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 Mon of Week 3, i.e. Jan 19th
- Software - Aspen
  - Locals: confirm operation.
  - Online: run via Remote Desktop - will confirm address
- 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:
  - Tues 7-9pm, thru Mon (7 sections)
  - Only the Monday lab meets during Winter Carnival week
  - Lab 10 (last lab) during Week 13 of semester.

There are currently open slots in four 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.”
Zones of Protection

- Overlapping
- Preferably at CB

(Note: CT is actual boundary of Zone 1)

Zone A

Zone B

EE 5210 - Power Systems Protection
Spring 2001
No CB?

Zone A

Zone B
## Typical Spacings and Clearances in a Substation

See up-to-date NESC to verify!

<table>
<thead>
<tr>
<th>Voltage Level (KV)</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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<tbody>
<tr>
<td>7.5</td>
<td>1'-6&quot;</td>
<td>7½&quot;</td>
<td>3'</td>
<td>8'</td>
<td>7&quot;</td>
<td>1</td>
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<tr>
<td>15</td>
<td>2'</td>
<td>10&quot;</td>
<td>3'</td>
<td>2'</td>
<td>12&quot;</td>
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<tr>
<td>23</td>
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<td>4'</td>
<td>2'-6&quot;</td>
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<td>34.5</td>
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<td>15&quot;</td>
<td>5'</td>
<td>3'</td>
<td>18&quot;</td>
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<tr>
<td>46</td>
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<td>4</td>
</tr>
<tr>
<td>69</td>
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<td>2'-5&quot;</td>
<td>7'</td>
<td>5'</td>
<td>6'</td>
<td>4</td>
</tr>
<tr>
<td>115</td>
<td>7'</td>
<td>3'-7½&quot;</td>
<td>10'</td>
<td>7'</td>
<td>9'</td>
<td>5</td>
</tr>
<tr>
<td>138</td>
<td>8'</td>
<td>4'-1&quot;</td>
<td>12'</td>
<td>8'</td>
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<td>4'-10&quot;</td>
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<td>9'</td>
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<td>14</td>
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<td>230</td>
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<td>18'</td>
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<td>16</td>
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<tr>
<td>345</td>
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<td>18'</td>
<td>20'</td>
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<td>19</td>
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<tr>
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<td>25'</td>
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</tbody>
</table>
Bushings—HV Lead
Connections into equipment.

Oil-Level gage

4-Bolt Pad

Porcelain Bushing

Dry: Porcelain

"Wet": Oil-Filled

Bushing Collar

Sheet metal

Tank

Bushing Well

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