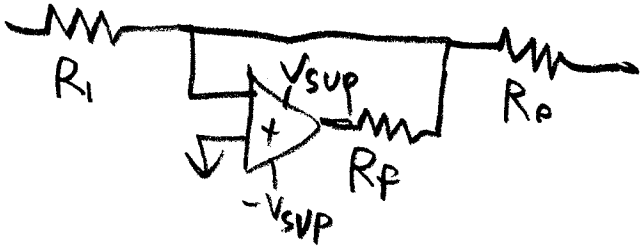
ECE4803 HW #3 Soln's

1) General structure is



Asides:
#2: $R_o = 49.9k \| 390k = 44.24\ k$
#4: $R_o = 75k \| 1.5M = 72.34\ k$

From lecture, plug in negative supply voltage for Vin>0 case

$$V_{out} = \frac{\frac{V_{in}}{R_1} + \frac{V_{sup}}{R_f}}{\frac{1}{R_1} + \frac{1}{R_f} + \frac{1}{R_o}} \quad \text{for} \quad \frac{V_{in}}{R_1} + \frac{V_{sup}}{R_f} > 0$$

$$V_{in} > -V_{sup}\frac{R_1}{R_f}$$

Defines dead band

$$\text{slope is} \quad \frac{\frac{1}{R_1}}{\frac{1}{R_1} + \frac{1}{R_f} + \frac{1}{R_o}}$$

#1: edge: $(14V)\frac{10k\Omega}{150k\Omega} = 0.9333V$

slope: $\frac{\frac{1}{10}}{\frac{1}{10} + \frac{1}{150} + \frac{1}{100}} = 0.8571$

#2: edge: $(14V)\frac{49.9}{150} = 4.6573V$

slope: $\frac{\frac{1}{49.9}}{\frac{1}{49.1} + \frac{1}{150} + \frac{1}{44.24}} = 0.4037$

#3: edge: $(14V)\frac{91}{150} = 8.4933V$

slope: $\frac{\frac{1}{91}}{\frac{1}{91} + \frac{1}{150} + \frac{1}{18}} = 0.1501$

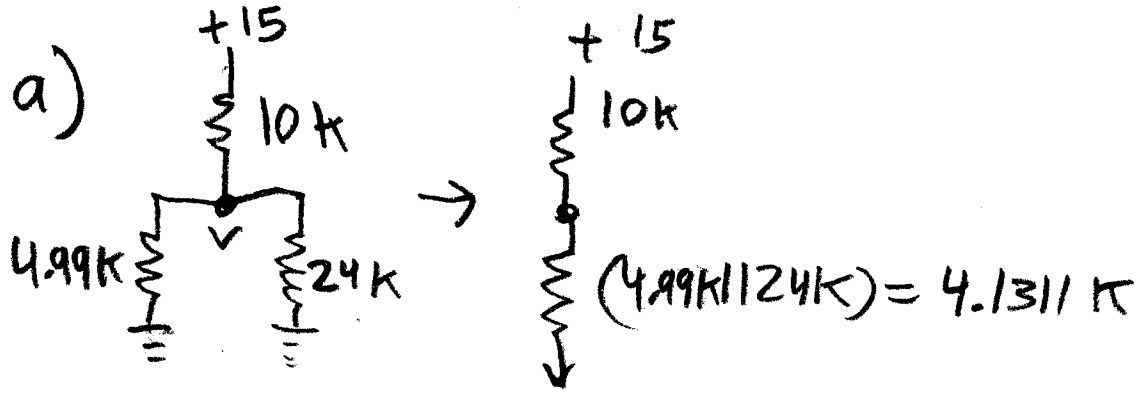
#4 edge: $(14V)\frac{30}{150} = 2.8V$

slope: $\frac{\frac{1}{30}}{\frac{1}{30} + \frac{1}{150} + \frac{1}{72.34}} = 0.6193$

#5 edge: $(14)\frac{68}{150} = 6.3467V$

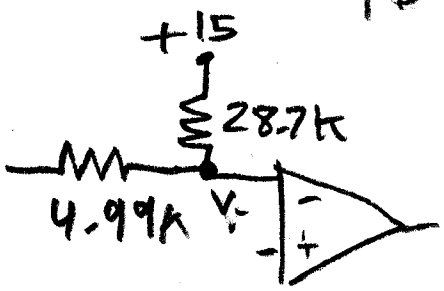
slope: $\frac{\frac{1}{68}}{\frac{1}{68} + \frac{1}{150} + \frac{1}{33}} = 0.286$

2) a)



voltage divider: $15 \cdot \frac{4.1311}{10+4.1311} \approx \boxed{4.39\ V}$

b) V_{tri}



$$V_- = \frac{V_{tri}(28.7) + 15 \times 4.99}{28.7 + 4.99}$$

$$33.69\, V_- = 28.7 V_{tri} + 74.85$$

$$28.7\, V_{tri} = 33.69 V_- - 74.85$$

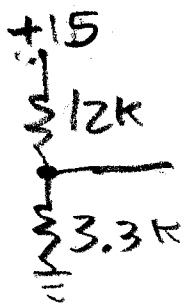
$$V_{tri} = 1.1739 V_- - 2.608$$

For $V_- = 4.39$, $V_{tri} = 2.5454$ V

$V_+ = 0$, $V_{tri} = -2.608$ V

CAside: For $V_- = 4.29$, $V_{tri} = 2.4280$ V

3) a) n-channel

b) 

$$(5V)\times\frac{3.3k}{3.3k+12k} = \boxed{1.078\ V}$$

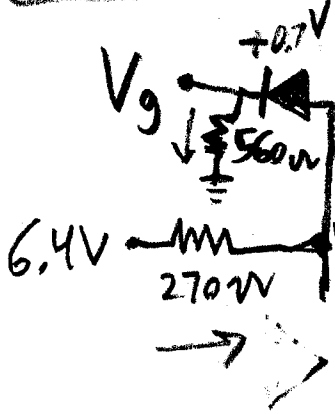
c) $\frac{I_{ON}}{C} T_o = V_{th}$

$$I_{ON} = V_{Tn} f_o C$$

$$= (1\ V)(4186\ Hz)(10\ nF)$$

$$= 4.186\times10^{-5} A = \boxed{41.86\ \mu A}$$

d) $\boxed{0\ V}$

e) 

$$\frac{V_g}{560\Omega} = \frac{6.4-(V_g+0.7)}{270\Omega}$$

$$V_g 270 = (6.4 - V_g - 0.7)560$$

$$V_g(270+560) = (6.4-0.7)560$$

$$\boxed{V_g = 3.846\ V}$$

If we used 5.6 instead of 6.4, we get

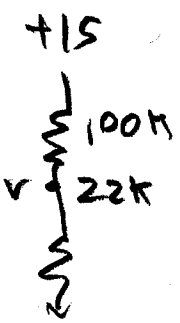
$$\boxed{V_g = 3.3\ V}$$

c) DC value $\frac{-2.608 + 2.5454}{2} = \boxed{-0.0313\ V}$

pk-to-pk: $2.608 + 2.5454 = 5.1534\ V$

$\frac{0.0313}{5.1534} = \boxed{0.61\%}$

d)



$V = (15V)\frac{22k}{22 + 100k} = \boxed{2.7\ V}$

e) $\frac{I_{con}}{C} T_o = 2 V_{pk\text{-}pk}$

$\left(\frac{I_{con}}{4.7nF}\right)\left(\frac{1}{261.63Hz}\right) = 2 \times 5.1534\ V$

$I_{con} = (2 \times 5.1534\ V)(4.7nF)(261.63\ Hz)$

$= 1.2674 \times 10^{-5}\ A$

$= \boxed{12.674\ \mu A}$