PROBLEM SET #11

Issued: Friday, November 20, 2020

Due: Friday, December 4, 2020 at 12:00 noon via **Gradescope**

1. Two identical CE amplifiers are connected in cascade, as shown in Fig PS11.1. The first stage is fed with a source v_{sig} having a resistance $R_{sig} = 8k\Omega$. A load resistance $R_L = 12k\Omega$ is connected to the collector of the second stage. Each BJT is biased at $I_C = 0.25mA$ and has $\beta = 100,\ C_\mu = 1\ pF, C_\pi = 10\ pF$. Each stage utilizes a collector resistance $R_C = 12k\Omega$. Find the input resistance R_{in}, overall voltage gain, v_{o2}/v_{sig} and f_H.

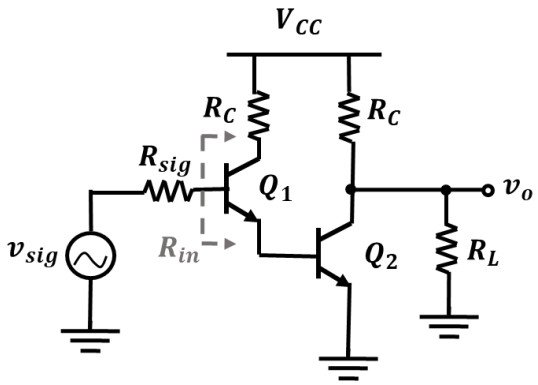

Fig PS11.1

2. Sedra & Smith, Problem 7.130

3. Fig PS11.2 shows a three-stage amplifier in which the stages are directly coupled. The amplifier, however, utilizes bypass capacitors, and, as such, its frequency response falls off at low frequencies. For our purposes here, we shall assume that the capacitors are large enough to act as perfect short circuits at all signal frequencies of interest. The three transistors have $C_\mu = 0.5\ pF$, and $C_\pi = 6\ pF$.

a) Find the dc bias current in each of the three transistors. Also find the dc voltage at the output. Assume $|V_{BE}| = 0.7V, \beta = 100$, and neglect the Early effect.

b) Find the input resistance and the output resistance.

c) Evaluate the voltage gain v_o/v_i and f_H.

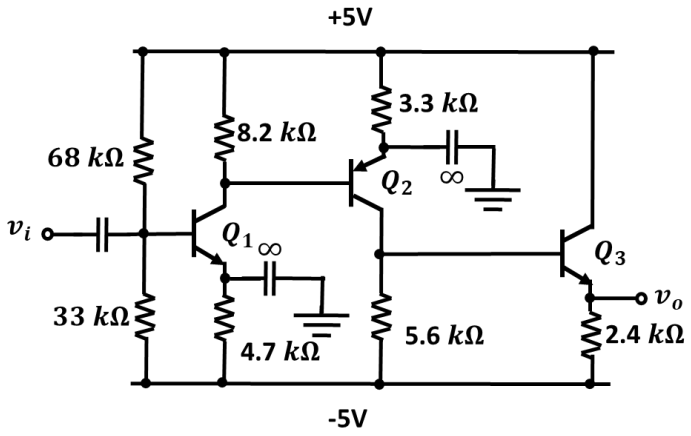

Fig PS11.2

4. For the amplifier in Fig PS11.3, assume that M_1 and M_2 have the parameters listed in Table PS.11.1. Find the overall voltage gain $\frac{v_o}{v_s}, R_{in}, R_{out}, f_L$ and f_H.

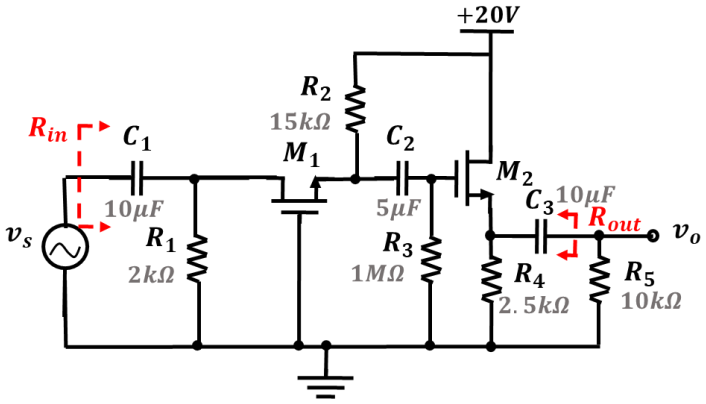

Fig PS11.3

PARAMETER	VALUE	UNIT
W	200	μm
L	1.2	μm
μ_n	480	$cm^2/(V \cdot s)$
μ_p	250	$cm^2/(V \cdot s)$
C_{ox}''	0.5	$fF/\mu m^2$
V_{tn}	-2	V
V_{tp}	4	V
L_{ov}	0.1	μm
C_{db0}	20	fF
C_{sb0}	20	fF
V_0	0.7	V
λ	0.02	V^{-1}

Table PS11.1

5. For the CMOS amplifier in Fig PS11.4, $\lambda_3 = 0.01V, K_{n1} = K_{n2} = K_{n4} = \frac{5.0mA}{V^2}$, $K_{p3} = \frac{2.5mA}{V^2}, I_1 = 200\mu A, I_2 = 500\mu A,\ I_3 = 5mA, R_D = 375k\Omega, C_{gs} = 20\ fF, C_{gd} = 5\ fF$ and $V_{TP3} = -1V$. What is the voltage gain, cutoff frequency f_H, input resistance and output resistance of the amplifier if $R_L = 2k\Omega$?

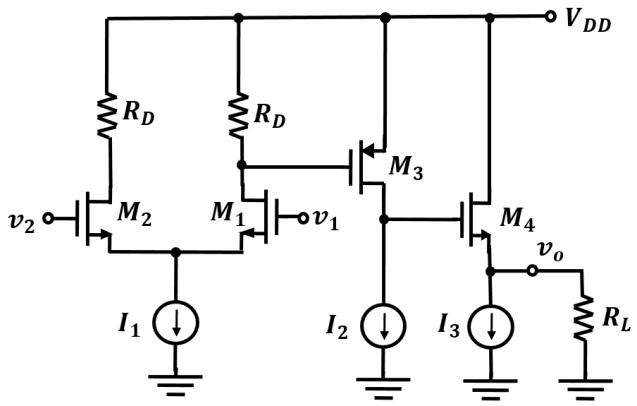

Fig PS11.4