1. (a) The triangular signal of Fig. 1(a) is input to the class A amplifier of Fig. 1(b). The amplifier has the following parameters: $V_{CC}=5V$, $V_{BE}=0.7V$ (assume constant), $V_{CE,sat}=0.3V$, $R_L=2k\Omega$, and the bias current is designed to be $I=V_{CC}/R_L$. Sketch the output voltage $v_o$.

(b) What type of feedback is employed in the circuit below:

(c) We discussed three types of power amplifiers or output stages in class: Class A, Class B, and Class AB. Which type has the worst distortion? ________________

Which type has the highest power efficiency? ________________

Which type has the lowest power efficiency? ________________

(d) If we put a square wave into a feedback amplifier, and the output shows too much ringing for our application, is the phase margin too high or too low? ________________
2. An amplifier has a dc gain of $10^5$ and high-frequency poles at $10^5$ Hz, $3.16 \times 10^5$ Hz, and $10^6$ Hz. For a phase margin of $45^\circ$ find the value of $\beta$ and the corresponding closed-loop gain.

3. Consider the amplifier below. When the source voltage $V_s$ has zero dc component, the output dc voltage is $V_o=5V$. Let both BJTs have $\beta=50$, and assume constant $V_{BE}=0.7V$ for both BJTs. Determine the dc voltages at all nodes and the dc emitter currents of $Q_1$ and $Q_2$. Use feedback analysis to find $V_o/V_s$ and $R_{in}$.

![Amplifier Circuit](image)

4. Consider the circuit shown below. The transistor has $\beta=100$, and is biased so that the dc operating point is $I_B=0.015mA$, $I_C=1.5mA$, and $V_o=4.7V$. Determine the small-signal loop gain.

![Transistor Circuit](image)

5. Consider a feedback amplifier for which the open-loop gain $A(s)$ is given by

$$A(s) = \frac{1000}{(1+\frac{s}{10^5})(1+\frac{s}{10^5})^2}$$

If the feedback factor $\beta$ is independent of frequency, find the frequency at which the phase shift is $180^\circ$, and find the critical value of $\beta$ at which oscillations will commence. (Hint: A good initial guess for the desired frequency is $10^5$ rad/sec.)
6. The datasheet of the PN2222A bipolar transistor contains the following information:

Maximum allowable junction temperature \( T_{J_{\text{max}}} = 150^\circ\text{C} \)
Maximum power dissipation \( P_{D_{\text{max}}} = 625 \text{ mW at ambient temperature } T_A = 25^\circ\text{C} \)
Junction-to-case thermal resistance \( \theta_{JC} = 80^\circ\text{C/W} \)

(a) Draw an equivalent electrical circuit for this thermal system. Label all components as well as the junction temperature \( T_J \), the case temperature \( T_C \), and the ambient temperature \( T_A \). (Note that we are not using a heat sink in this problem.)

(b) Find the case-to-ambient thermal resistance \( \theta_{CA} \).

(c) Assuming an ambient temperature of 25°C, what is the case temperature \( T_C \) when the transistor dissipates 500 mW?

7. Exercises 12.31 and 13.18