The lab final will examine knowledge obtained from performing the laboratory projects scheduled from the syllabus for this quarter and any additional material provided as notes. Students will have reference to their laboratory notebooks and will need to bring their calculator. All material will be provided at each work bench, including engineering paper for the test answers. Just bring your notebook, calculator, pencil and eraser. The final exam is planned to last fifty minutes. The following is a brief summary of the knowledge learned.

Laboratory Notebook: Sufficient documentation so that a peer should be able to reproduce the same results with the same equipment.
Format: see laboratory experiment write-up notes
Data tables: units and sample calculations
Figures: annotation, linear and logarithmic scales
Accuracy and precision
Calculation of error: \( \% \text{error} = \frac{(\text{meas} - \text{ref})/\text{ref}}{\text{ref}} \times 100 \)
mean = average of N measurements
standard deviation = square root of \([1/(N-1)] \text{ sum of (measurement - mean)}^2\]
note: discussed in Physics 133 lab manual introduction material

Instrumentation:
Agilent 34601A DMM: DC, AC, Ohm, precision
Agilent 54622A Oscilloscope: voltage and time measurements, dual channel, math, trigger, x-y plot, print; check initial settings (probe, trigger settings, etc.)
Agilent 33120A Function Generator: initial settings (50 ohm vs high Z), function, amplitude, DC offset, frequency
Agilent E3640A DC Power Supply: display, limit
TPS Dual DC Power Supply: limits, common point (+, - voltages)

Components: R, C, L, potentiometer, diodes, op amp, use of protoboard

Measurements: resistance (input and output, DC and small-signal AC), voltage measurements (peak-peak, amplitude, rms), sinusoidal waveforms (amplitude, period/frequency, phase), current (Ohm’s law), stored energy, diode characteristics, power, efficiency, step response using square wave source, time constant

Circuits and Electronics: diode clipper, half- and full-wave rectifier; op amp: inverting, non-inverting, buffer, summer