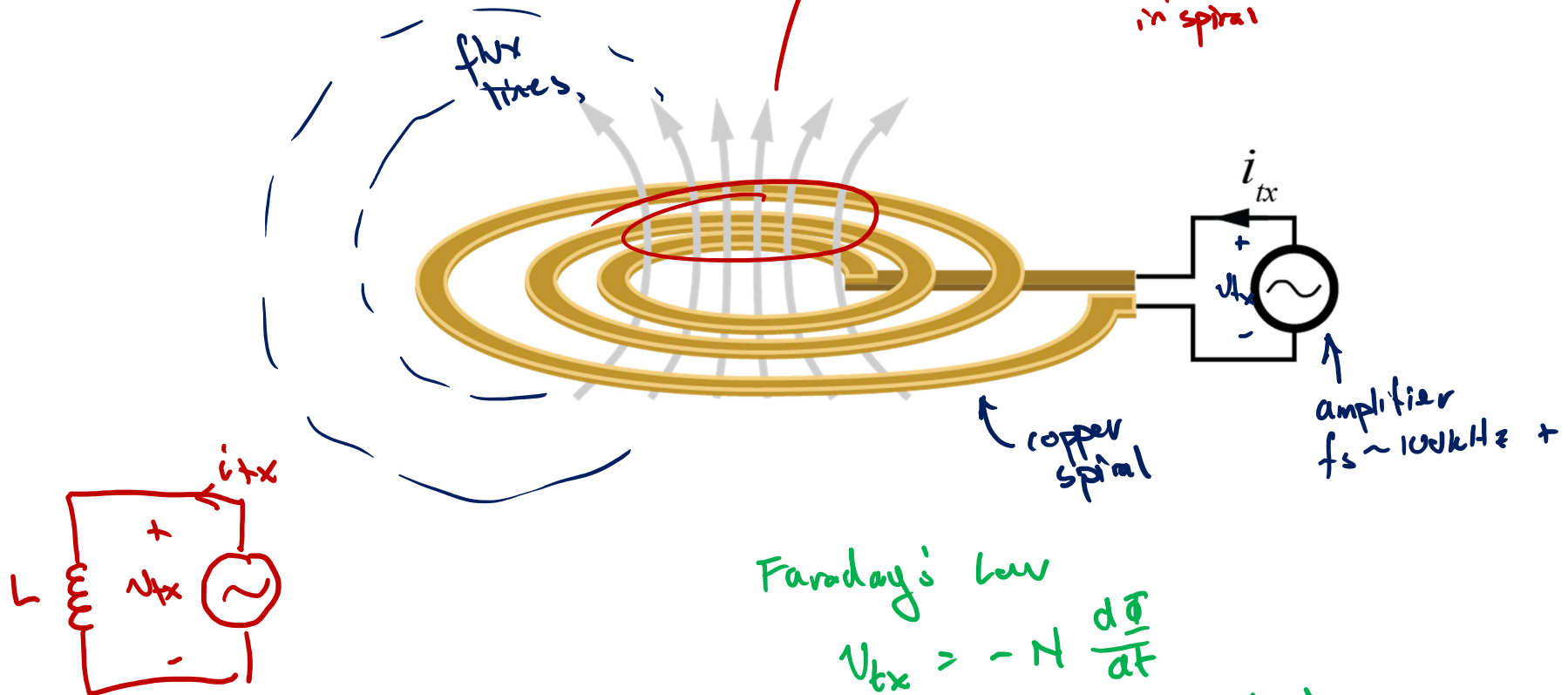Fast charging wireless stand 2018
And wireless charger duo

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Wireless Power Transfer (WPT)

Ampere's law

geometric/materials coefficient

$$\text{flux } \Phi = N \, \alpha \, i_{tx}$$

H of turns in spiral

flux lines,

copper spiral

i_{tx}

amplifier $f_s \sim 100kHz +$

Faraday's Law

$$v_{tx} = -N \frac{d\Phi}{dt}$$

$$v_{tx} = -N \frac{d}{dt} \left(N \alpha \, i_{tx} \right)$$

$$v_{tx} = -N^2 \alpha \frac{d \, i_{tx}}{dt}$$

$$\underbrace{\qquad}_{L}$$

$$V = L \frac{di}{dt}$$

Wireless Power Transfer (WPT)

separately
(case)
(table)

Wireless Power Transfer (WPT)

$$\emptyset \leq \underline{\Phi}_r \leq \underline{\Phi} \quad (\text{transmitter})$$

v_{rx}

→ to battery charger
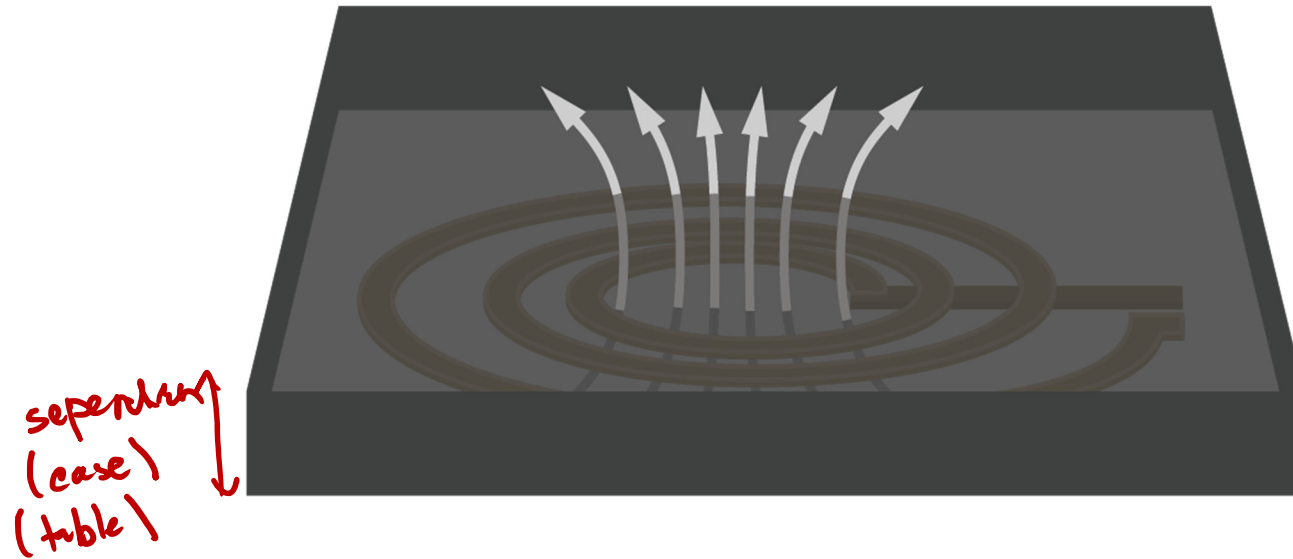
$$v_{rx} = -N \frac{d\Phi_r}{dt}$$
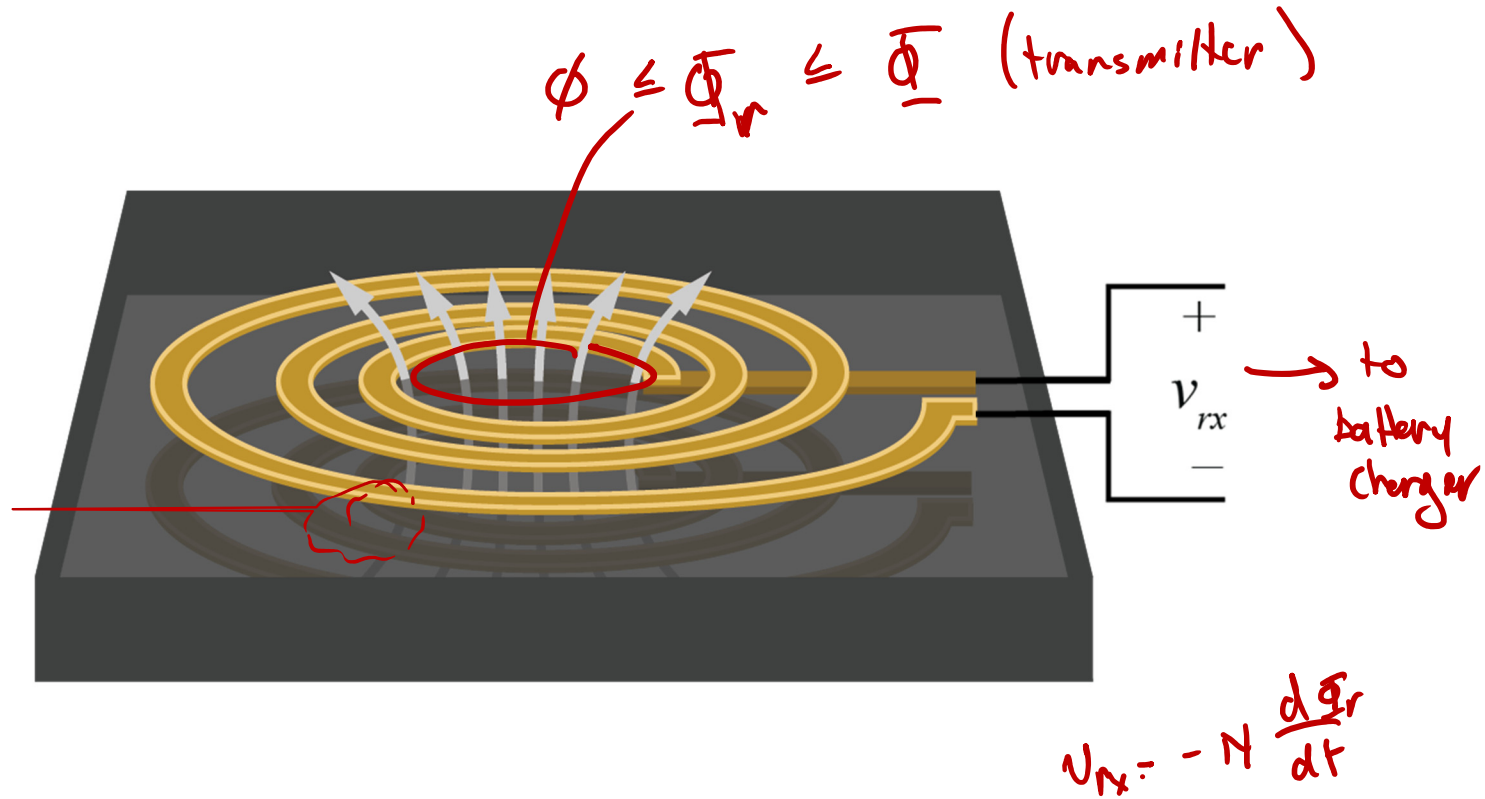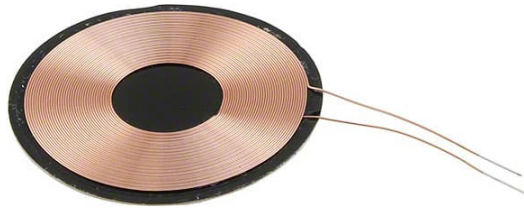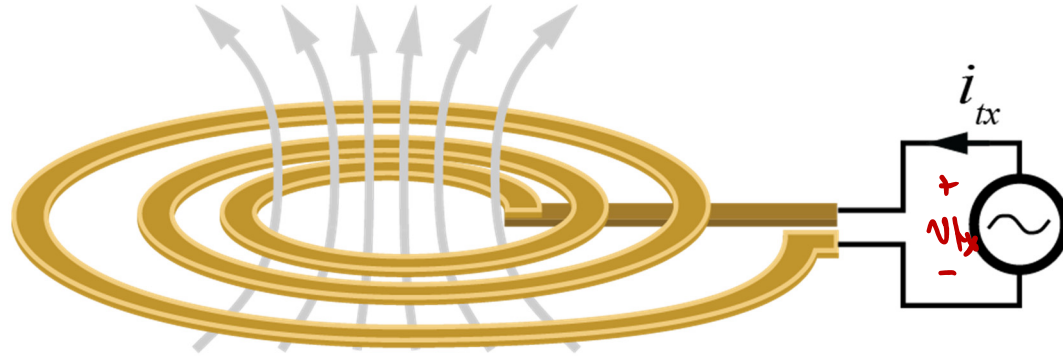
WPT System Design

Example Coil
TDK Part Number: WR282840-37K2-LR3
3 x 3 cm, 37 turns, L = 46 µH, f_s = 100 kHz

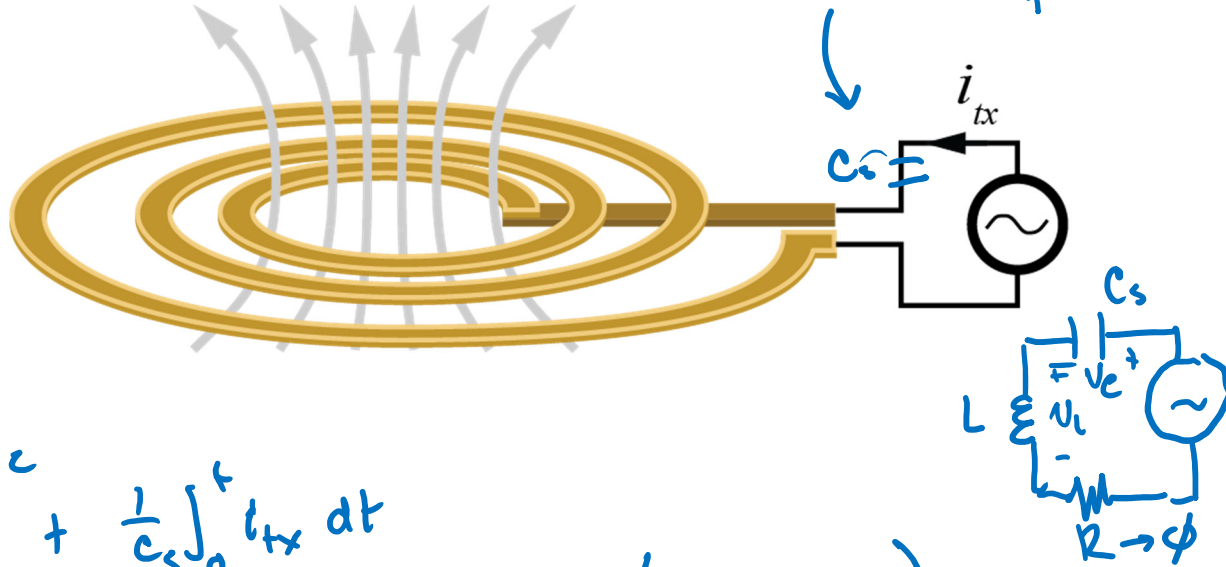Let's say $i_{tx} = I_A \sin(\omega_s t)$ ω / $I_A = 5A$ $\quad$ $\omega_s = 2\pi f_s$

$$v_{tx} = L \frac{di_{tx}}{dt} = L \frac{d}{dt} I_A \sin(\omega_s t) = \underbrace{L I_A \omega_s} \cos(\omega_s t)$$

$$\approx \left(144V\right) \cos(\omega_s t)$$

yikes!

WPT System Design

Add series capacitor

Again
$i_{tx} = I_A \sin(\omega_s t)$

$v_{tx} = v_L + v_c$

$= L \dfrac{di_{tx}}{dt} + \dfrac{1}{c_s} \displaystyle\int_0^t i_{tx}\, dt$

$= L I_A \omega_s \cos(\omega_s t) + \dfrac{1}{c_s} \dfrac{1}{\omega_s} I_A \left(-\cos(\omega_s t)\right)$

$v_{tx} = \left[L\omega_s - \dfrac{1}{c_s \omega_s} \right] I_A \cos(\omega_s t)$

ex: set v_{tx} to near zero

$L_s \omega_s = \dfrac{1}{c_s \omega_s} \longrightarrow \boxed{\omega_s = \dfrac{1}{\sqrt{L_s c_s}}}$
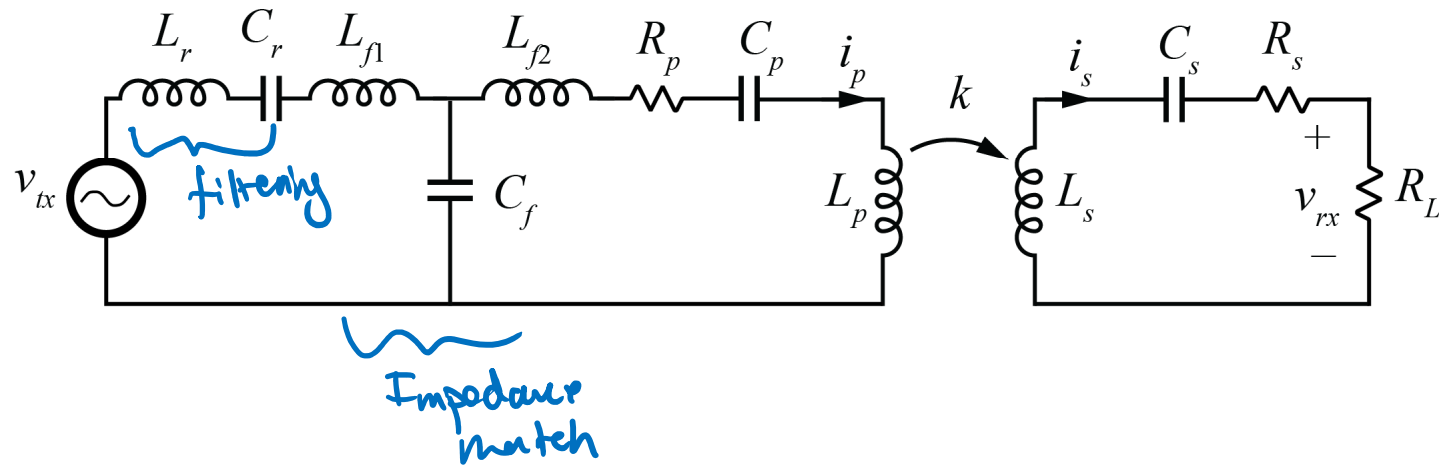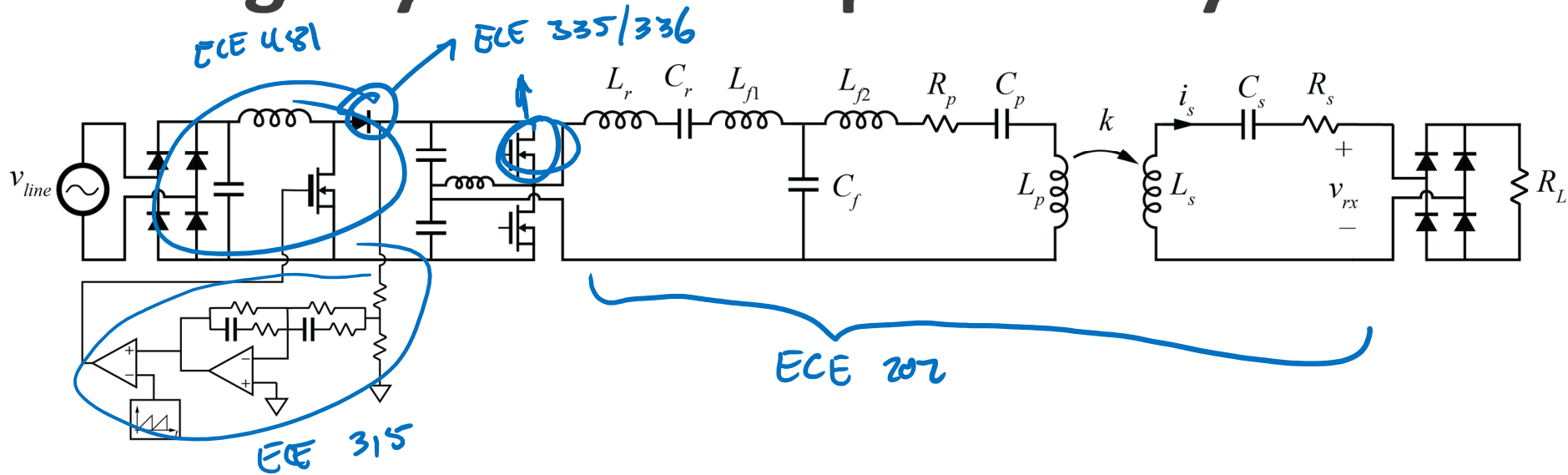
Receiver Side
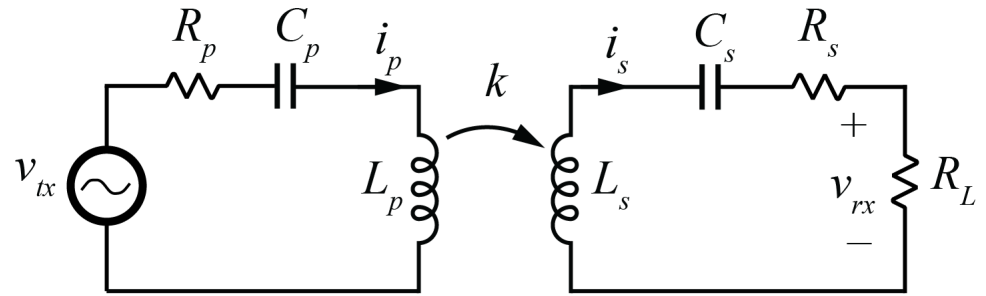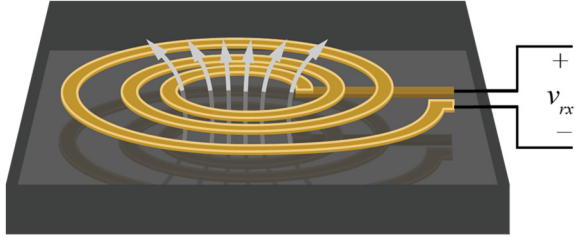
coupled inductors
(ch 13)

4 DEs or 4th order DE

A Slightly More Complicated System

A Slightly More Complicated System

Course Content

- Magnetically Coupled Circuits (Ch 13)
- Sinusoidal Steady-State Analysis (Ch 10)
- AC Circuit Power Analysis (Ch 11)
- Fourier Circuit Analysis (Ch 17)
- Circuit Analysis in the s-Domain (Ch 14)
- Frequency Response (Ch 15)
- Two-Port Networks (Ch 16)
- ~~Polyphase Circuits (Ch 12)~~ [ECE 325]

Transform-Based Solutions