PROBLEM SET #9

Issued: Friday, November 1, 2019

Due: Friday, November 8, 2019, at 12:00 noon via Gradescope.

1. Sedra & Smith, Problem 10.1
2. Sedra & Smith, Problem 10.3
3. Sedra & Smith, Problem 10.7
4. Sedra & Smith, Problem 10.31
5. For the amplifier in Figure PS9.1, assume that M_1 has the properties listed in Table PS9.1. First, find values for each of the MOSFET internal capacitances C_{GS}, C_{GD}, C_{DB} and C_{SB} assuming that the body terminal is grounded. Then find the voltage gain A_v, input and output resistances R_{in} & R_{out}, upper and lower corner frequencies f_L & f_H, and the maximum amplitude of the signal source v_s. Note that R_{in} and R_{out}, by convention, should not include either the source or load resistances, which are boxed in red in Figure PS9.1.

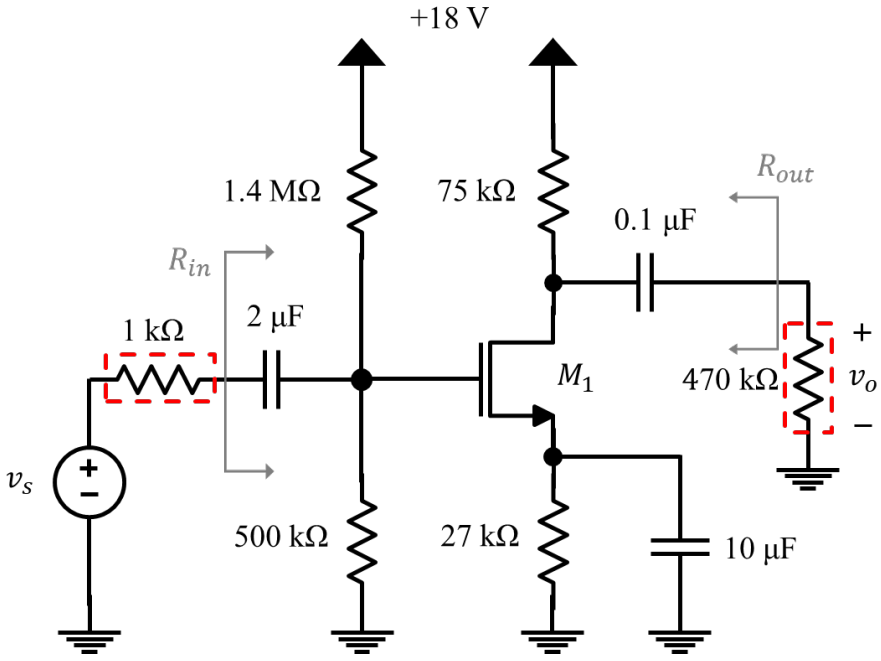

Figure PS9.1

PARAMETER	*VALUE*	*UNIT*
W	20	μm
L	1	μm
μ_n	500	$cm^2/(V{\cdot}s)$
C_{ox}''	0.5	$fF/\mu m^2$
V_{tn}	0.9	V
L_{ov}	0.05	μm
C_{db0}	15	fF
C_{sb0}	15	fF
V_0	0.7	V

Table PS9.1

6. For the amplifier in Figure PS9.2, assume that Q_1 has $\beta = 150$, $V_A = 100$ V, $C_{jc,0}$ = 1.0 pF, $C_{je,0}$ = 3.5 pF, $V_{bi,c}$= 0.9V, $V_{bi,e}$= 1.0V, and τ_F = 1 ns. You should also calculate the collector-to-substrate capacitance C_{CS} assuming $C_{cs0} = 20$ fF and $V_{bi(collector-substrate)} = 0.65$ V. Find A_v, R_{in}, R_{out}, f_L, f_H and the maximum amplitude of the signal source v_s.

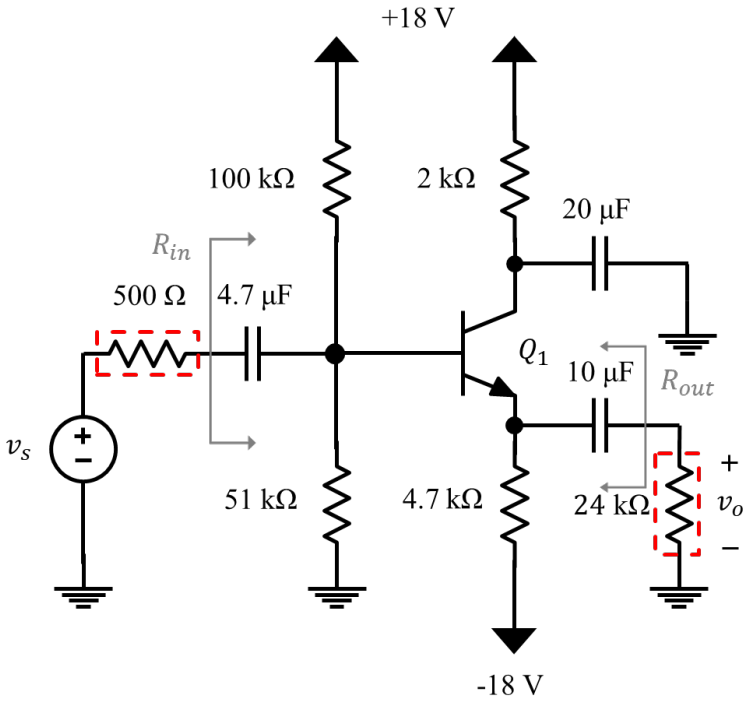

Figure PS9.2

7. A single-transistor amplifier is needed that has a gain of 50 dB and an input resistance of 100 kΩ. What is the preferred choice of amplifier topology and technology (i.e. BJT vs. MOSFET)? Explain your reasoning for making this selection.

8. A single-transistor amplifier is needed that has a gain of approximately 0 dB and an input resistance of 15 MΩ with a load resistor of 5 kΩ. What is the preferred choice of amplifier topology and technology? Explain your reasoning for making this selection.

9. A single-transistor amplifier is needed that has a gain of approximately +20 V/V and an input resistance of 5 kΩ. What is the preferred choice of amplifier topology and technology? Explain your reasoning for making this selection.