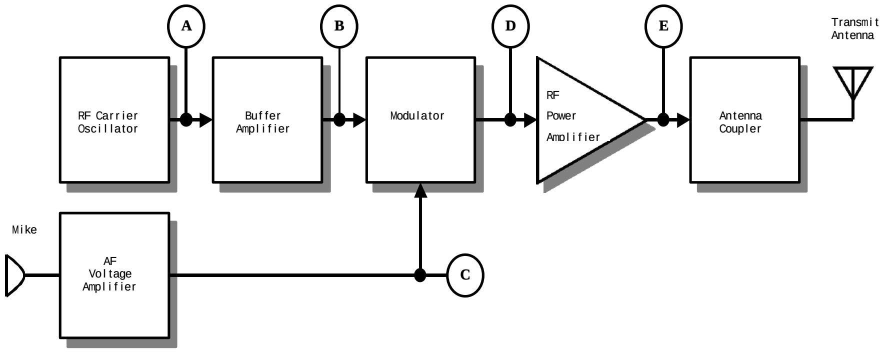
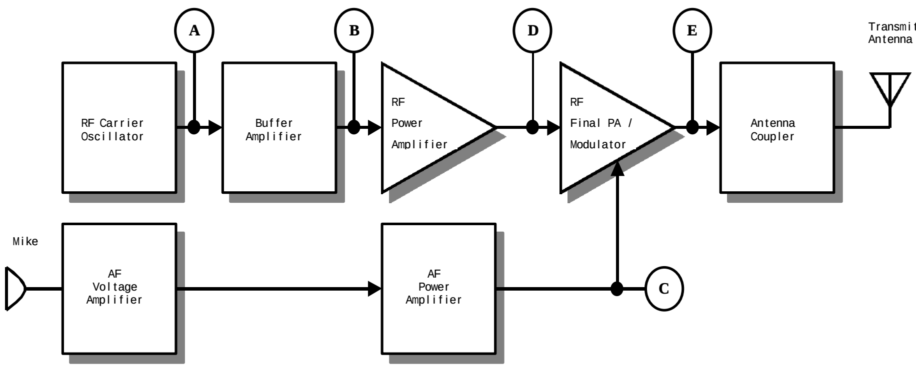
Homework #4 Solution Set

(12 points - 1 per problem)

1. *Draw a block diagram of both low and high-level AM transmitters*.



Low-Level Transmitter (Figure 4-1)



High-Level Transmitter (Figure 4-2)

2. *How can a high-level AM transmitter be identified when examining the schematic or block diagram*?

Look for the place where modulation occurs. A high-level transmitter modulates in the last or final amplifier stage.

3. *What is meant by the term "frequency stability" when referring to oscillators*?

Frequency stability is the ability to keep the carrier frequency constant. It is often measured in ppm (parts per million).

4. *What two design features are used in AM transmitters to enhance oscillator stability*?

The two design features are <u>voltage regulation</u> for the oscillator stage, and <u>buffering</u> (the addition of an isolator or buffer amplifier stage at the oscillator output).

5. *What are the two functions of an antenna coupler*?

An antenna coupler serves to <u>impedance match</u> the antenna to the final RF power amplifier, and <u>attenuates harmonic energy</u> to prevent it from reaching the antenna.

6. *A certain AM transmitter requires 1A from a 48VDC supply. It produces 36 W of RF output. What is its DC efficiency*?

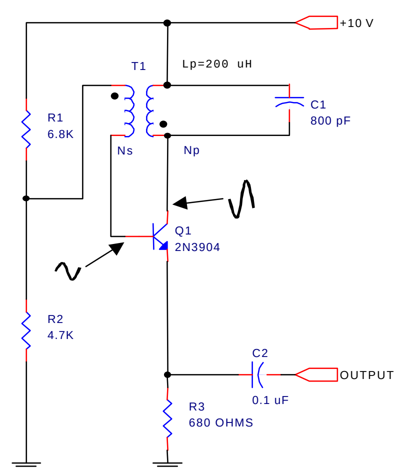
The efficiency is found as follows:

$$h = \frac{P_{out-RF}}{P_{in-DC}} = \frac{36W}{(48V)(1A)} = \underline{\underline{75\%}}$$

7. *If an oscillator is built like the block diagram of figure 4-4 and has a feedback gain B of 0.01, what minimum gain A would be needed for it to keep running (if already running)*?

The Barkhausen criteria state that the loop gain AB must be at least 1 for an oscillator to keep running. The minimum gain A would therefore be <u>100</u> to satisfy the requirement.

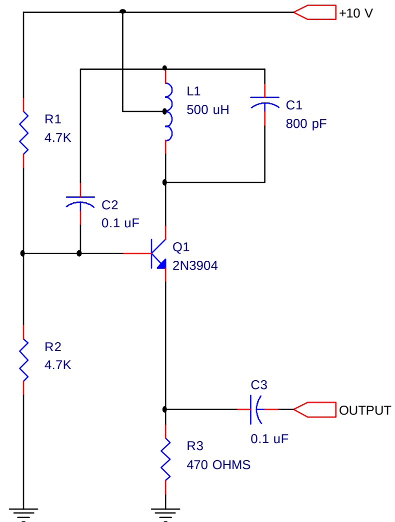
8. *What will the oscillation frequency of the oscillator in figure 4-8 be if Lp= 100 uH and C1 = 1 nF*?



[Figure 4-8]

$$f = \frac{1}{2p\sqrt{LC}} = \frac{1}{2p\sqrt{(100mH)(1nF)}} = \underline{\underline{503.3KHz}}$$

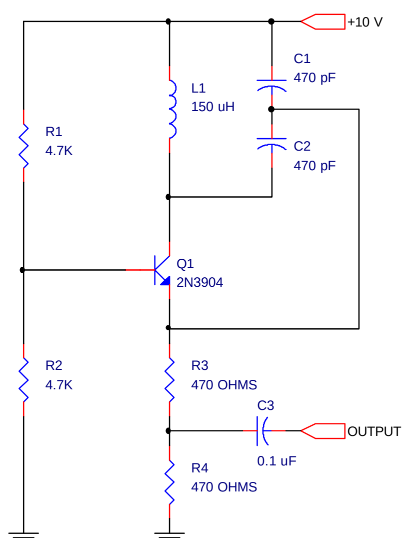
9. *Calculate the frequency of the oscillator of figure 4-9 if L1=1 mH and C1=400 pF***.**



[Figure 4-9]

$$f = \frac{1}{2p\sqrt{LC}} = \frac{1}{2p\sqrt{(1mH)(400pF)}} = \underline{\underline{251.6KHz}}$$

10. *What frequency will be produced by the oscillator of figure 4-11 if L1=500 mH, C1=330 pF, and C2=470 pF***?**



[Figure 4-11]

$$C_t = \frac{C1C2}{C1 + C2} = \frac{(330pF)(470pF)}{330pF + 470pF} = 193.88pF$$

$$f = \frac{1}{2p\sqrt{LC_t}} = \frac{1}{2p\sqrt{(500mH)(193.88pF)}} = \underline{\underline{511.17KHz}}$$

11. *What is added to a Colpitts oscillator in the Clapp configuration? How does the change increase frequency stability*?

A small capacitance is added in series with the inductor. This added capacitance "dominates" the tank circuit since it is much smaller than the two voltage divider capacitors. Because the added capacitance dominates the tank, the circuit becomes much less sensitive to variations in capacitances around the tank, such as those of the active device.

12. *How are Q and bandwidth of a tuned circuit related? If Q is increased, what happens to bandwidth*?

Q and bandwidth are inversely related; BW = f/Q. If Q is increased, bandwidth becomes smaller.