Class “A”, “B”, and “C” Amplifiers

Session 6d for Electronics and Telecommunications
A Fairfield University E-Course
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Module: Semiconductor Electronics
(in two parts)

- Text: “Electronics,” Harry Kybett, Wiley, 1986, ISBN 0-471-00916-4
- References:
  - Electronics Tutorial (Thanks to Alex Pounds)
  - Electronics Tutorial (Thanks to Mark Sokos)
- 5 - Semiconductors, Diodes and Bipolar Transistors
  - 5 on-line sessions plus one lab
- 6 - FETs, SCRs, Other Devices and Amplifiers
  - 5 on-line sessions plus one lab
- Mastery Test part 3 follows this Module

Section 6: FETs, SCRs, Other Devices and Operational Amplifiers

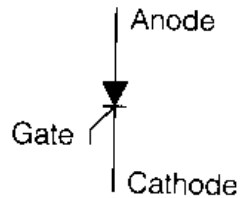
- 0BJECTIVES: This section reviews additional important semiconductor devices and their applications. The Operational Amplifier is also studied.

Section 6 Schedule:

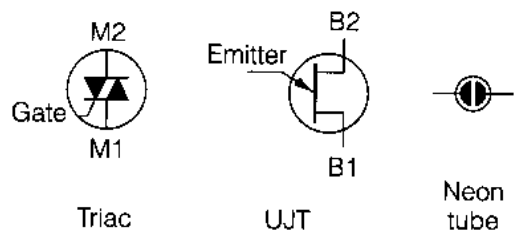
Session 6a	01/15	Field Effect Transistors	Kybett pp 70 – 77, pp 201-209
Session 6b	01/20	Transistors as a switch	Kybett pp 78 –107
Session 6c	01/22	SCR's, Triacs and UJTs	Notes
Session 6d (Lab - 02/01, Sat.)	**01/27**	**Class "A", "B", and "C" Amplifiers**	**Notes**
Session 6e	02/05	Op-Amps	Kybett pp 209-215
Session 6f (Quiz 6 due 02/23)	02/10	Review for Quiz 6	
Session 6g	02/24	Discuss Quiz 6	
Session 6h	02/26	Review for MT3	
MT3	03/01	MT3 Exam	
Session 6i	03/10	Discuss MT3	

Last Time: Other Devices

- SCR: Half wave current controlled triggered switch
  - 4 layers, normally off, triggered on
  - Reverse bias turns it off



- Triac: Full wave triggered switch
  - Effectively two SCR's in parallel (reverse polarity)
- Diac (and neon bulb): 2-terminal Avalanche device
  - Normally high impedance,
  - Low impedance triggered by threshold voltage
  - Reverse bias turns it off
- UJT: 3-terminal voltage controlled avalanche/recovery

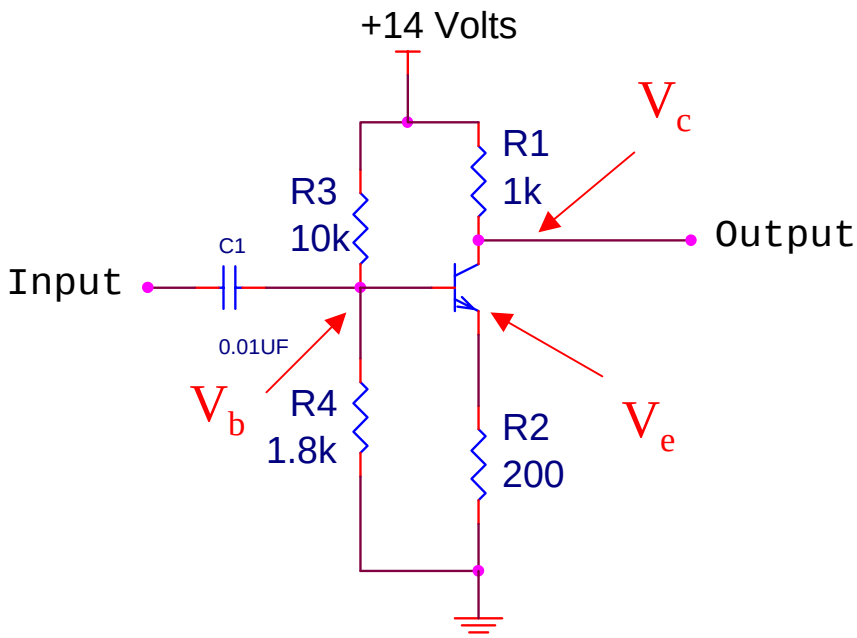


Class A Amplifier

- Transistor is biased on
  - Avoid cutoff
  - Avoid saturation
- Provide linear amplification
- Low power efficiency
  - DC bias causes power dissipation in the transistor
  - Its always in its active region

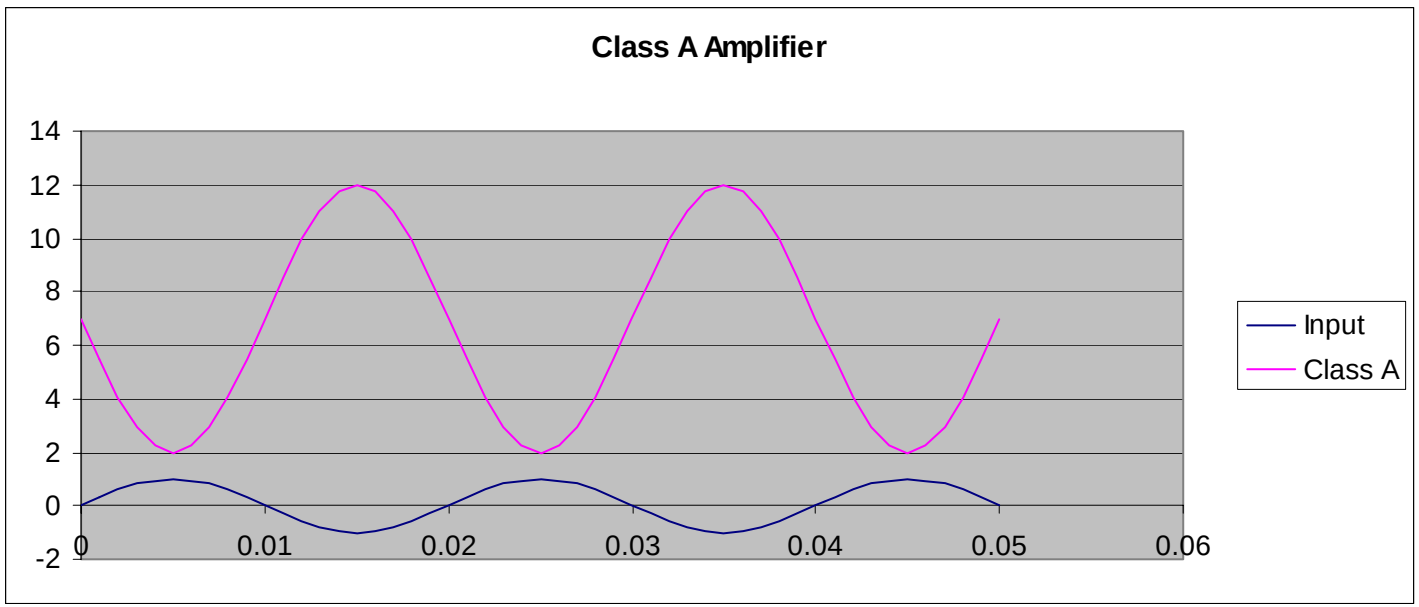
Biasing the Common Emitter Amplifier

- $V_b = 14*1.8/(11.8)$
  $= 2.1v$ (voltage divider)
- $V_e = V_b - 0.7 = 1.4v$
- $I_e = 1.4/200 = 7$ ma
- $I_c \sim I_e = 7$ ma
- $V_c = 14 - 1000*.007$
  $= 7$ v
- Gain $\sim -R_1/R_2 = -5$



Class A Amplifier Waveforms

- One volt (peak) AC input
- Five volt AC output riding on 7 volt DC
  (Oops, the bottom of the sine wave is clipped; the transistor saturates)

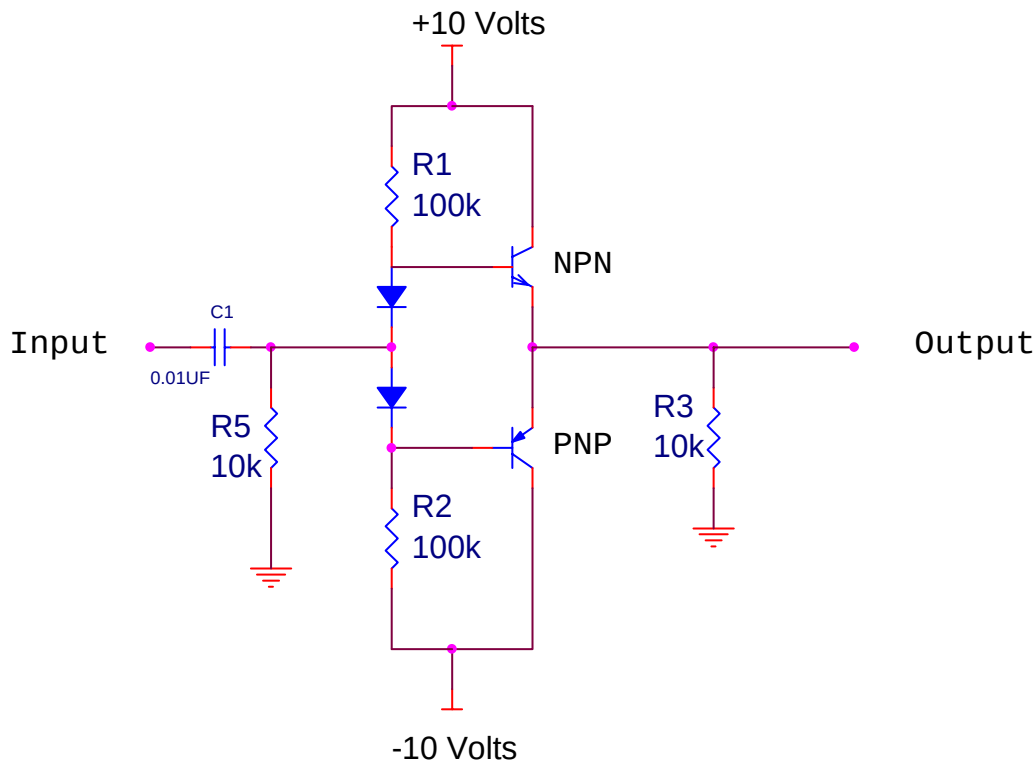


Class B Amplifier

- Use complementary pair of transistors
  - NPN with PNP
  - N-channel with p-channel
- One transistor is active during the positive going half of the AC signal
- The other transistor is active during the negative half of the AC signal
- Higher power efficiency (better than 50%)
- Some “crossover” distortion
  - Reduced in class AB
  - Bias both transistors slightly on

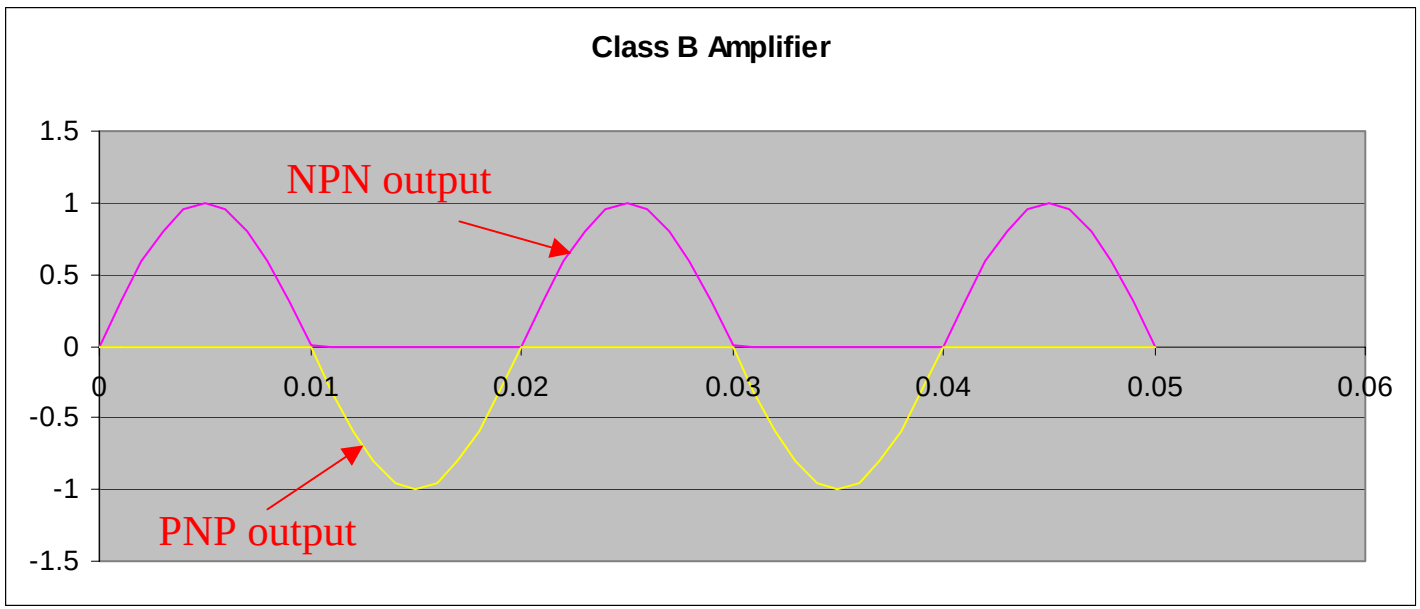
Class B Common Collector Biasing

- Both diodes are forward biased
- NPN base at +0.7v
- PNP base at –0.7v
- Output is at 0 v DC
- Both transistors slightly on
- Positive input turns NPN on / PNP off
- Negative input turns PNP on / NPN off



Class B Amplifier Waveforms

- The output is the whole sine wave with no DC power dissipation.
- This output circuit (often using MOSFETS) is in your HiFi amplifiers and drives your low impedance speakers

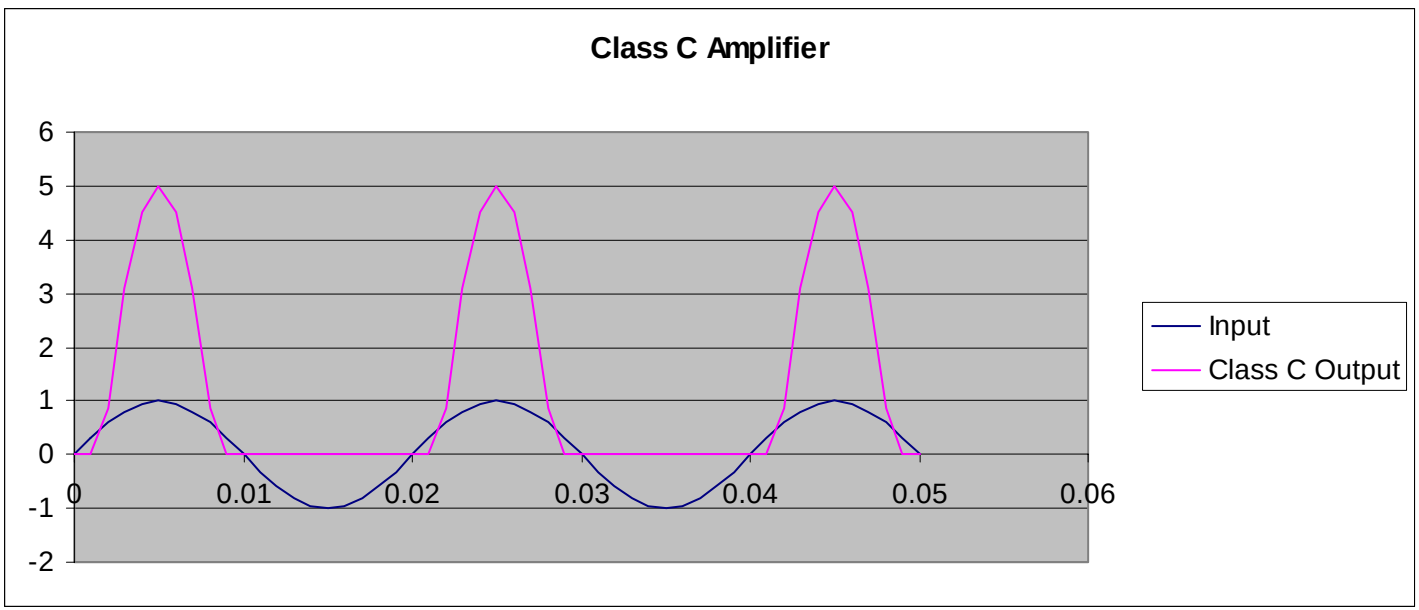


Class C Amplifiers

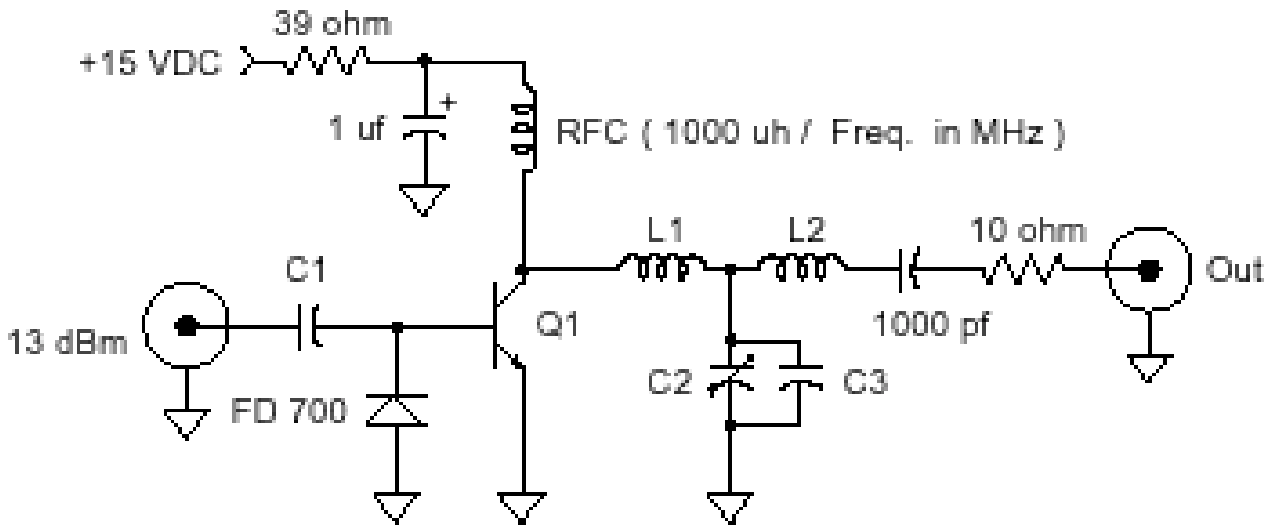
- The transistor is biased off
- It only conducts current for a portion of the positive peak input.
- The resulting output pulses drive a resonant circuit to produce a sine wave output
  - Think of you pushing a child on a swing
- High power efficiency (about 80%)
- Good as high power radio frequency transmitters

Class C Amplifier Waveforms

- Current pulse at each peak of the input sine wave
- Transistor is off for most of the input cycle
- Useful for driving a high Q resonant circuit at its resonant frequency



A Class “C” RF Amplifier



Freq.	P out	C1	C2	C3	L1	L2	RFC	Q1
30 MHz	30 dBm	150 pf	15 pf	39 pf	1.5 uh	1.2 uh	33 uh	2N5109
100 MHz	24 dBm	68 pf	10 pf	none	.82 uh	.47 uh	10 uh	2N5109
200 MHz	30 dBm	33 pf	10 pf	none	.47 uh	.27 uh	5.6 uh	MRF227

One Watt Class-C Amplifier

The FD700 diode keeps the duty-cycle near 50% for good efficiency for a wide range of input power levels.

Amplifier Summary

Class	Duty Cycle	Efficiency	Application
A	100%	Low	Linear small signal
B (AB)	50%	~ 50%	Linear power
C	< 50%	~ 80%	RF Power
D	High speed switching	~ 85%	DC power supplies and Low frequency linear power

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