1. Introduce bipolar junction transistors
   - “Transistor man” (from The Art of Electronics (2nd edition) by Horowitz and Hill)
     - Transistors are not “switches”
     - Base–emitter diode current sets collector–emitter resistance
     - Transistors are “dynamic resistors” (i.e., “transfer resistor”)
     - Act like closed switch in “saturation” mode
     - Act like open switch in “cutoff” mode
     - Act like current amplifier in “active” mode
   - Active-mode BJT model
     - Collector resistance is dynamically set so that collector current is $\beta$ times base current
     - $\beta$ is assumed to be very high ($\beta \approx 100-200$ in this laboratory)
     - Under most conditions, base current is negligible, so collector and emitter current are equal
     - $\beta \approx h_{fe} \approx h_{FE}$
     - Good designs only depend on $\beta$ being large
     - The active-mode model:
       * Assumptions:
         - Must have $v_{EC} > 0.2$ V (otherwise, in saturation)
         - Must have very low input impedance compared to $\beta R_E$
       * Consequences:
         - $i_B \approx 0$
         - $v_E = v_B \pm 0.7$ V
         - $i_C \approx i_E$
     - Typically, use base and emitter voltages to find emitter current. Finish analysis by setting collector current equal to emitter current.
   - Symbols
     - Arrow represents base–emitter diode (i.e., emitter always has arrow)
     - npn transistor: Base–emitter diode is “not pointing in”
     - pnp transistor: Emitter–base diode “points in proudly”
     - See part pin-outs for easy wiring key
   - “Common” configurations: hold one terminal constant, vary a second, and use the third as output
     - common-collector ties collector to DC voltage so that variations in base cause variations in emitter ("emitter follower" or "voltage buffer")
     - common-base ties base to DC so that variations in emitter cause variations in collector ("current buffer" or "current source")
     - common-emitter ties emitter to DC so that variations in base cause variations in collector ("voltage amplifier")
     - emitter can be degenerated by a resistor between emitter and DC
     - emitter degeneration adds feedback and increases linearity
       - Increased base–emitter voltage $\implies$ increased collector current $\implies$ increased $R_E$
       - voltage $\implies$ decreased base–emitter voltage (i.e., negative feedback ensures base–emitter voltage of $\sim 0.7$ V)
       - With high $\beta$ or high $R_E$, collector current is independent of transistor nonlinearities (i.e., only depends on $v_B$ and $R_E$; linear amplifier of $v_B$)
     - emitter degeneration improves thermal stability (i.e., power dissipates across $R_E$ instead of transistor)
2. Laboratory experience

- When taking plots, save as CSV or BMP
  - Saving as BMP prevents extra work, but make sure scope plots show all required information
    * Intervals between horizontal and vertical divisions should be clear
    * In most cases, channel grounds should be shown
    * Channels should be labeled in report (e.g., “top waveform is input”)
  - If saving as CSV, be sure to...
    * Label axes and show units
    * Identify waveforms (e.g., “input” and “output”)
- Variable resistors: Potentiometers or resistance boxes
- Follow lab book
- Use handouts for guidance on particular circuits
  - Procedure (and troubleshooting)
  - Schematics and explanations
  - Pin-outs (avoid use of electrolytic capacitors)