

# Solid-State Electronics

- Purpose of electronic circuits is to process information
- Information can be encoded either as an *analog* signal or as a *digital* signal
- For an analog signal, some electrical quantity (voltage, current, frequency,...) is proportional to the amplitude of the information
- For a digital signal, information is encoded, generally using only two analog values

# Electronic Circuits

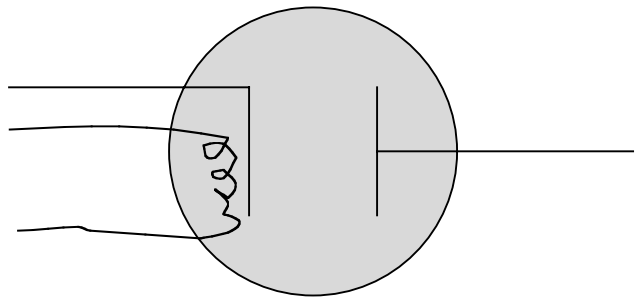
- Electronic circuits use both *passive* and *active* elements
- Passive elements include wires, resistors, capacitors, inductors, mechanical switches and relays,...
- Active elements include diodes and transistors
- Both passive and active elements are packaged using integrated circuits and circuit boards or modules

# Diodes

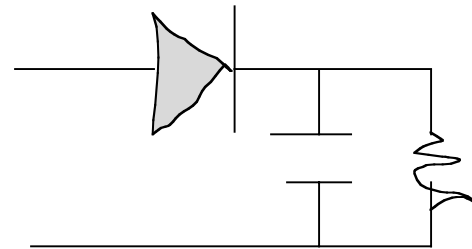
- Simplest active circuit element is a diode
- Diode conducts current in one direction but not the other direction
- Diodes are used primarily as rectifiers, today almost entirely in power circuits

# Diodes

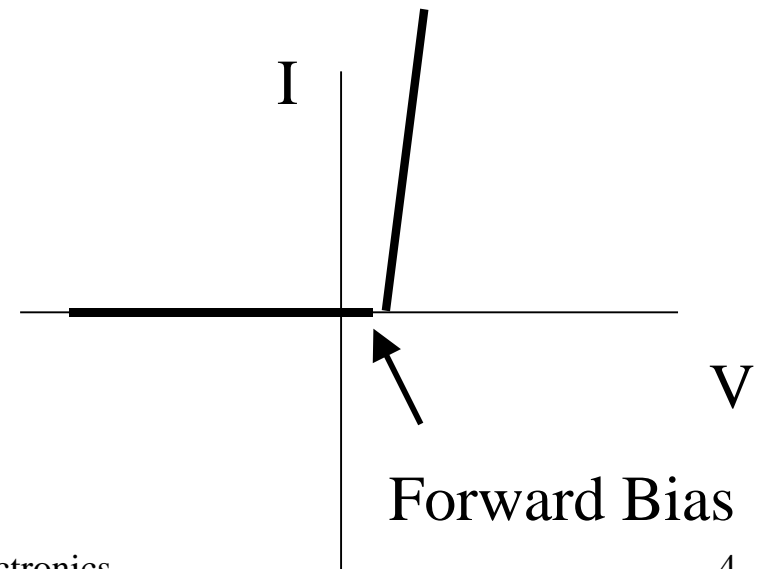
Vacuum Tube Diode



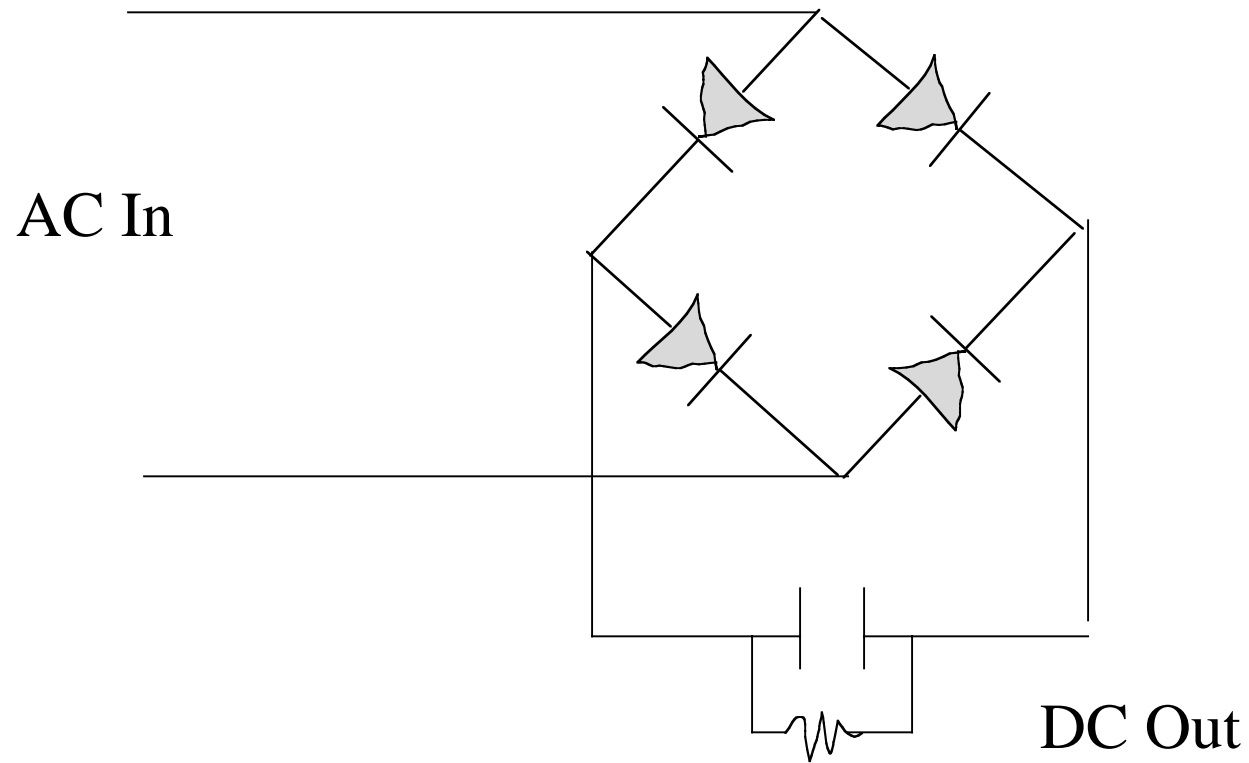
Half-Wave Rectifier



Diode Symbol: conducts  
+ current in arrow direction

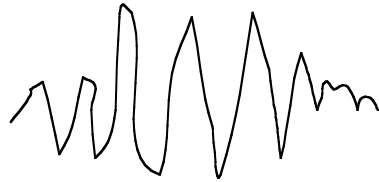


# Diodes



# Demodulation

Amplitude Modulation (AM)



Rectify



Then Low-Pass Filter (Smooth) with Inductor



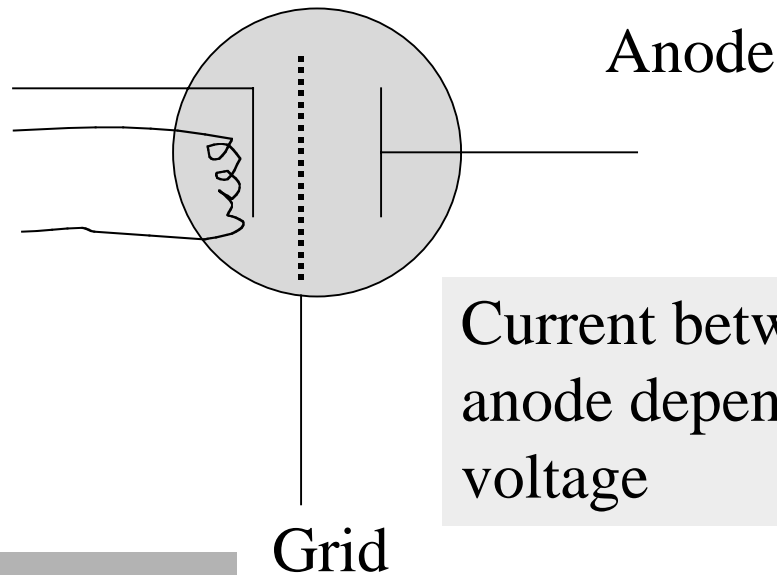
Feed in earphone and you have a  
“crystal set”—usable for  
Morse code and low-quality audio

# Power Amplification

- Diodes do not provide any power amplification
- Major problem because all circuits have losses
- Need a circuit element where a small current can control a large current

# Vacuum Triode

Cathode

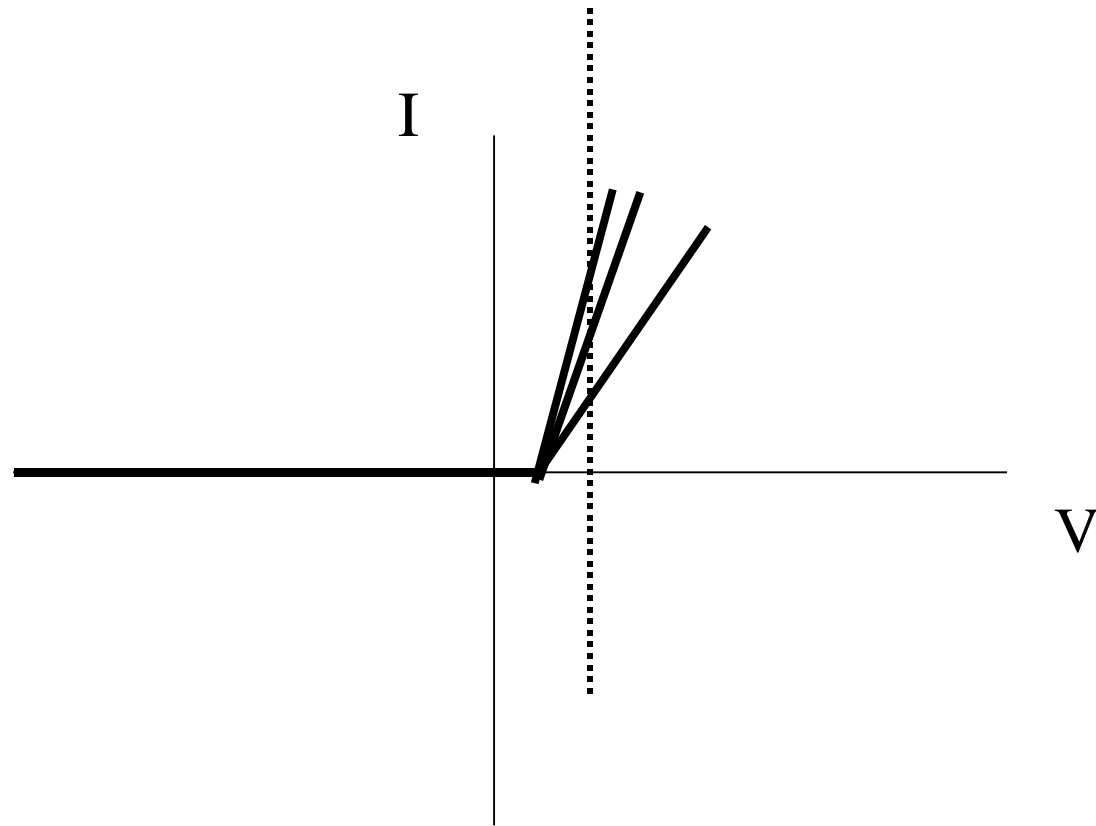


Current between cathode and anode depends on grid voltage

Grid has high impedance; so big voltage change requires little current or power

Grid designed to be a poor electron emitter

# Vacuum Triode

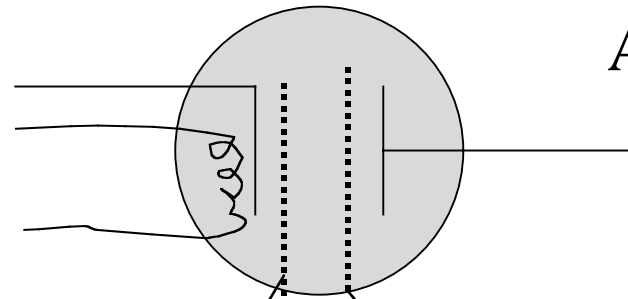


# Gates

- Digital circuits require logical elements or gates
- Example is an AND gate that produces a HIGH output if and only both inputs are HIGH
- How would you make a vacuum tube gate?

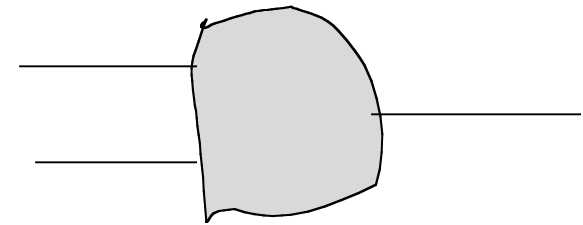
# Vacuum Tetrode AND

Cathode

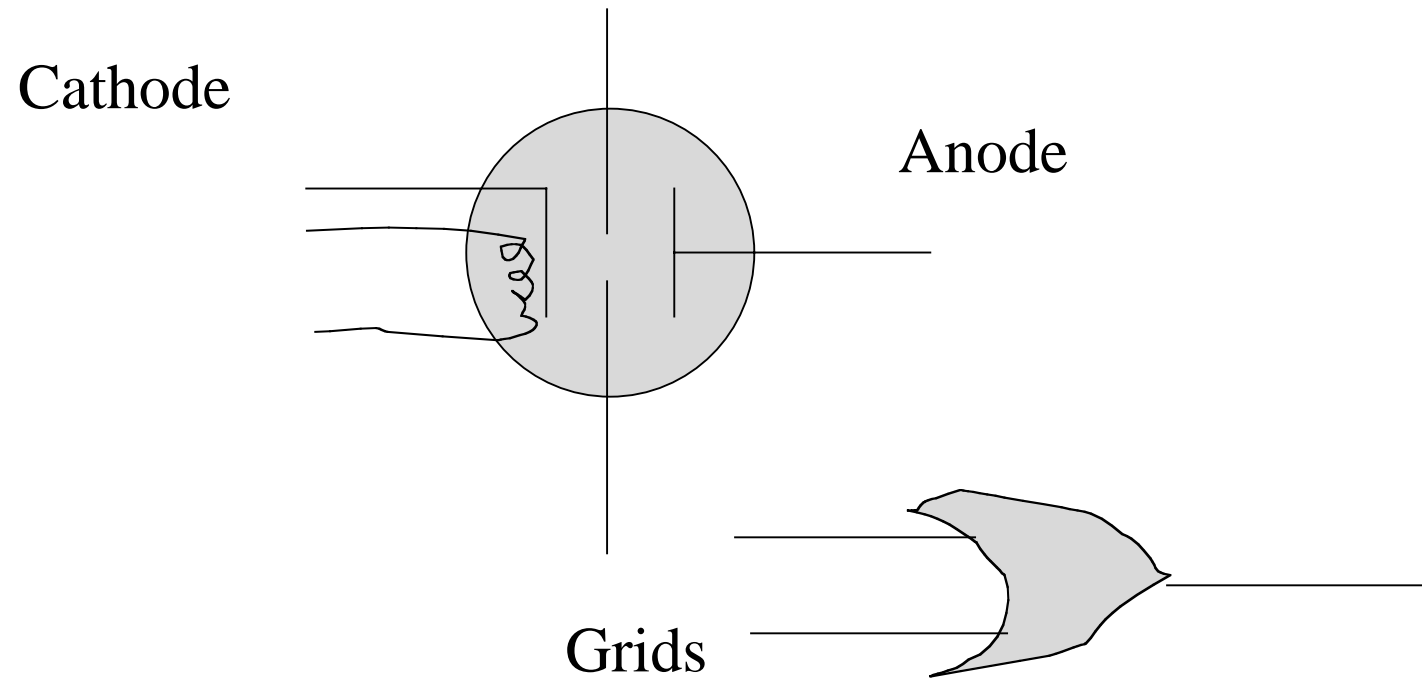


Anode

Grids



# Vacuum Tetrode OR



# Solid State Electronics

- Use semiconductors—silicon or germanium
- Are tetravalent; have covalent bonds
- Add small amounts of impurities
- Arsenic has valence 3: p-type semiconductor
- Phosphorus has valence 5: n-type semiconductor

# Semiconductor Diode

