Topics for Today:

- **URL:** [http://www.ece.mtu.edu/faculty/bamork/EE5223/index.htm](http://www.ece.mtu.edu/faculty/bamork/EE5223/index.htm)
- Labs - EE5224 - Begins Wed of Week 2, i.e. Jan 23rd
  - Locals: confirm operation.
  - Online: run via Remote Desktop - wts.cecn.mtu.edu
- Zones of protection, operation and protection strategies
- How to read a one-line (print out week 1 handout “Sub Schem”)
- Instrument transformers: VTs, CTs, CCVTs, MOCTs, etc.
- CTs - pedestal vs. bushing
- CT saturation & accuracy, ratios, multi-ratio Cts
- Next: print out “CT” handout, Study Chapter 5 info on CT saturation & accuracy
SMART GRID CAREER OPPORTUNITIES – EE5224 Lab:

- First protection lab meets next week Wednesday. The weekly cycle for labs will be to meet in EERC SB35 as follows:
  - Wed 10am - noon
  - Thurs 10-noon and 4-6pm
  - Mon 7-9pm

There are currently open slots in three lab sections. You are invited to first orientation lab. Check it out, I will approve late add.

You are encouraged to add this lab, the employers
- consulting firms,
- utilities,
- grid transmission companies,
- corporate or gov’t R&D groups, and
- equipment manufactures

look very highly at this practical experience with state of the art equipment and practical knowledge of relay applications and smart grid technologies. “Relay engineers are like gold.”
B III

368 - Trip 8, 9, 10, 11

Gen

Mot
Zones of Protection

- Overlapping
- Preferably at CB

(Note: CT is actual boundary of Zone!)

Zone A

EE 5210 - Power Systems Protection

Zone B

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### Typical Spacings and Clearances in a Substation

**See up-to-date NESC to verify!**

<table>
<thead>
<tr>
<th>Voltage Level</th>
<th>Min Conductor Spacing</th>
<th>Min Switch Spacing Ph-Ph</th>
<th>Min L-L Phase Clearance</th>
<th>Min No. Bells at Deadend</th>
<th>Min Cable Size</th>
<th>Min Bus Size</th>
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<tr>
<td>7.5</td>
<td>1'-6&quot;</td>
<td>7½&quot;</td>
<td>3'</td>
<td>18&quot;</td>
<td>2'-6&quot;</td>
<td>7&quot;</td>
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<tr>
<td>110</td>
<td>2'</td>
<td>10&quot;</td>
<td>3'</td>
<td>2'</td>
<td>2'-6&quot;</td>
<td>12&quot;</td>
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<tr>
<td>23</td>
<td>2'-6&quot;</td>
<td>12&quot;</td>
<td>4'</td>
<td>2'-6&quot;</td>
<td>3'</td>
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<tr>
<td>150</td>
<td>1'5&quot;</td>
<td>15&quot;</td>
<td>5'</td>
<td>3'</td>
<td>4'</td>
<td>18&quot;</td>
</tr>
<tr>
<td>34.5</td>
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<td>46</td>
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<tr>
<td>69</td>
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<td>7'</td>
<td>5'</td>
<td>6'</td>
<td>31&quot;</td>
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<tr>
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<td>12'</td>
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<tr>
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<td>16'</td>
<td>11'</td>
<td>16'</td>
<td>89&quot;</td>
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<tr>
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<td>18'</td>
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<tr>
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<tr>
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</table>
Bushings - HV Lead

Connections into equipment:

- 4-Bolt Pad
- Porcelain Bushing
- Trench
- Sheet metal tank
- Bushing Well

Dry: Porcelain
"Wet": Oil-Filled

- Draw-Lead - Low Current
- Bolted/Clamped - High Current

Oil-Level gage

EE 5210 - Power Systems Protection  Spring 2001

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