Ongoing List of Topics:

- URL: http://www.ece.mtu.edu/faculty/bamork/EE5223/index.htm
- Term Project - Due Friday (remote students can negotiate extension)
  - Invited presentations: ~2:45 - 5:00pm Monday; EERC B45
- SCADA protocols, Event Recorders, transducers
- Real-time Communications for protection & control
  - PLC, leased lines, optic, VHF, UHF, MW, wireless, satellite, BPL
- Wrapup
  - Term Project Report
  - One last "assessment"
  - Term Project Presentations

Cyber-security

- CIP
- IEC 61850
EE 4223/5223 - On-Campus Term Project Presentations

Time: Finals Week Mon Apr 25th 2:45-5:00pm
Room: EERC B45

Allotted Time: 15-20 minutes per presentation

<table>
<thead>
<tr>
<th>Team</th>
<th>Team Members</th>
<th>Topic</th>
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<tr>
<td>1</td>
<td>*Vikas Gaikhe</td>
<td>Effects of Distributed Generation on Distribution</td>
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<td>*Zekeriya Dereli</td>
<td>protection</td>
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<td>*Jordan Bosque</td>
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<td>2</td>
<td>*Milind Malichkar</td>
<td>Transformer Differential Protection Using SEL- 487E</td>
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<td>*Sunilkumar Mehta</td>
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<td>5</td>
<td>Nicholas Oberski</td>
<td>Improved Transformer Protection and Arc Flash Safety</td>
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<td>*Pushpanjali Prasad</td>
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<td>*Mangesh Sapre</td>
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<td>3</td>
<td>Chris Verhulst</td>
<td>Capacitor Bank Protection I</td>
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<td>Stephen Parrish</td>
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<td>9</td>
<td>Nathan Czapski</td>
<td>Capacitor Bank Protection II</td>
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<td>Travis Gale</td>
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<td>Justin Ayers</td>
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<td>20</td>
<td>*John Lukowski</td>
<td>SEL421 Transmission Line Protection</td>
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<td>Andrew Nastase</td>
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<td>*Brent McCoy</td>
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Invited Team Presentations (need 6, please respond earliest at convenience):

1) Transformer Differential Protection (Group 2)
2) SEL 421 Line Protection (Group 20)
3) Affects of Distributed Generation on Distribution Protection (Group 1)
4) Operation of Relay Testing Equipment using Saturated Input Waveforms (Group 7)
5) Capacitor Bank Protection (Group 3 and Group 9) - I believe they have some difference in their term project
6) Improved Transformer Protection and Arc flash safety using S&C Trans-Rupter (Group 5)

7) Hybrid Electric Vehicle Charging (Group 4)
8) Microprocessor vs Electromechanical Relays (Group 6)
9) Protection of Distribution transformer from use of electric vehicle (Group 8)

2 Changeover

12-15 min

3-6 Q&A

20 mins

~ 20 slides
Some pointers on final report:

**Executive Summary - one page, three paragraphs**
- Orientation/refresh on what the problem was and why project carried out
- Overview of what was done
- Results, conclusions and recommendations

Statement of Contributions (one paragraph for each team member)
- "Hard skill" contributions: engineering analysis, design, programming, simulation, lab testing, etc.
- "Soft skill" contributions: literature search, technical writing/drawing/documentation, presentations, etc.
- Name and signature below each paragraph. Whole team must agree.
The Future

IEC 61850

- XML tagged data
  (Next obvious step in SCADA)

- Looks like real-time control of power grid will be like a generic network.

- Cyber-security is a big deal.
Security Issues Now:

- G1: Hard-wired relay-contact control logic.
- G2: "
- G3: mProc.

Interoperability

Protocol Converter
- Relays of various make.
- SCADA Languages
- etc.
Communications - SCADA, CONTROL, Relaying.

- PLC: Power Line Carrier
  - Couple via CCVT
  - 30-450 KHz
    (Usually <300 KHz if icing)

  \[\text{Transverse Radiation of Signal}\]

  - Fog, Mist: \(E\) increased

- High-speed, narrow bandwidth
- Dedicated channel, owned by util
- Tends to be very reliable.
- Common use in sub-transmission.
Comm (cont'd)
- Leased Line (owned by others)
- Copper Pair
- Fiber optic (1 mw)
- Microwave
- Point-to-point
- 132 channels
- 2 GHz
- 3 GHz
- 6 GHz
- 10 GHz

Fade margin
Shield Wire
- Inside
- Wrap
- Buried
- Fiber Optic
- Wireless / Embedded Proc.

- BPL - Broadband over Power Line
  2 - 30 MHz (up to 80 MHz)

Practical Apps:

ISP

Like coat

- ≤ 25 KV
- ≤ 800 m
- Local Dist.,
  Neighborhoods.

Combined w/ wireless.
Relay Comm - Peer-to-peer

- Share real-time sampled waveforms
- Timing - GPS, time stamp
Event Recorders - GPS

- V, I
- Logic var. change of state.

SCADA - Comm protocols
- DNP, UCA
- XML

Protocol Converter.
TCP/IP - ~4 billion ⇒ IPv6

Mipsyscan (103)