# Advanced Amateur Radio Licence

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# Outline

# Tubes

- Diode: Electrons will flow in a vacuum from a hot cathode to an anode, but not the other way.
- Triode: Adding a grid in between at a variable voltage, allows to control a large current with a small current.
- Tetrodes and pentodes: Operation of the triode has some linearity and other problems. Tetrodes and pentodes add other grids (screens) to clean this up (roughly speaking).
- The Cathode may be heated separately by the filament, or heater.
- All this metal junk may have stray capacitance, and require *neutralization* in RF work.

# Grounded Grid amplifier

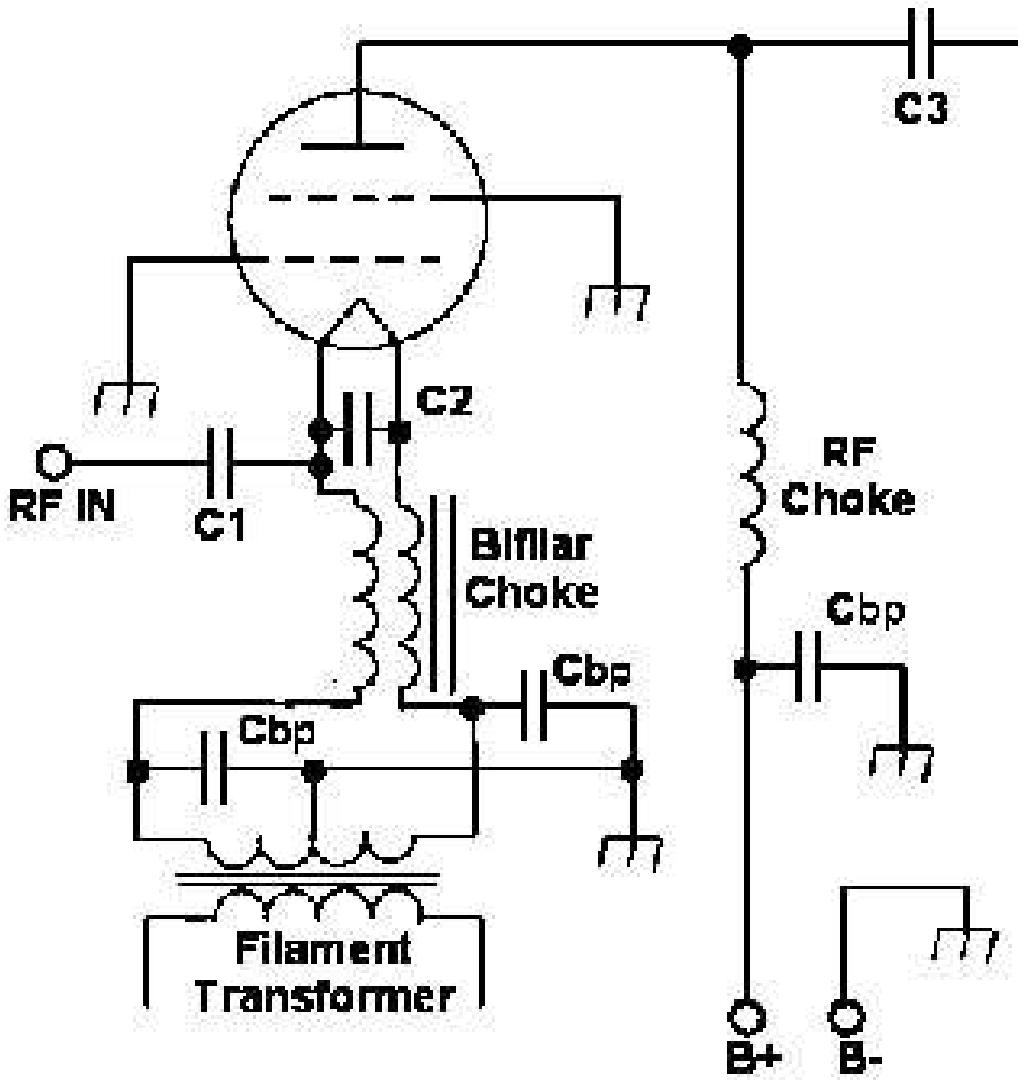



Image taken from `http://wb0nni.dakotamade.com/ggbasic.html`. See there for discussion, also the answer to the grounded grid questions

# Semiconductors

- Semiconductors are materials such as silicon, germanium or gallium arsenide (GHz freq).
- Note that pure Si is an insulator.
- When doped, there are either extra electrons (N-type), or missing electrons (holes) (P-Type)

# Diodes

- Hot-Carrier or Schottky - Low forward voltage drop and fast switching. Cats-whisker detector is a form of Schottky diode. Good for VHF/UHF mixers and detectors. Metal contact on a single type of doped semiconductor. 

- PIN diode - Have a layer of intrinsic semiconductor between the P and N layers. Low capacitance and fast switching. Good for RF switch
- Point-contact diode: Group III metal makes a sharp contact on N-type semiconductor. Some metal dissolves into the semiconductor generating a small P region. The 1N34 Germanium diode is an example, makes good RF detectors.

# Diodes

- Varactor diode - varies internal capacitance with applied voltage 

- Zener diode - regulates voltage through breakdown at a specific voltage level via the Zener mechanism, and some avalanche mechanism.
- Avalanche diode - (not on exam). Can suppress voltage spikes through avalanche breakdown - not as regulated as Zener.

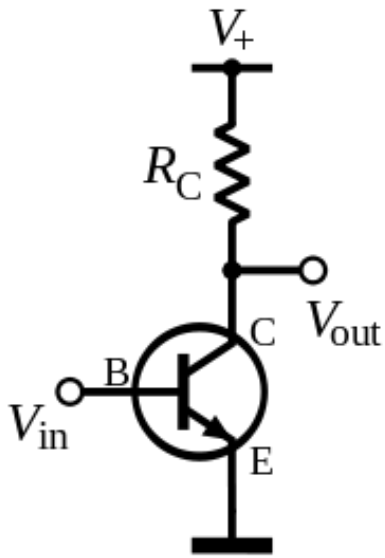
# Bipolar Junction Transistor

- PNP or NPN types. Current positive to negative against the arrow.
- Allows small base-emitter current to control large collector emitter current.
- $I_e = I_b + I_c$
- Common base current gain $\alpha = I_c/I_e$
- Common emitter current gain $\beta = I_c/I_b = H_{fe}$
- Common collector current gain $\gamma = I_e/I_b$
- $\alpha = \frac{\beta}{1+\beta} = \frac{\gamma-1}{\gamma}$
- $\beta = \frac{\alpha}{1-\alpha} = \gamma - 1$
- $\gamma = 1 + \beta = \frac{1}{1-\alpha}$

# Other active components

- FETs (Field Effect Transistors): A three terminal device, with source, drain and gate.
  - Enhancement mode FET: No channel, no current flows at zero voltage. Voltage must be applied to create the channel and allow current to flow.
  - Depletion mode FET: Channel, current flows with zero voltage applied. Voltage must be applied to shut it off (or encourage it)
  - Junction FET: has a PN junction to separate the gate
  - MOSFET: Metal-oxide-semiconductor separates the gate. Static sensitive.
- SCR: A three terminal (anode, cathode and gate), four layer (PNPN) device. Once triggered by gate current, behaves like a junction diode. In amateur radio, frequently used in crowbar overvoltage protection.

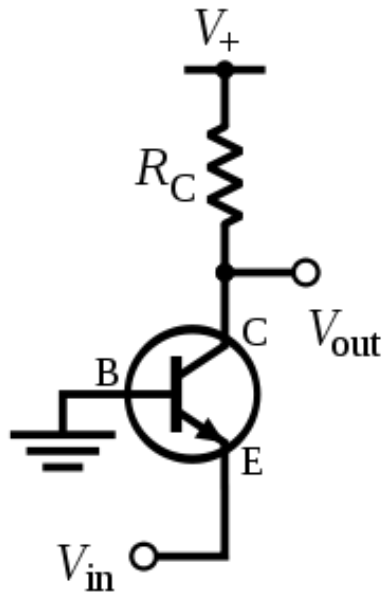
# Common Emitter




http://en.wikipedia.org/wiki/File:NPN_common_emitter.svg

- Current amplification $>> 1$. Voltage amplification $>> 1$
- phase reversal (180 degrees)
- similar to FET common source
- in the FET common source, the input impedance is essentially determined by the gate biasing network
- in the FET common source, output impedance is essentially determined by the drain resistor.

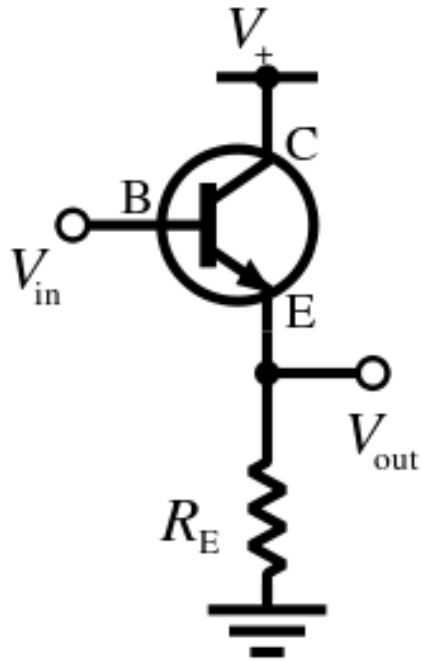
# Common Base




http://en.wikipedia.org/wiki/File:NPN_common_base.svg

- Current amplification $< 1$ Voltage amplification $>> 1$
- no phase shift
- low input impedance
- similar to FET common gate

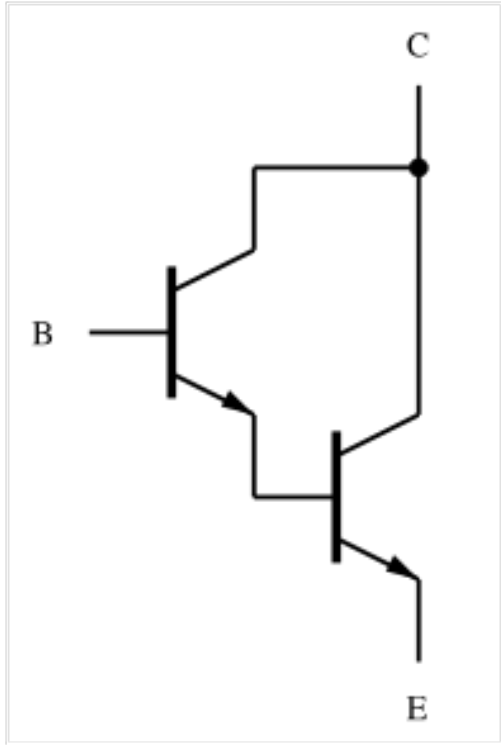
# Common collector




http://en.wikipedia.org/wiki/File:NPN_emitter_follower.svg

- Current amplification $>> 1$. Voltage amplification $< 1$
- no phase shift
- aka emitter follower
- similar to FET common drain (source follower)

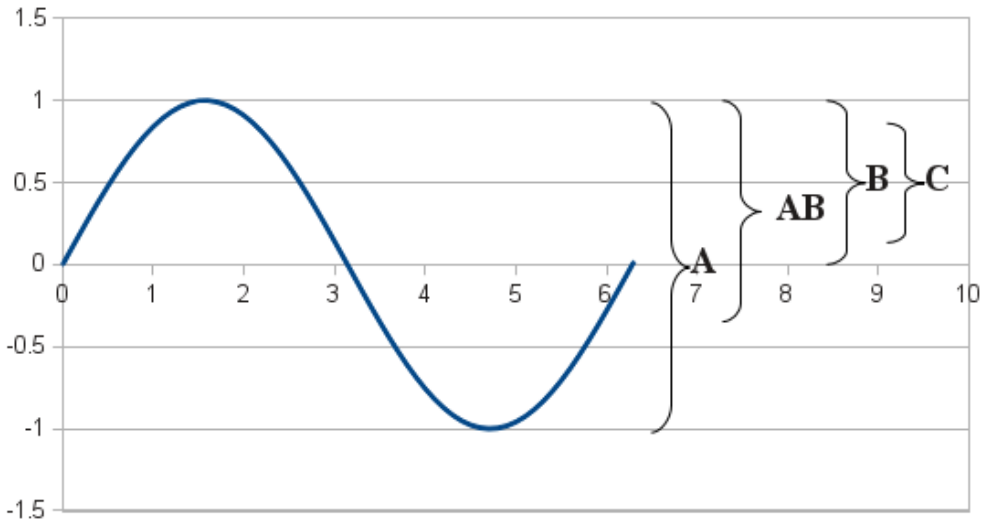
# Darlington pair




http://en.wikipedia.org/wiki/File:Darlington_pair_diagram.svg

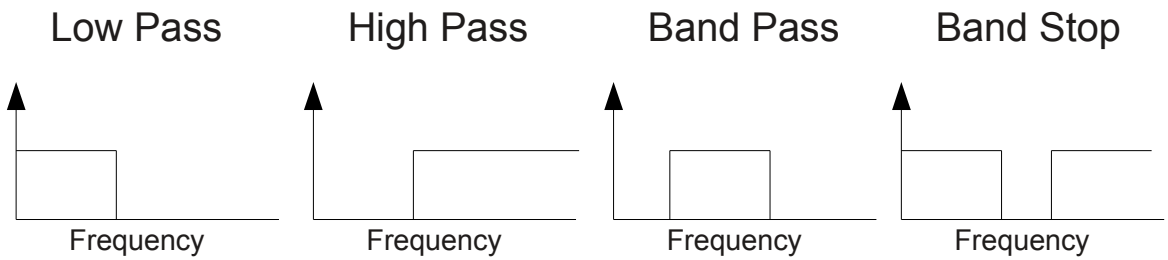
- Current amplification $>> 1$. Voltage amplification $>> 1$
- high gain
- high input impedance
- low output impedance

# Amplifier classes




- A: full 360 of phase, most linear, least efficient
- AB: More than 180 of phase, but less than 360 (SSB)
- B: 180 of phase
- C: Less than 180 of phase. Most distortion, most efficient (CW, RTTY or FM)

# Filters

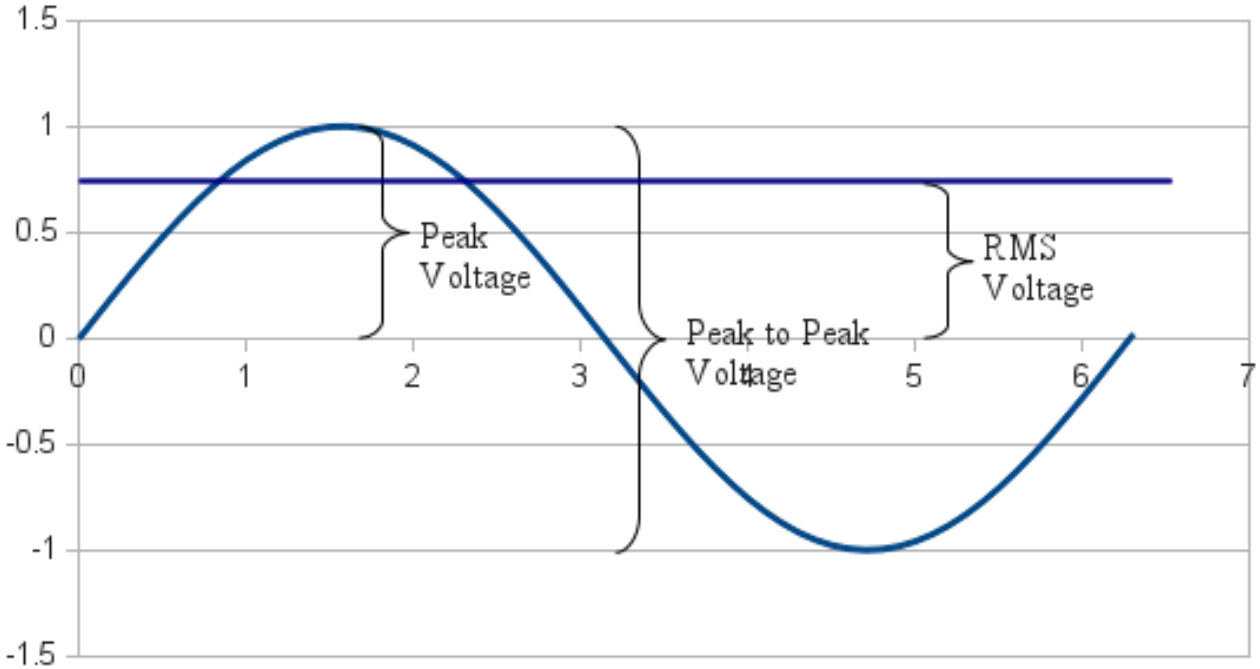



- Butterworth is flat (smooth as butter), but sacrifices steepness of skirts
- Chebyshev type I is described in the hamstudy notes (passband ripple).
- Chebyshev type II exists, has stopband ripple instead
- Both Chebyshevs accept some ripple in return for steep skirts
- Elliptic filters are a family of filters that range between Butterworth, and the two Chebyshevs at the extremes.
- Cavity filters and helical resonators are physical objects. Cavity filters have very narrow BW.

## See the hamstudy notes

- Operational Amplifiers
- Mixer and frequency multiplier (explain image frequency)
- Digital Logic
- Quartz Crystals

# Voltages and PEP




- Peak Envelope Power: $PEP = E_{RMS}^2/R$

# See Notes

- For the rest of the meters, see the hamstudy notes