We strongly recommend that you read about a topic before it is covered in lectures.

<table>
<thead>
<tr>
<th>Lecture Date</th>
<th>Topics Covered</th>
<th>Reading from Giancoli</th>
</tr>
</thead>
<tbody>
<tr>
<td>#23 Mon 4/8</td>
<td>Review Exam 2.</td>
<td></td>
</tr>
<tr>
<td>Wed 4/10</td>
<td>Exam 2 covering assignments 4, 5 &amp; 6, and all material covered in the reading assignments and in lectures through Mon 4/1 (last names A-K in 26-100, L-Z in Walker)</td>
<td></td>
</tr>
<tr>
<td>#24 Fri 4/12</td>
<td>Transformers - Car Coils</td>
<td>Sect. 26-4, 26-5 &amp; 29-6</td>
</tr>
<tr>
<td></td>
<td>RC Circuits</td>
<td></td>
</tr>
<tr>
<td>#25 Wed 4/17</td>
<td>Driven LRC circuits - Resonance</td>
<td>Chapter 31 through Sect. 31-6</td>
</tr>
<tr>
<td></td>
<td>Metal Detectors (beach/airport)</td>
<td>Lecture Supplement</td>
</tr>
</tbody>
</table>

Due before 4 PM, Wednesday, April 17 in 4–339B.

Problem 7.1
Ideal transformer.
Giancoli 29-42.

Problem 7.2
A transformer for impedance matching.
The generator in the diagram has an internal resistance \( r \) of 0.4 \( \Omega \) and produces an EMF between the points \( A \) and \( B \) of \( \mathcal{E}(t) = 150 \cos(\omega t) \) (in volts), with \( \frac{\omega}{2\pi} = 50 \text{ Hz} \).

\[ \begin{array}{c}
\mathcal{E}(t) \\
\hline \\
A \\
\hline \\
B
\end{array} \quad \begin{array}{c}
A' \\
\hline \\
B'
\end{array} \quad \begin{array}{c}
r = 0.4 \Omega \\
\hline \\
R = 15 \Omega
\end{array} \]

(a) If the load resistor \( R = 15 \Omega \) (with \( A \) connected to \( A' \), and \( B \) to \( B' \)), what average power will be delivered to the load?

The maximum power is delivered to a load when the load “impedance” (in this case the resistance \( R \)) is equal to the generator impedance (resistance \( r \)). In our case, \( R \gg r \). However, the load and generator impedances can be matched by connecting a transformer between the terminals \( AB \) (primary side of the transformer with \( N_1 \) windings) and \( A'B' \) (secondary side of the transformer with \( N_2 \) windings).

(b) What should the ratio \( \frac{N_1}{N_2} \) be for an ideal transformer so that there will be a maximum transfer of power to the load \( R' \)?

(c) How much power is then delivered to the load?
Problem 7.3
*RC circuit.*
Giancoli 26-45.

Problem 7.4
*RC circuit.*
Giancoli 26-46.

Problem 7.5
*Electromagnet with small air gap.*
An electromagnet has a steel core ($\kappa_M \approx 2500$) with an approximately circular cross sectional area of 4 cm$^2$. The radius of the magnet is 7 cm; there is a small air gap of only 2.5 mm (see sketch). The current through the magnet’s 120-turn coil is 15 A. What will the magnetic field strength be (approximately) inside the air gap?

![Electromagnet Sketch](image)

Problem 7.6
*RC Circuit.*
A series RC circuit (see left diagram below) is driven by a periodic square wave voltage $V(t)$ with a period $T = 0.3$ sec (see right diagram). $V(t) = 0$ V for $t < 0$; after $t = 0$, the voltage alternates between 15 V and 0 V; $R = 40 \, \Omega$, $C = 150 \, \mu F$. We will call the voltages across the capacitor and the resistor $V_C(t)$ and $V_R(t)$, respectively.

![RC Circuit Diagram](image)

(a) Calculate the current $I(t)$ in the circuit, the voltage $V_C(t)$, and the power delivered by the driving source as a function of time for the first full period ($0 < t < T$).

(b) Sketch in *one graph* $V(t)$, $V_C(t)$, and $V_R(t)$ in the time interval $0 < t < 2T$. 
(c) How much energy is dissipated in the resistor during one period?
    Hint: $RC << T$, thus $e^{-T/2RC} << 1$.

Recitations.

There are 28 recitation sections (see the 8.02 Website). If for any reason you want to change section, please see Maria Springer in 4-352.