Topics for Today:

- Introductions
- Startup
  - Book, Syllabus
  - Course Expectations, Grading
    - Attend all lectures, actively participate.
    - Come to class on time - 1:05pm
    - Turn in work on time
    - Interview trips: not an excused absence
- Labs - EE4224/5224 - Begin in Week 2-3
- Software - Aspen: 15-bus academic version
- Bus Configurations (§10.1 thru §10.10)
- Zones of protection
- Intro to system protection. Always be aware of:
  - Reliability: dependability vs. security
  - Selectivity
  - Speed (i^2t heating ==> "time = damage")
  - Simplicity, Economics
- Study Chapter 1, review Ch. 2, §3.1 thru §3.4

3120, 4221, 4222
Key Goals of Protection

- Economics
- Reliable (always trip for problem)
- Fast ("time is damage")
- Selectivity (only trip what's needed) (Minimum)
- Simplicity
  - Fewer parts
  - Cheaper
  - Faster to troubleshoot/fix
Protection - From What?

- Lightning
- S.C.s. S.C.s. - 5223
- Faults
- Operational Errors (controls) - 5230
- Switching Surges (Overvoltages) - 5220
- R-L-C

- Lines
- Cables - 30-50 yrs
- Transformers - 30-40 yrs
- Generators
- Buses
- Motors
- Capacitor Banks
- Reactor Banks
- FACTS devices - 10-20 yrs.
Instrument transformers - used to "step down" primary voltages and currents to lower standard levels.

- Current: 0.5A - CT
  Voltage: X1-X3: 0-120V
  X2-X3: 0-69.3V
  X1-X3: 0-115V
  X2-X3: 0-66.4V

Ex:

Note that "PT" designation is obsolete - new designation is "VT". Economics usually point to use of CVT or CCVT for voltages above 69-KV, VTs for lower voltages.

Note that linear couplers, which produce a secondary voltage proportional to the primary current, were in vogue for a while in the 50's & 60's but never caught on. Used mainly in bus differential schemes. Requires special relays (voltage instead of current input) - this additional cost hobbled it. (See p.353, Blackburn)
One-line Symbols:

- **CIRCUIT BREAKER** (High Voltage)
- Air-Break Circuit Breaker (Low Voltage)
- Fused Disconnect Switch
- Fused cutout
- Disconnect Switch
- Air-Break Switch w/arc restriction

**Circuit Switcher**

Vacuum interrupter trips first, then switch opens. Can't interrupt high fault currents like CB, but cheaper. Often used on HV side of transformer. Can close & open on full load current also, so provides function of load-break switch as well.
Bus Configurations (at substations)

Comm (Control) Heirarchy

SCADA - System Control & Data Acqu
Relays

G1 - Electromechanical - Coils

G2 - Electronic

G3 - mProc

G4 - Advanced mProc
- IEC 61850
- Embedded Proc
- Comm Network
- IP6, 10 Gbs
Next: Bus Configs - Sects. 10.1 - 10.10.

- Single Bus
- Double Bus
- Ring Bus
- "Breaker-and-a-half"
- "... third"