LECTURE 10

AC Circuits

and

Sampling Labs

Schedule Change

- AC Circuits will be Monday and Tuesday
- Sampling Lab will be Wednesday and Thursday

Outline– AC Ciruits

- Safety for circuits with >50 volts
- Prelab material
- Lab tests
- Results

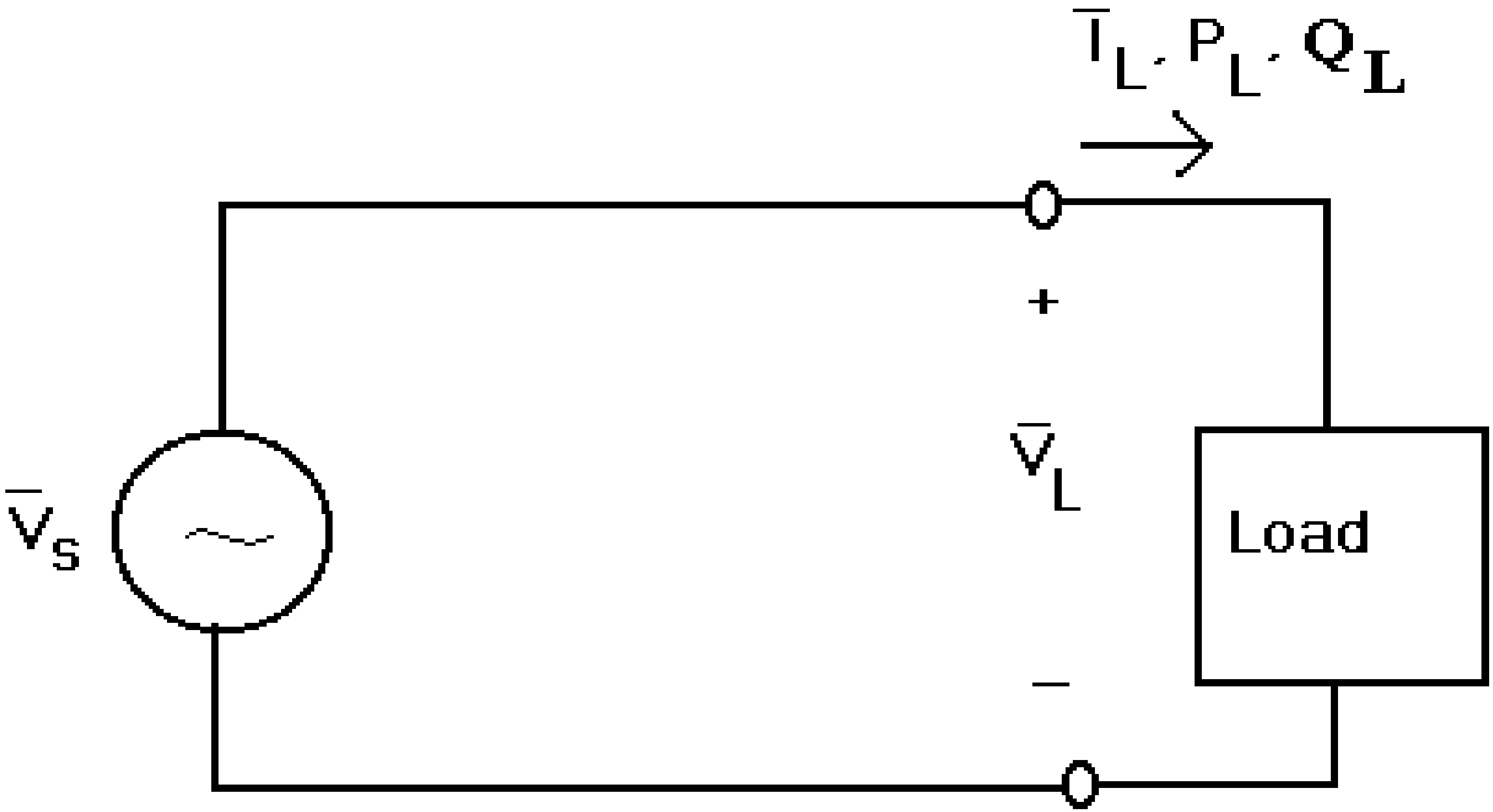
Basic electrical safety

- Electrical injuries due to tissue heating, nerve system disruption, reflex actions, arc burns.
- 5 ma is the “let go” current
- Path of current through the body is important
- Body impedance is primarily in the skin

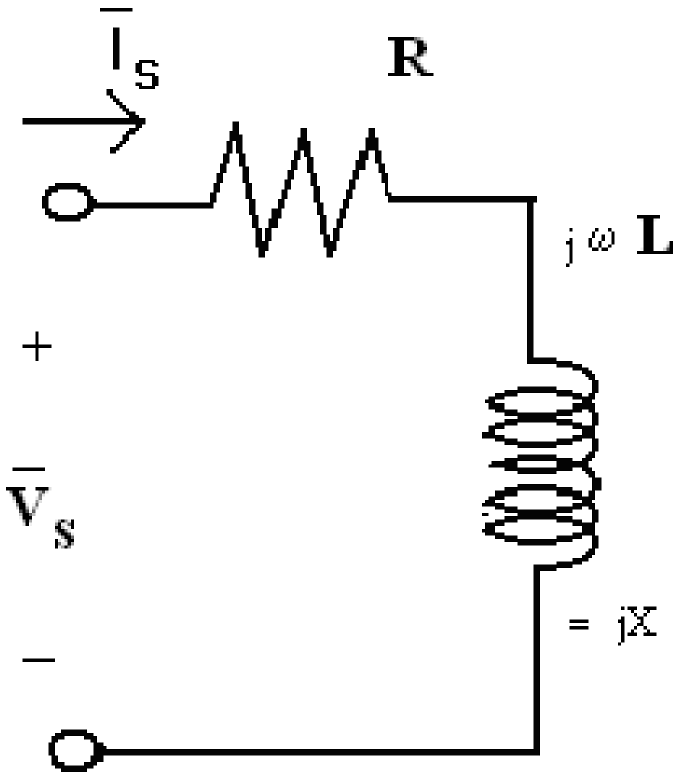
Laboratory Safety Procedures

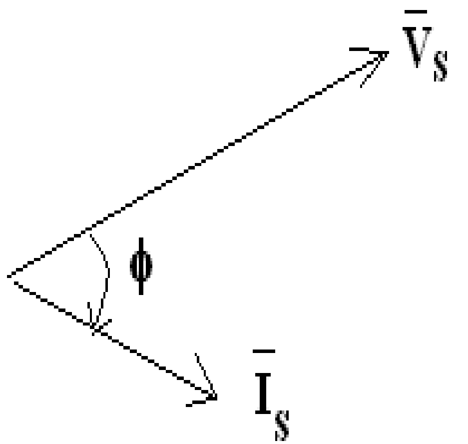
- Eye safety– goggles
- Work only on dead circuits
- Have instructor check circuit before energizing
- Avoid having to reach across hot resistors/hot wires
- No loose jewelry
- Work with one hand

Theory

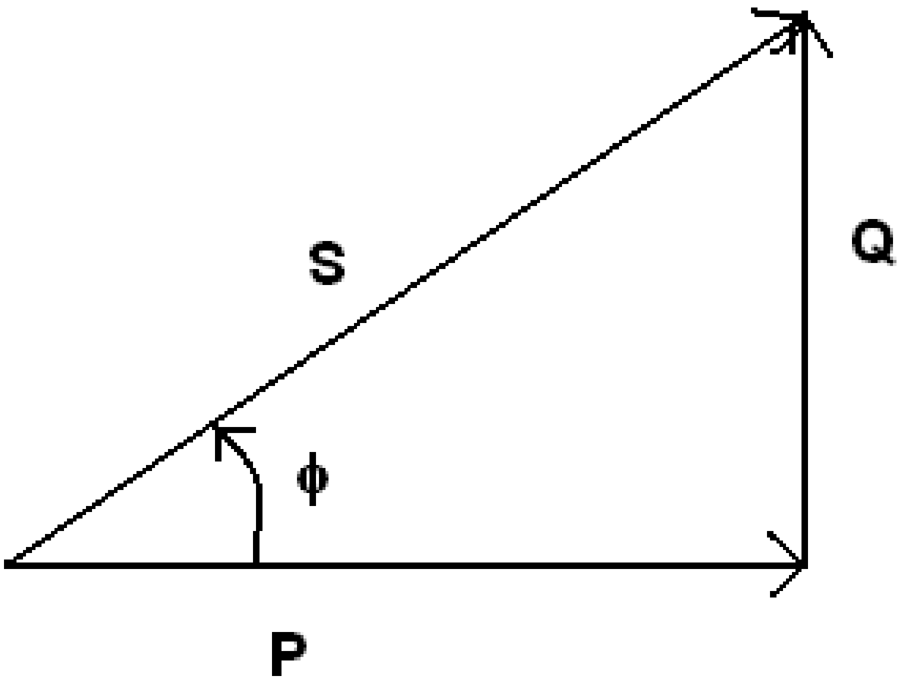


RL Load





Power Triangle



$S = VI =$ volt-amps

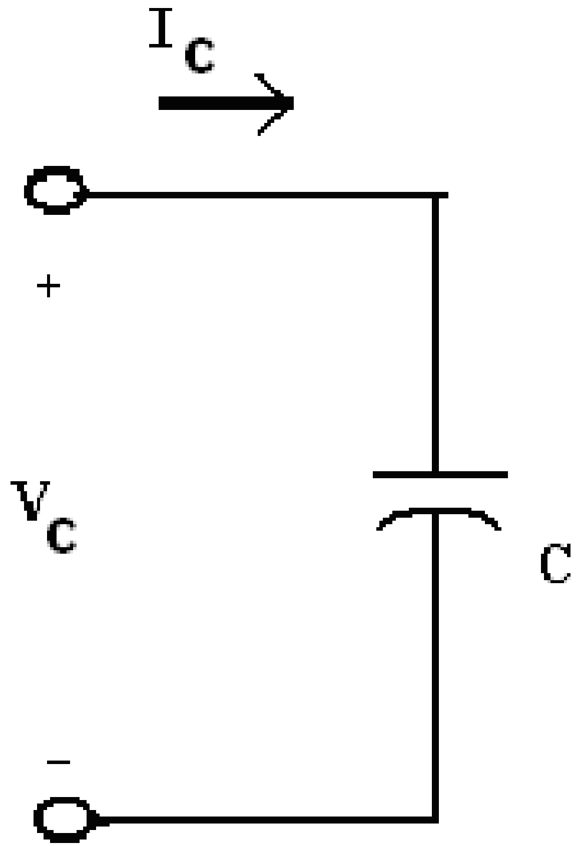
$P = VI\cos\phi =$ watts

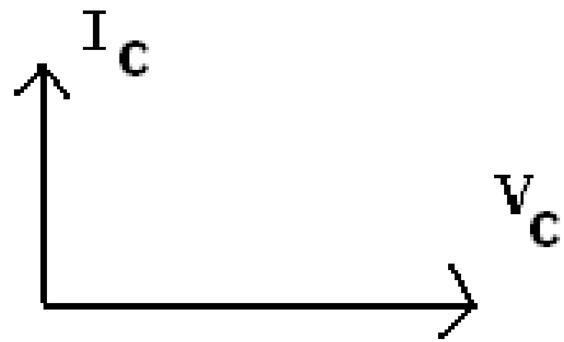
$Q = VI\sin\phi =$ vars

power factor $= P/S$

$= \cos(\phi)$

$S^2 = P^2 + Q^2$





$P_{cap} = 0$

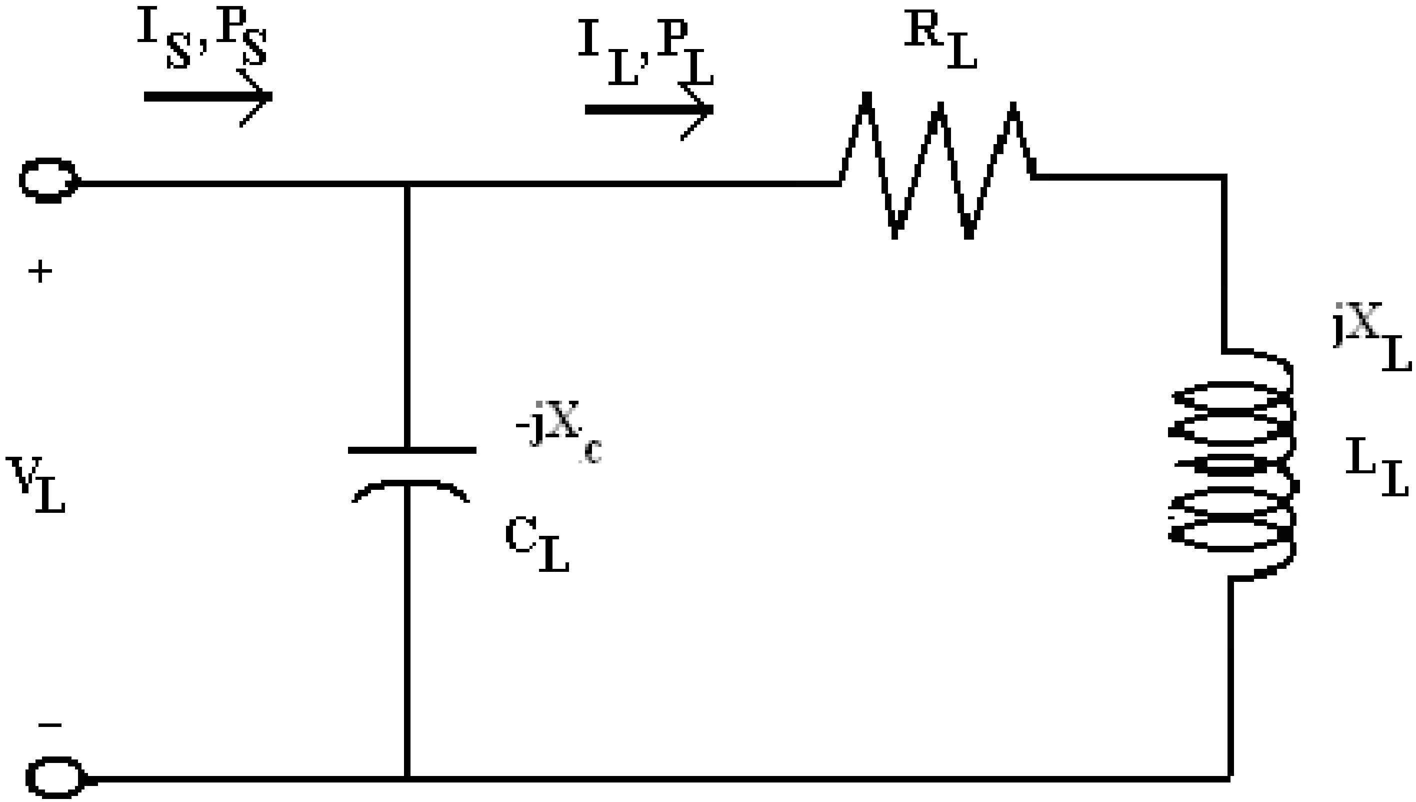
$Q_{cap} = -V_C I_C$

NEGATIVE vars flow **TO** the cap

POSITIVE vars flow **FROM** the cap

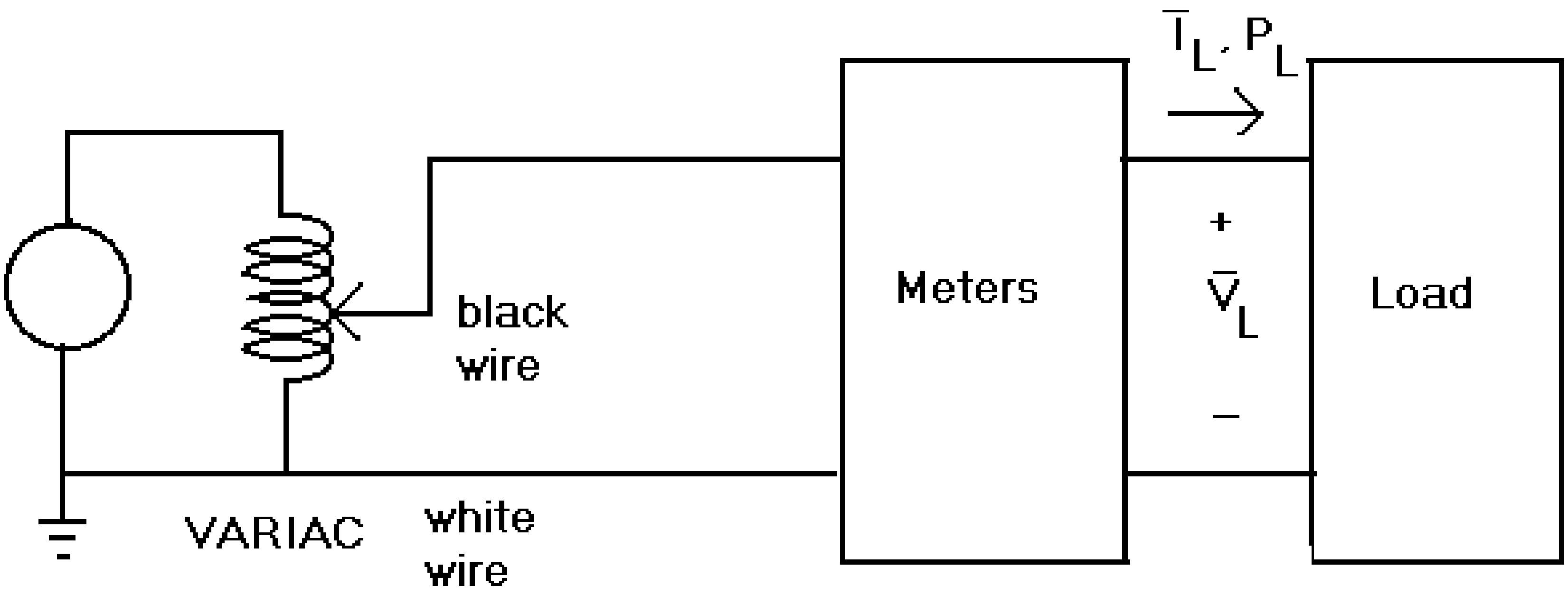
Measurements

- Measure V (volts), I (amps), and P (watts)
- S=VI
- $\phi = \cos^{-1}(P/S)$
- $Q = (S^2 - P^2)^{1/2}$



Constant V_L means constant I_L and P_L as C_L changes

Measurement circuit



Metering circuit

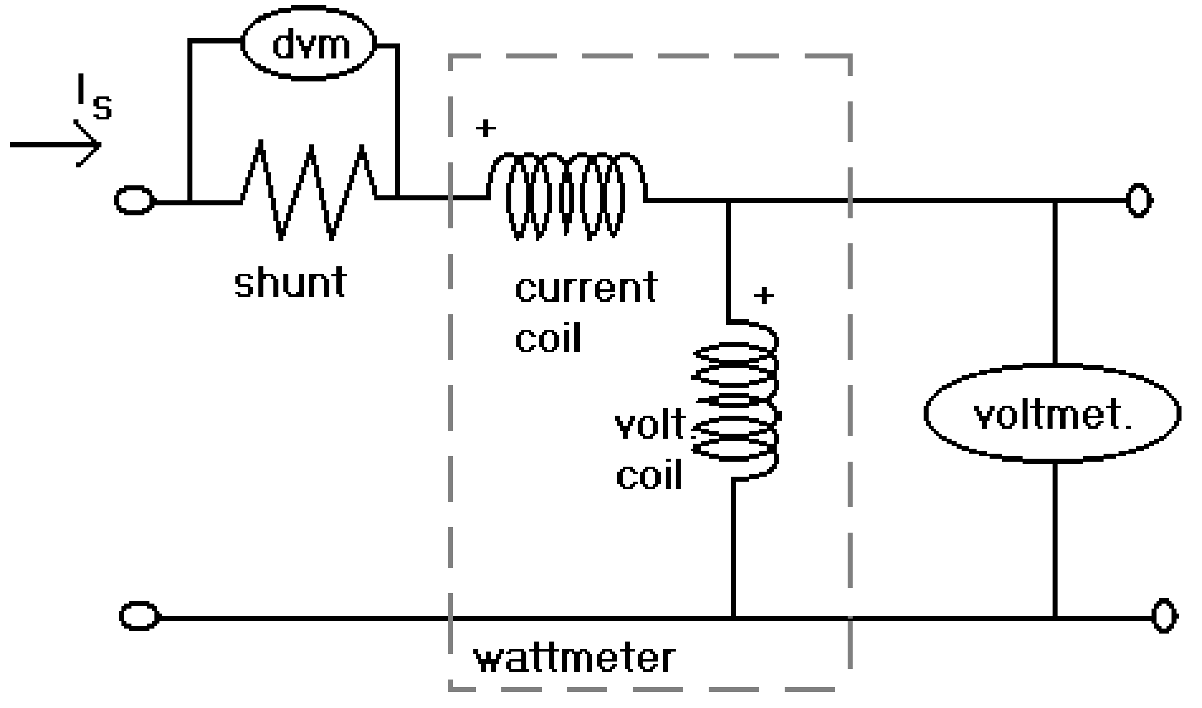


Figure 3. Ammeter, wattmeter, and voltmeter connection diagram.

Results

- C will generate vars–L will consume vars
- If capacitive vars = inductive vars, there will be unity power factor (and minimum source current)
- Further increase in capacitance will create a leading power factor (and current will be larger)

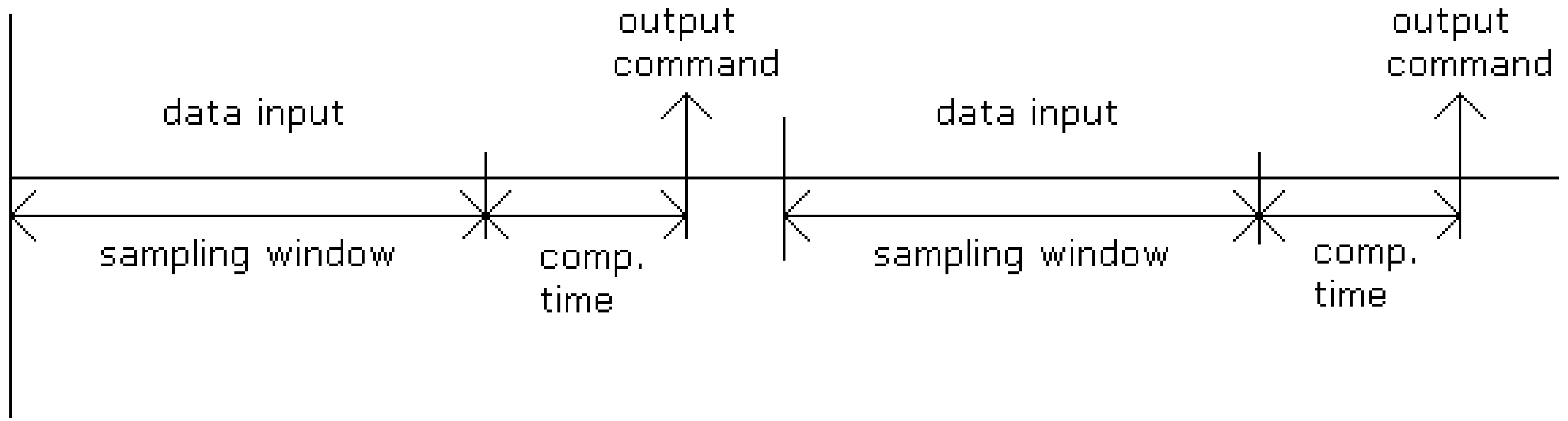
Results

- For each operating point—
  - – Measure V, I and P
  - – Calculate S and ϕ
  - – Draw power triangle to scale
  - – Determine capacitive vars from the source measurement
  - – Predict capacitive vars by formula ωCV^2

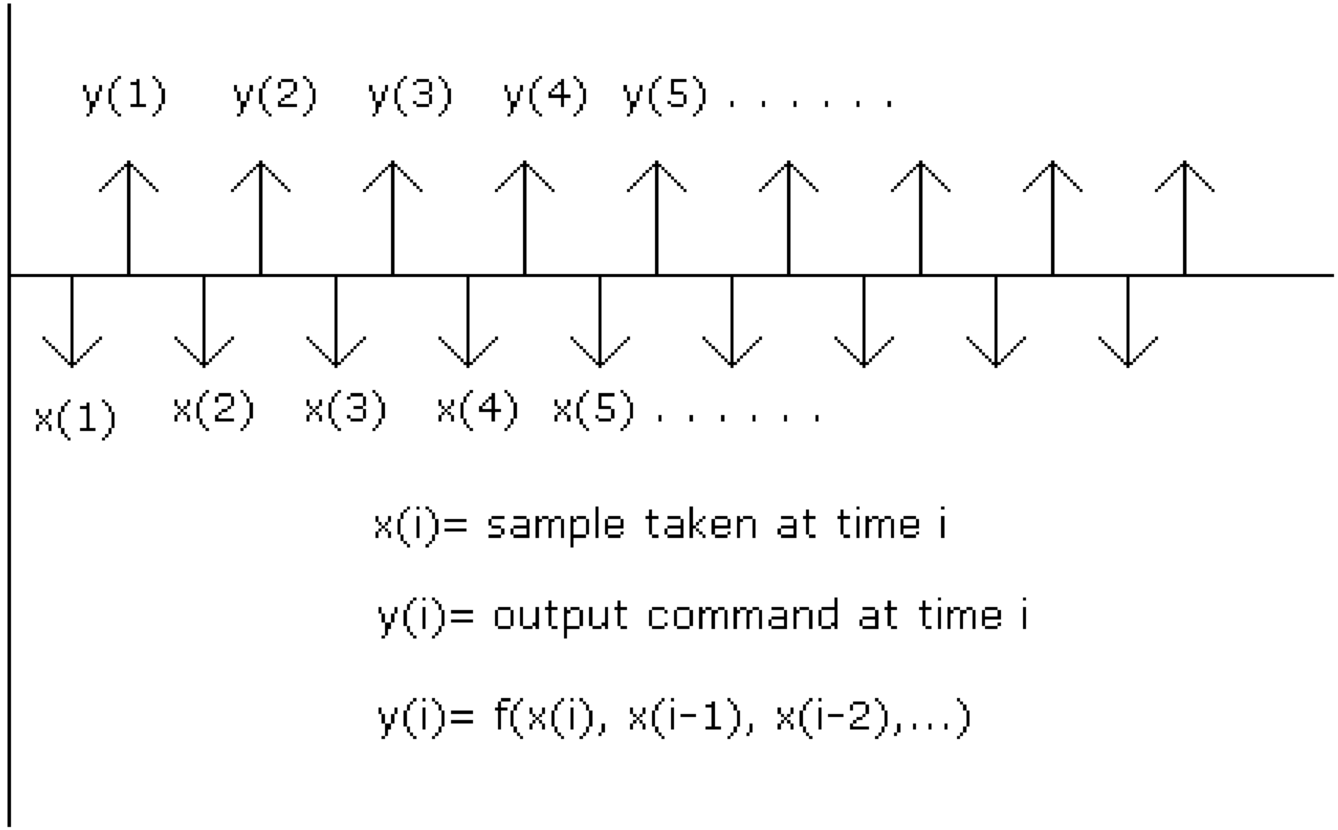
Sampling Lab-- Objectives

- Use shift registers in LabView
- Use continuous sampling to estimate signal characteristics
- Integrate and differentiate signals in real time

Windowed Data Gathering (what we did previously)



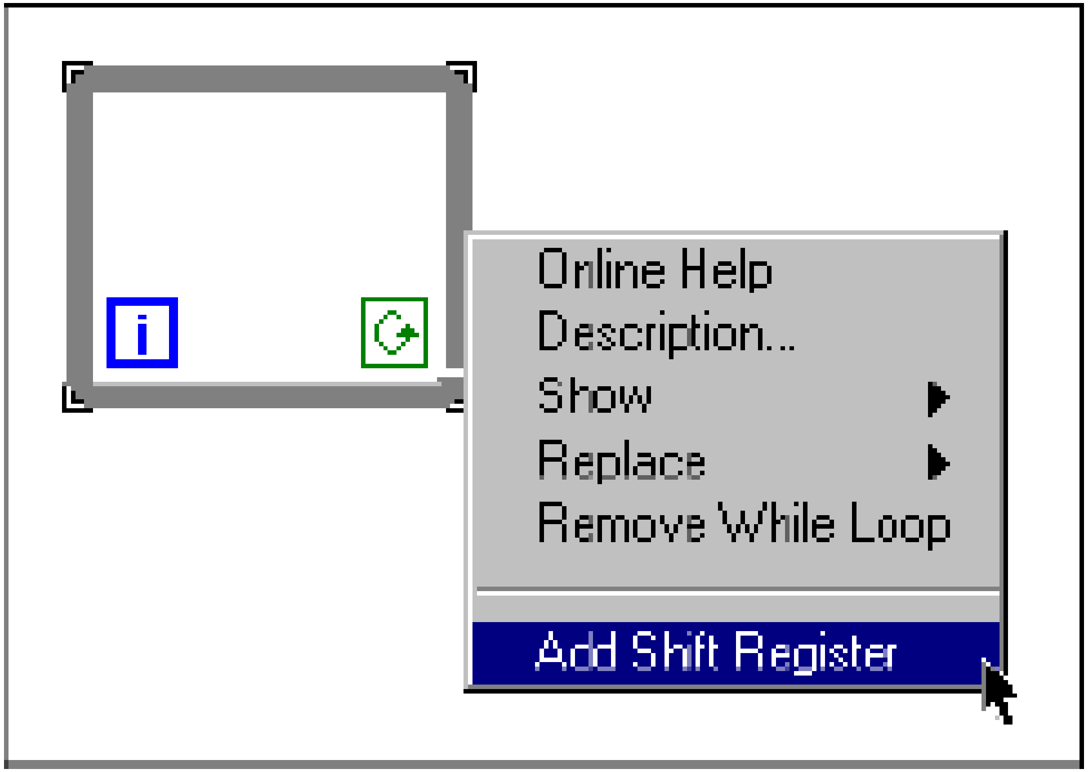
Continuously sampled signal

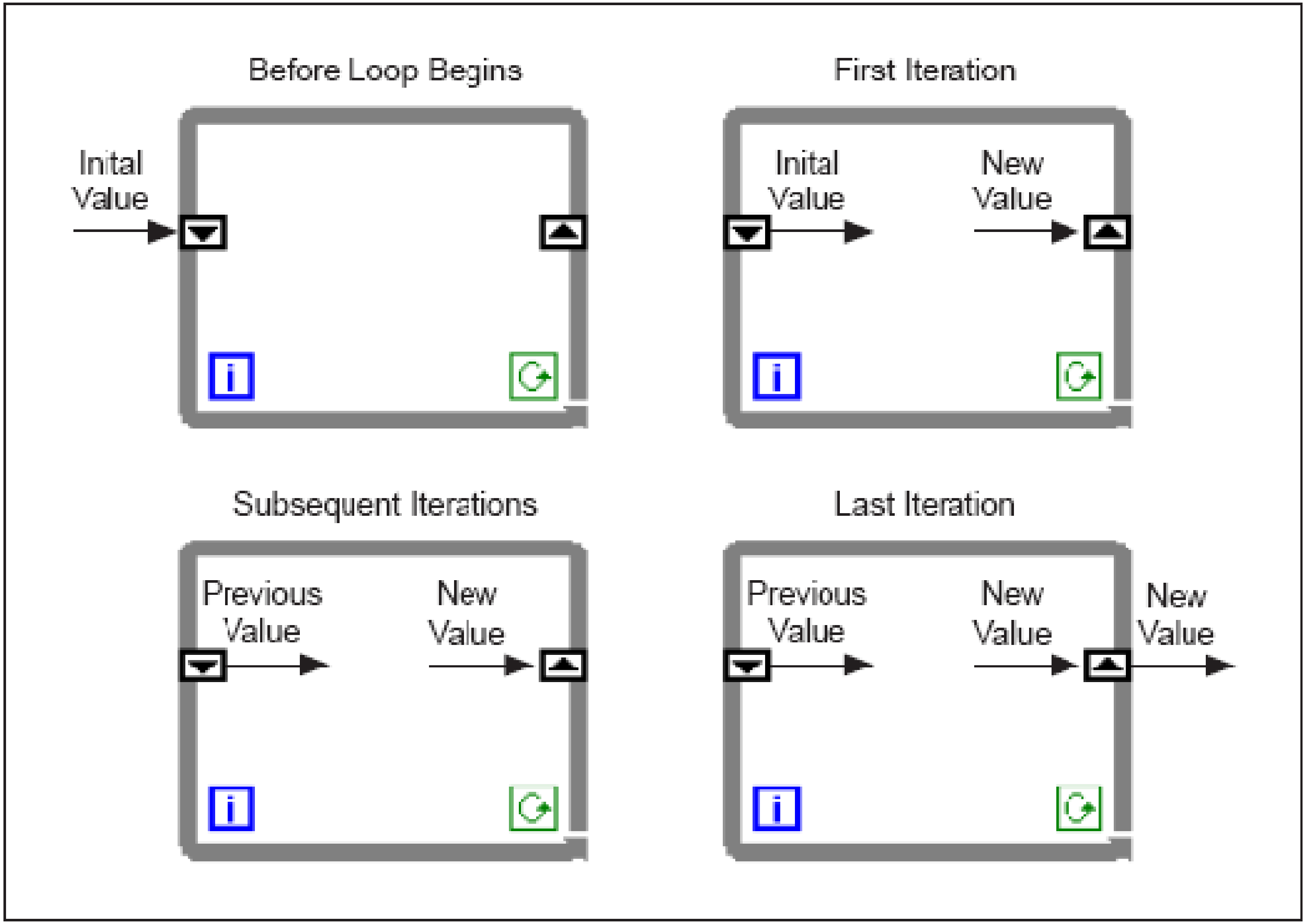


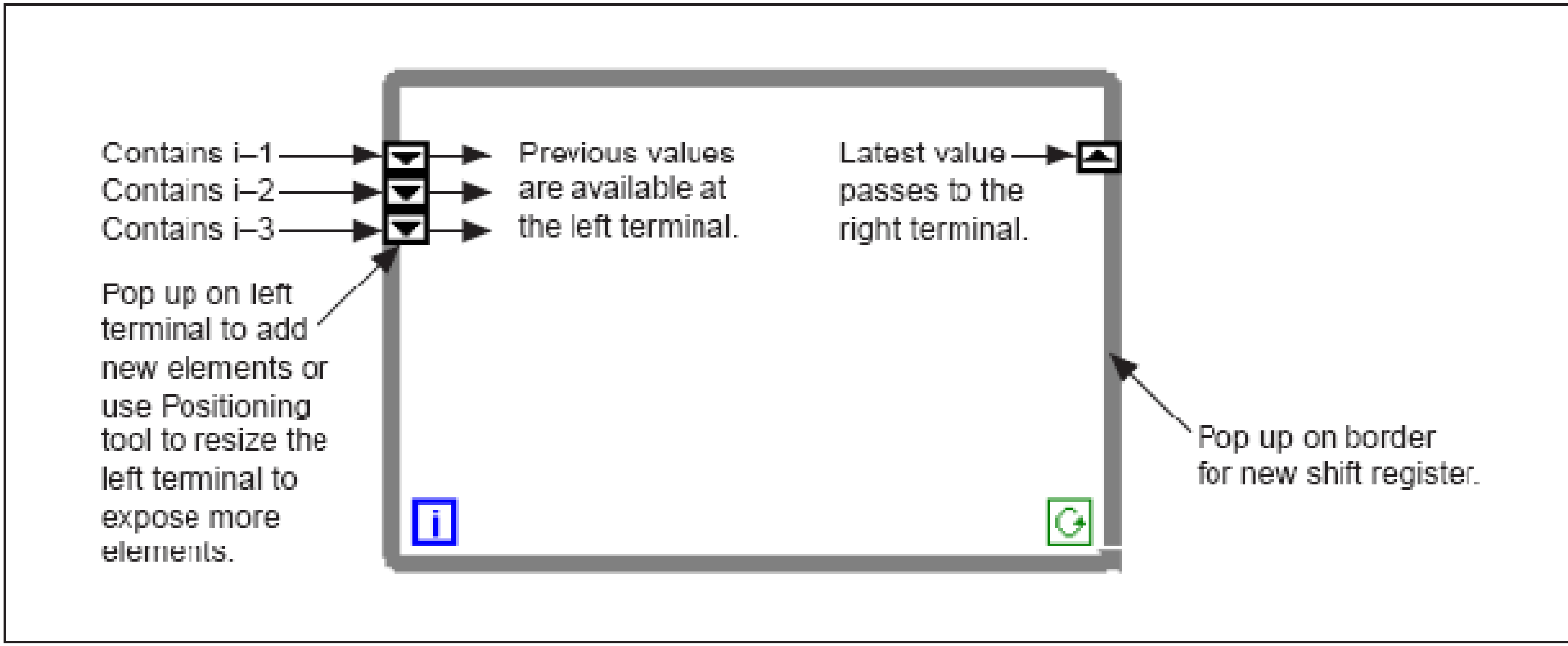
Comparison

- Suppose the sampling theorem dictates a sampling rate of 1khz.
- Suppose you need to have 100 samples to characterize the wave
- In windowed data, you could make a decision no quicker than every 0.1 sec.
- In continuously sampled data, you can make a decision every 1 millisecond.

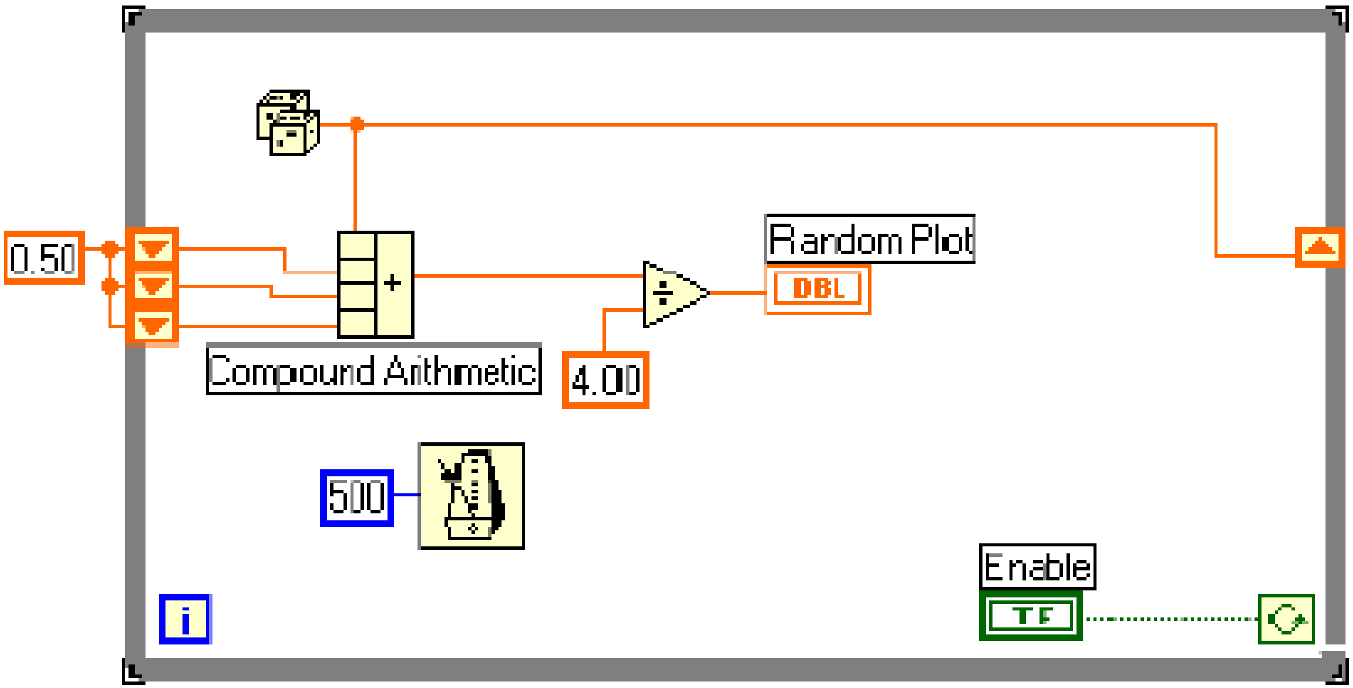
Shift Registers




Before Loop Begins
Inital
Value
First Iteration
Inital
Value
New
Value
Subsequent Iterations
Previous
Value
New
Value
Last Iteration
Previous
Value
New
Value
New
Value


Contains i–1
Contains i–2
Contains i–3
Previous values are available at the left terminal.
Latest value passes to the right terminal.
Pop up on left terminal to add new elements or use Positioning tool to resize the left terminal to expose more elements.
Pop up on border for new shift register.

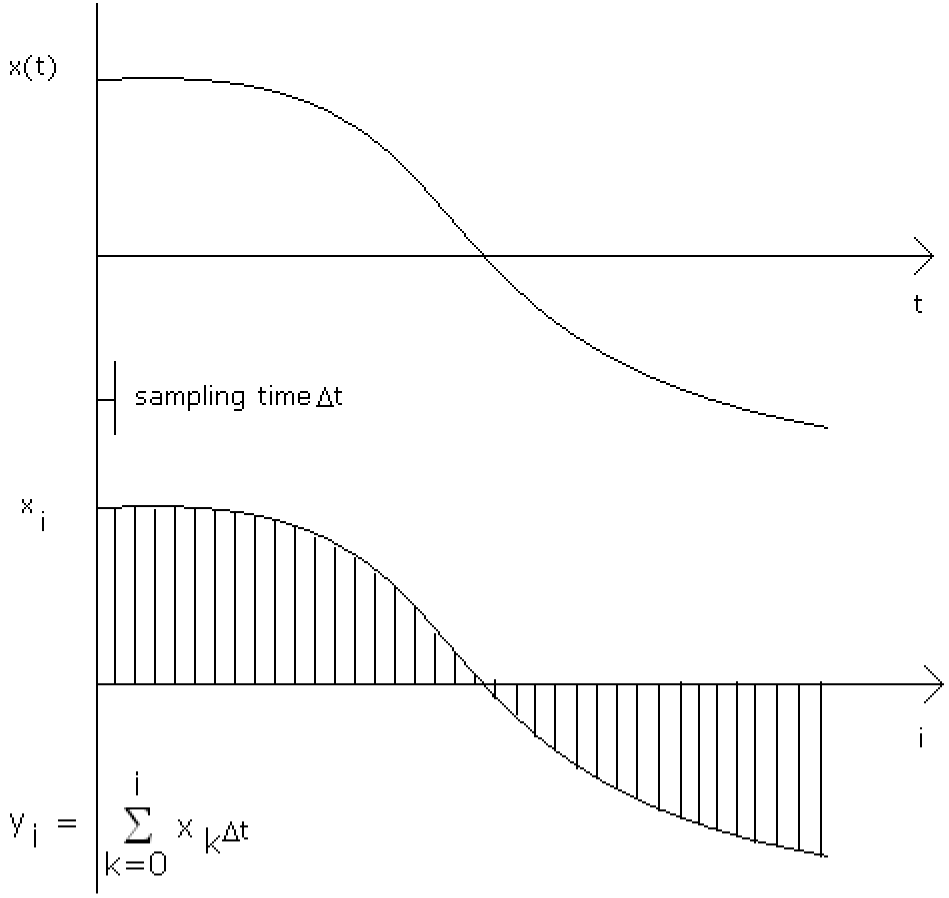
Averaging Circuit



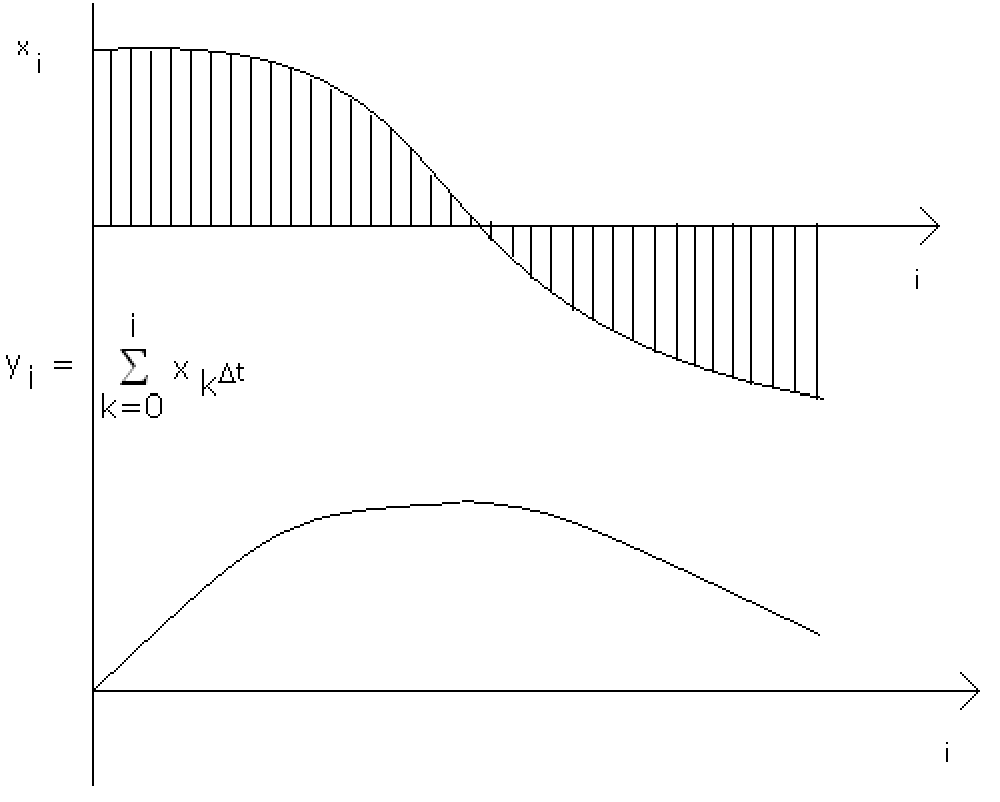
We will do…

- Averaging
- Integrating
- Differentiating
- RMS’ing

Real Time Integration--discretization



Integration-- summation



Algorithm

$$y(i) = \sum_{k=0}^{i} x(k)\Delta t = y(i-1) + x(i)\Delta t$$

What is the integral of a…

- Sine wave?
- Square wave?
- What is the derivative of these signals?
- How would you do a running RMS?