Passive Bandpass and Notch Filters
Experimental Procedure

• It is not in the lab manual. It is posted on Week 8 module on Scholar.
Bandwidth and Q Factor

• The difference between the frequencies (in Hz) where the power is ½ of the maximum output power (the -3 dB point) is the bandwidth of the filter

  – Maximum power to output occurs at $f_0 = Q\beta$, where Q is the quality factor of the filter.

• A high Q filter has a small bandwidth, almost no other signals except for the one at the center frequency will be sent to the load for a bandpass filter or removed from the signal sent to the load for a notch filter.
-3dB point

- Defined as the point at which the power at the point of measurement is 50% of the power supplied to the circuit.

\[ dB = -10 \log \left( \frac{P_{load}}{P_S} \right) = -20 \log \left( \frac{V_{load}}{V_S} \right) \]
Nonideal Components

• Voltage Source
  – Velleman function generator acts like an ideal voltage source in series with a Thévenin equivalent resistor.

• Capacitors
  – Tolerance on capacitors in kit is +/- 20% at best
    • It is difficult to purchase capacitors with tighter tolerances.

• Inductors
  – Parasitic resistances and capacitances result from the way inductors are fabricated.
Voltage Source

- An ideal voltage source attached to a load.
  \[ V_o = V_s \]

- A nonideal voltage source is an ideal voltage source in series with R.
  \[ V_o \text{ is a fraction of } V_s \]
Maximum Power to a Load

• For a nonideal voltage source, which is composed of a ideal voltage source (or Thévenin source) and Thévenin impedance, the maximum power to the load is obtained when the load impedance is equal to the Thévenin impedance.
  – For audio systems, the Thévenin impedance is designed to be 8Ω.
  – For most electronic instruments, the Thévenin impedance is designed to be 50Ω.
  – For TV antenna, the Thévenin impedance is designed to be 75Ω.
Measurement of Capacitance

• Capacitance can be measured using the MY-64 digital multimeter as long as the value of C is between 1pF-20μF.
  – Note that the accuracy of the measurement degrades considerably as the capacitance value increases. (MY-64 specifications)
  • Measurement is performed at 20 kHz.
• There is a narrow black rectangle with slits and two prongs in the box for your digital multimeter.
  – This slides into the two capacitance measurement slots on your digital multimeter. It helps create a better connection to the narrow wires of the capacitors.
Inductors

- Generally - coil of conducting wire
  - Usually wrapped around a solid core. If no core is used, then the inductor is said to have an ‘air core’.

Alternative Names for Inductors

- Reactor - inductor in a power grid
- Choke - designed to block a particular frequency while allowing currents at lower frequencies or d.c. currents through
  - Commonly used in RF (radio frequency) circuitry
- Coil - often coated with varnish and/or wrapped with insulating tape to provide additional insulation and secure them in place
  - A winding is a coil with taps (terminals).
- Solenoid – a three dimensional coil.
  - Also used to denote an electromagnet where the magnetic field is generated by current flowing through a toroidal inductor.
Properties of a Real Inductor

• Real inductors do dissipate energy due resistive losses in the length of wire and capacitive coupling between turns of the wire.
  – The frequencies at which the capacitive element of the inductor is noticed is above the frequencies the corner frequencies of the RLC circuit designed in this experiment.