Procedure:

1. Instrumentation:

(a) The instrumentation allows you to measure RMS line-line voltages, line-neutral voltages, line currents, phase currents, total three phase average power, average power measured by the two wattmeters in two wattmeter method and average power measured by the three wattmeters in three wattmeter method. The instantaneous values are also made available through graphs.

2. Wye Connected Resistive Load:

(a) Use the file 1_3PH_MMTS_Y_R_LOAD.psc.

(b) Open the file and press RUN (from run time tool bar) to run the file. Turn the three phase switch, “SW” and the neutral switch, “NEUTRAL” to ON position.

(c) Adjust the three sliders to vary the resistive load on respective phases until the line current is approximately 10 A on all three phases. Once this is achieved leave the slider undisturbed.

(d) Check to see if there is any neutral current flowing. The neutral current should be zero if the load is balanced.

(e) To make the two wattmeter method work the neutral current should be made zero. To do so open switch the neutral switch from ON position to OFF position.

(f) Press STOP, from run time tool bar, to stop the simulation or wait until the simulation ends. Press SAVE to save the program. If the program asks you to “save current controls to the default template”, press NO.

(g) Now press RUN again. The simulation runs with new slider position. Wait until the simulation ends. Once the simulation ends,

(h) Measure and record $V_{1-2}$, $V_{2-3}$, $V_{1-3}$, $V_{1-N}$, $V_{2-N}$, $V_{3-N}$, $I_1$, $I_2$, and $I_3$.

(i) Measure and record $P_{WM1}$ and $P_{WM2}$ obtained from two-wattmeter method.

(j) Compare your value of $P_{3\phi}$ measured using the two wattmeter method with the value given by

$$P_{3\phi} = \sqrt{3} V_{L\ L} I_{L} \cos(\theta)$$

(k) Measure and record $P_1$, $P_2$, and $P_3$ (Three-wattmeter method).

(l) Compare your value of $P_{3\phi}$ measured using the two wattmeter method with the value given by

$$P_{3\phi} = P_1 + P_2 + P_3.$$

(m) Open all line switches.
Using PSCAD to Create and Run Time Domain Simulations

EMTDC - Solver

Electromagnetic Transients

- Power systems normally in steady-state
- Allows use of RMS phasors
- Switching operations, faults, lightning,
- Response frequencies from DC to MHz
- Response generally dies out rapidly
- Large voltage and currents are possible
- RLC response to change in volt or current
Typical Transients-
capacitor switching

EI

Typical Transients-
fault current

EI

B.K. Johnson

Spring 2014
transient recovery voltage

Analyzing Transients

- Understand the transient you want to model
- Good data to form detailed models
- Mathematical model of the system
- Solve coupled differential equations
- Options:
  - Hand calculations in the LaPlace domain
  - Hand calculations in the time domain
  - Time domain numerical simulation
The Electromagnetic Transients Program-EMTP

- Hermann Dommel, Germany, then BPA
- Numerically solves difference equations
- Fixed versus variable time-step
- EMTP has become and industry standard (verified models)
- MatTRAN, NETOMAC, and SimPOW are other alternatives

EMTP Variants

- Original version mainly modeled RLC elements switches, sources and lines
- Many extensions and several versions
  » ATP: Alternate transients program
  » EMTP96: Latest in the line of EPRI-DCG (now just DCG) "The EMTP" or "EMTP-RV"
  » EMTDC: Reduced size version available free from their web site.
  » Microtran: University of British Columbia
PSCAD EMTDC

• PSCAD is the graphical user interface
• EMTDC is the numerical solver
• For this course you can run the cases supplied through course web page
  » Capture the results
  » You can modify the files or create new cases if you're interested
  » We will discuss that here

Getting PSCAD/EMTDC

• Available in the Senior Design Lab
• Free Student Edition (15 node limit)
• Download from: http://www.pscad.com/
  » Download How To PDF for Student Edition
  » Download the Program itself
  » Download GNU Fortran Compiler
    – unless you have compatible one installed
  » These are large downloads