You should work in teams of 3 students and deliver your results by **Tuesday, March 9**.

1. For the following circuit

![Circuit Diagram](image)

Show that the quiescent operating currents are $I_{CQ1} \simeq 486 \mu A$ and $I_{CQ2} \simeq 1.35 mA$, and use the two-port method discussed in the lectures to

a) determine the type of amplifier that is appropriate for the feedback analysis and the feedback network’s parameters $\beta$, $R_{11}$ and $R_{22}$;

b) find the voltage gain, $v_{out}/v_{in}$, the input resistance seen by the source and its $1k\Omega$ input resistance, and the output resistance seen by the load $R_L$.

Assume $h_{fe} = 100$, $V_{BE} = 0.7V$ and $V_A = 50V$ for both transistors.

2. Use SPICE to find the voltage gain, $v_{out}/v_{in}$, the input resistance seen by the source and its $1k\Omega$ input resistance, and the output resistance seen by the load $R_L$. for the previous circuit. Compare the results to those in the previous problem.

3. For the following amplifier

![Amplifier Diagram](image)

a) write an expression for the loop gain if $R_1 = 1k\Omega$, $R_2 = 20k\Omega$, $C_C = 0$, and the op amp transfer function is

$$A(s) = \frac{2 \times 10^{11} \pi^2}{(s + 2\pi \times 10^2)(s + 2\pi \times 10^4)}$$

and use it to estimate the phase margin analytically.
b) use MATLAB (or Octave) to make a Bode plot of $T(s)$. What is the phase margin of this circuit?

c) Can compensation capacitor $C_C$ be added to achieve a phase margin of 45°? If so, what is the value of $C_C$. 