Lecture 1

I. Bazarov, Newman 210 / Wilson 373

Website: blackboard.cornell.edu (self enroll)
       => TA info, office hours, etc.

       I. Bazarov, Supplement

Labs: 401 MW 7:30PM - 10:30PM starts today!
       402 TR 1:25PM - 4:25PM

HW: 1 each week, due next week (Friday)
     Soln. handed out \rightarrow \text{no} late HW accepted

Grade: 40\% lab
       40\% exam (prelim + final)
       15\% HW
       5\% participation (e.g. mailing list)

More info: Blackboard, printouts, 1st lab (!)

Goals:  - design & build simple circuits
         - trouble shoot equipment
         - analyze complicated circuit diagrams
Typical Electronic Device

**Input Transducer**: Converts physical quantity into electric signal (and vice versa)

- **Input Transducer**: e.g. thermistor \((T \rightarrow R)\)
  - Microphone (sound \(\rightarrow\) electric signal)

- **Output Transducer**: e.g. LED (electr. \(\rightarrow\) light)
  - Speaker (electr. \(\rightarrow\) sound)
  - Robotic arm (aka actuator)

**Two Types of Circuits**

- **Analog**: Info is represented by continuously varying signal
  - Typical functions: amplification
  - Filters (bass, treble)
  - Mixing
  - Q: Possible problems?
    - Sensitive to noise
    - P.S. drift

- **Digital**: Input/output signals have discrete values, e.g. 0 and 5V
  - Typical functions: memory, storage, logic, etc.
Basic quantities of interest

\[ V = \text{voltage} = \text{electric potential difference} \]
(measured w.r.t. some reference, e.g. "ground")

\[ [V] = \text{volts} \]

\[ q \Delta V = \Delta P E \] (of charge \(q\) due to \(\Delta V\))

\[ I = \text{current} = \text{charge flow rate} = \text{charge/unit time} \]

\[ [I] = \text{amps} \]

\[ \text{direction: dir. of +ve charge flow} \]

DC : \(I, V\) indep. of time
AC : \(-\) time varying

Convention

\[ I, V - \text{pure dc} \]
\[ i, \Delta - \text{ac or dc+ac} \]

\(I, V\) - represent physical quantities (sound, temp, color, etc.)

Electric circuit - interconnection of electric devices which creates and/or manipulates \(I, V\) to perform some function.

Linear circuit devices

1. Resistor

\[ V_2 \frac{R}{\Omega} V_1 \]

\[ I \]

obeys Ohm's law

\[ I = \frac{V_2 - V_1}{R} = \frac{V}{R} \]

\[ [R] = \text{ohm, } \Omega \]
"I-V curve" \( R \neq f(I,V) \)

<table>
<thead>
<tr>
<th>Color</th>
<th>Value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>0</td>
<td>n/a - 20%</td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
<td>silver - 10%</td>
</tr>
<tr>
<td>ROY</td>
<td>2.3</td>
<td>gold - 5%</td>
</tr>
<tr>
<td>G</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>6.7</td>
<td>Richard of York gave battle in vain</td>
</tr>
<tr>
<td>Gray</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>9</td>
<td></td>
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</tbody>
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Typical power rating \( \frac{1}{4} \) to \( \frac{1}{2} \) W

Conductance = inverse resistance = \( G = \frac{1}{R} = \frac{I}{V} \)

\([G] = \text{siemens (mho)}\)

Series resistors:

\( R_T = \sum R_k \) add resistances

Parallel:

\( G_T = \sum G_k \) add conductances, \( R_T = G_T^{-1} \)

\( R_T = \frac{R_1 R_2}{R_1 + R_2} = R_1 \parallel R_2 \)

\( \Delta \rightarrow Y : \quad R = \frac{R_a + R_b + R_c}{R} \)
\( R_1 = \frac{R_b R_c}{R} \), \( R_2 = \frac{R_c R_a}{R} \), \( R_3 = \frac{R_a R_b}{R} \)

\( Y \rightarrow \Delta : \quad G = G_1 + G_2 + G_3 \)
\( G_a = \frac{G_2 G_3}{G} \), \( G_b = \frac{G_3 G_1}{G} \), \( G_c = \frac{G_1 G_2}{G} \)

\( n_1 \) \( n_2 \) \( n_3 \)

\( R_a \) \( R_b \) \( R_c \)

\( \Delta \) \( Y \) transformation

can be made equivalent

proof: HW