Topics to Cover in the ECE review for the FE:

- Physics Review Capacitance
- Direct Current
- Resistance
- KVL, KCL
- Charging/Discharging a Capacitor
- Inductance
- Symbols
- Complex Numbers
- AC Circuits
- Complex Power
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<td>complex algebra, Laplace transforms, vector</td>
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<td>KCL, KVL</td>
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<td>Power</td>
<td>3-phase power, power factor and correction, synchronous generator</td>
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<td>Electromagnetics</td>
<td>static and dynamic fields, electromagnetic waves, transmission lines</td>
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<td>Control Systems</td>
<td>open loop and closed loop control, feedback systems</td>
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<td>Communications</td>
<td>Digital coding of analog information, transmission, modulation, decision theory</td>
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<td>Computer Networks</td>
<td>Network topology and architecture, protocol layers, security</td>
<td>EE 3710</td>
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<tr>
<td>Digital Systems</td>
<td>HDL, structural and behavioral models, synthesis, coding strategies for digital circuits</td>
<td>EE 4755</td>
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Physics Review:

• Electric Field due to a single charge
  \[ E = k \frac{q}{r^2} \quad k = 8.89 \times 10^9 \text{ Nm}^2/\text{C}^2 \]

• Uniform electric field due to a uniform distribution of surface charge (Gauss’s law):
  \[ E = \frac{\sigma}{\varepsilon_0} \rightarrow \frac{\text{surface charge density}}{\text{permittivity of free space}} \]

• Electric potential due to a single charge:
  \[ V = \frac{kq}{r} \]

• Potential difference in uniform electric field:
  \[ \Delta V = Ed \]

• Potential Energy:
  \[ \Delta U = q\Delta V \]

• Charge in a uniform electric field: \[ F = qE \quad qE=ma \quad q\Delta V = K_f - K_i \]
Examples 1, 2, 3
Capacitance: \( C = \frac{\varepsilon A}{d} \) (Farads)  
\[ C = \frac{Q}{\Delta V} \]

Energy stored in Capacitance:
\[ W(t) = \frac{1}{2} C \varepsilon v^2(t) \]

Insulators have a material property that enhances electric field capacity, which enhances capacitance.

Permittivity \( \varepsilon \)

Materials are compared to permittivity of free space:
\[ \varepsilon_0 = 8.85 \times 10^{-12} \text{ F/m} \]

For any material \( \varepsilon = \varepsilon_r \varepsilon_0 \)

\( \varepsilon_r \) = Relative Permittivity
5.2.2 COMBINATIONS OF CAPACITORS

SERIES

\[ i_s = v_1 - v_2 - v_3 \]

\[ V_s = V_1 + V_2 + V_3 \]

\[ i_s = C e_0 \frac{dV_s}{dt} = C e_0 \left( \frac{dV_1}{dt} + \frac{dV_2}{dt} + \frac{dV_3}{dt} \right) \]

\[ i_s = C e_0 \left( \frac{i_s}{c_1} + \frac{i_s}{c_2} + \frac{i_s}{c_3} \right) \]

\[ \frac{1}{C e_0} = \frac{1}{c_1} + \frac{1}{c_2} + \frac{1}{c_3} \]
Capacitors Connected in Parallel

\[ i_s = i_1 + i_2 + i_3 \]

\[ C_{eq} \frac{dv_s}{dt} = C_1 dv_1 + C_2 dv_s + C_3 dv_s \]

\[ C_{eq} = C_1 + C_2 + C_3 \]

\[ v_1 = V_s \left( \frac{C_2}{C_1 + C_2} \right) \]

\[ v_2 = V_s \left( \frac{C_1}{C_1 + C_2} \right) \]
Go to paper lecture notes