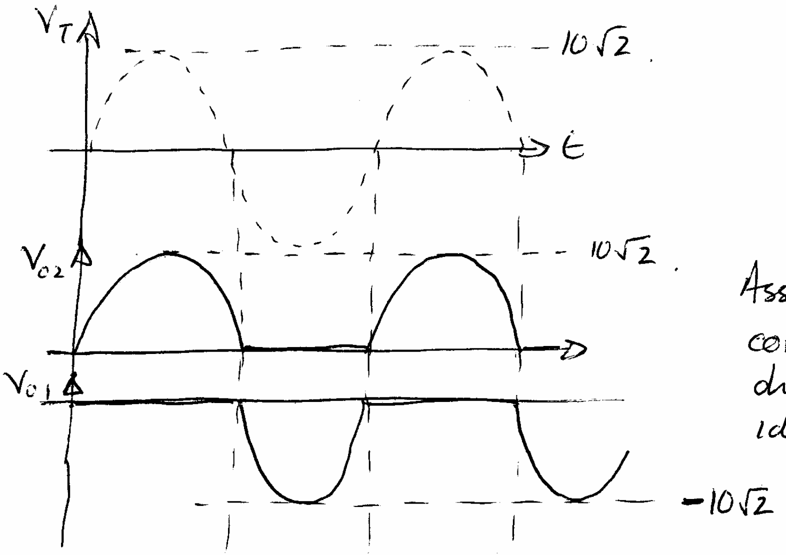
Q1

(i).



Assumption is components (inc diodes) are ideal.

(ii). $V_{T\,AVE} = 0$.

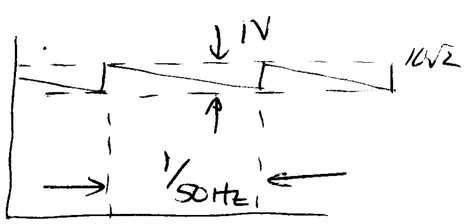
$V_{o1\,AVE} = -\frac{V_p}{\pi} = \frac{-10\sqrt{2}}{\pi} = \underline{\underline{-4.5V}}$

$V_{o2\,AVE} = \frac{V_p}{\pi} = \frac{10\sqrt{2}}{\pi} = \underline{\underline{4.5V}}$

(iii) A ripple no larger than 1V pk-pk with $I_L = 100mA$ is needed. Assume instantaneous charging...

$I = C\frac{dv}{dt} = C\frac{V_R}{1/50Hz}$

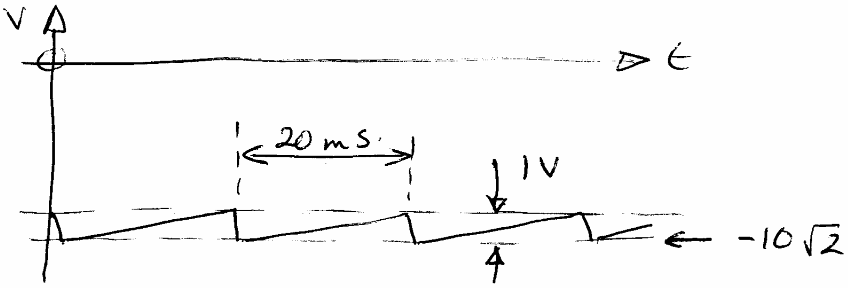
$= 100mA$.



$\therefore C = \frac{10^{-1}}{50 \times 1}$

$= \underline{\underline{2000\mu F}}$

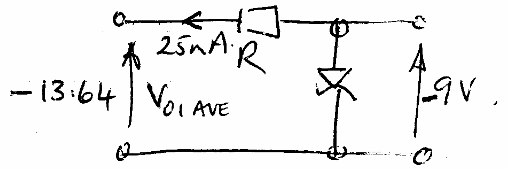
(iv)



(v) current through zener diode cct is

$\frac{100\,mA}{4} = 25\,mA$.

$V_{01\,AVE} = 10\sqrt{2} - 0.5$
$= 13.64\,V$.



$\therefore R = \frac{-9 - (-13.64)}{25\,mA}$

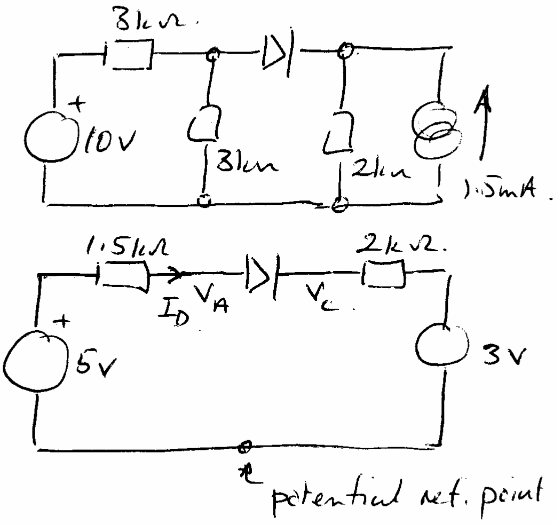
$= \underline{\underline{185\,\Omega}}$

For the ripple, R forms a potential divider with r_z

$v_{o\,ripple} = V_{in\,ripple} \cdot \frac{r_z}{R + r_z}$

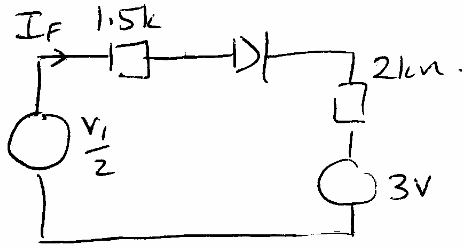
$= 1 \times \frac{6}{191} = \underline{\underline{31.4\,mV}}$ pk-pk

Q2(a)(i) The easiest way to approach this Q is to form Thevenin equivalents of both sources .... If one assumes no current flows, $V_A = 5V$ and $V_C = 3V$ so $V_A - V_C = 2V$ so current must be flowing.



$$I_D = \frac{5V - 3V - 0.7V}{1.5k\Omega + 2k\Omega} = \frac{1.3V}{3.5k\Omega} = \underline{\underline{371\mu A}}.$$

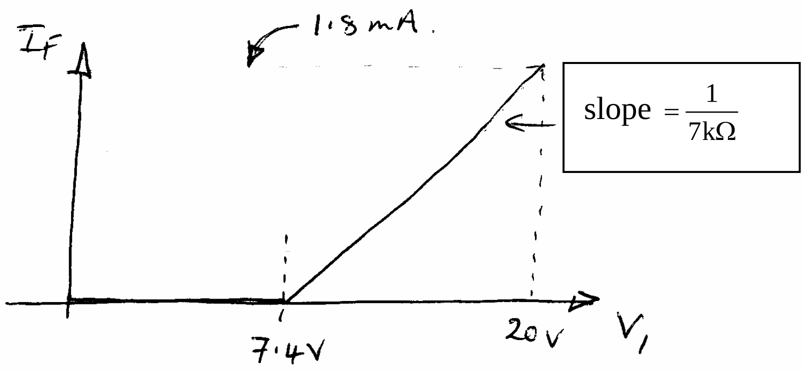
(ii) The critical value of V_1 is $3.7 \times 2 = 7.4V$. (this is when diode is on the point of conduction.)



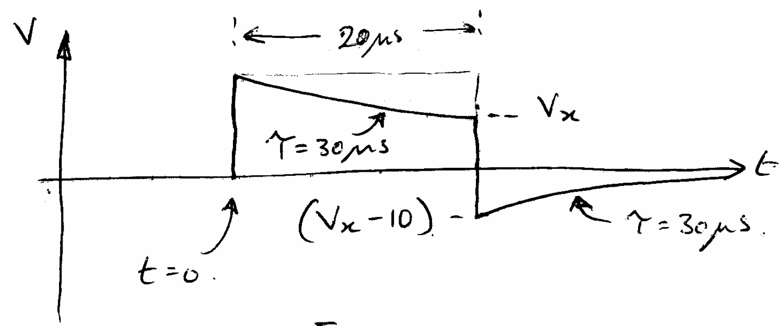
For voltages above this value, $\frac{\Delta V_1/2}{\Delta I_F} = (1.5+2)\text{k}\Omega$; for voltages below, $I_F = 0$

(4).

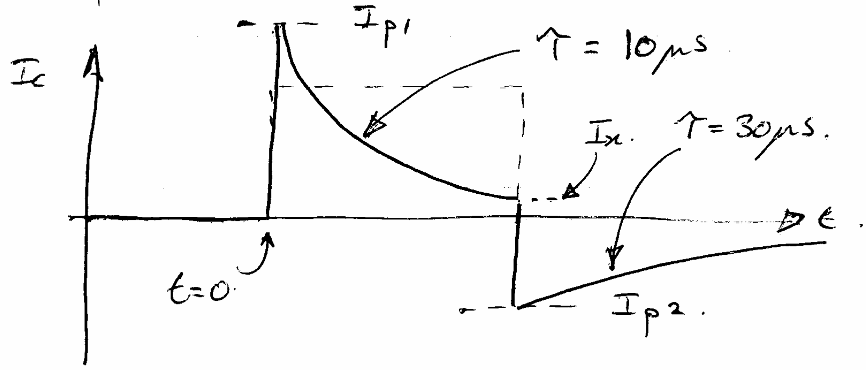
(iii) cont



(b)(i)



(ii)



$$I_{p1} = \frac{10V}{R_1 \| R_2} = \frac{10V}{1\,k\Omega} = \underline{10\,mA}$$

$$I_x = 10\,mA\, e^{-20\mu s/10\mu s} = 1.35\,mA.$$

and $V_x = 1.35\,V$.

$$\therefore V_x - 10 = -8.65$$

$$\text{So} \quad I_{p2} = \frac{-8.65\,V}{3k\Omega} = \underline{-2.88\,mA}.$$

Q3. (a)(i). D provides a path for the inductor current when the switch switches off and thereby limits the maximum voltage that appears across the switch at switch-off.

(ii) If T_1 has been "on" for a long time, all transient effects due to L will have settled down so....

$$I_{DON} = \frac{42}{R_L + r_{DSON}} = \frac{42}{84\,\Omega} = \underline{\underline{0.5A}}.$$

(neglecting r_{DSON} is permissible providing its neglect is stated as an approximation)

(iii) Power loss in T_1 $= I_{DON}^2\, r_{DSON}$
$= 0.5^2 \times 4$
$= \underline{\underline{1\,W}}.$

(iv) At turn-off, the 0.5A through $L + R_L$ is diverted through $D + R_S$. At the instant of turn off $I_F = 0.5A$ so 20V is dropped across R_S, and 0.7 across D, giving a max V_{DS} of

$$42 + 20 + 0.7 = \underline{\underline{62.7\,V}}$$

(b)(i). For figure 3b ...

$$18 = (I_C + I_1)R_L + I_1(R_F + R_B)$$

and $0.7 = I_1 R_B$.

where I_1 is the current through $R_F + R_B$.

eliminating I_1 ...

$$18 = I_C R_L + \frac{0.7}{R_B}\left[R_L + R_F + R_B\right]$$

$$\text{or } I_C = \frac{1}{R_L}\left[18 - \frac{0.7}{R_B}(R_L + R_F + R_B)\right]$$

$$= \underline{\underline{1.02\,mA}}$$

$$\text{and } I_1 = \frac{0.7}{R_B} = 70\mu A.$$

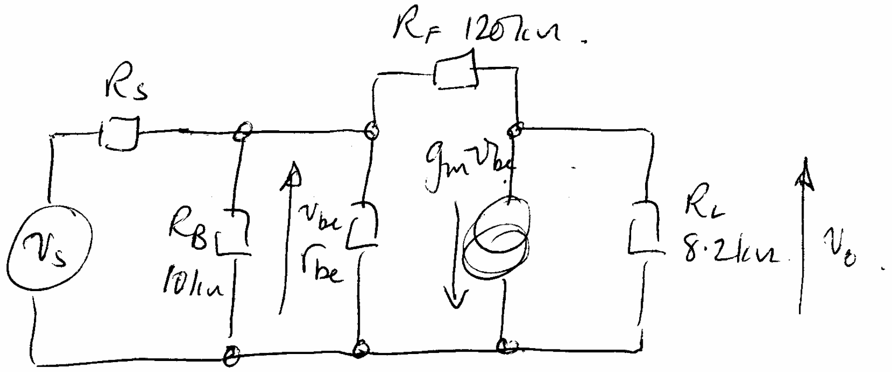
$$\therefore V_C = 18 - (I_1 + I_C)R_L = 18 - 1.09\,mA \times 8.2k$$
$$= 18 - 8.9\,V$$
$$= \underline{\underline{9.1\,V}}$$

$$g_m = \frac{eI_C}{kT} \text{ (from given useful relationships)}$$

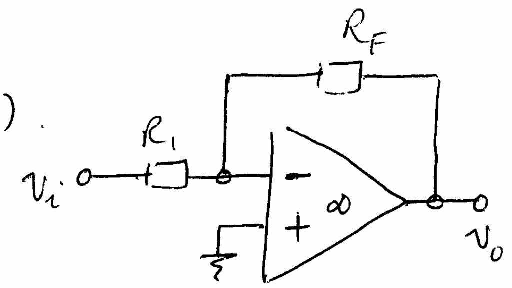
$$= \frac{1.02 \times 10^{-3}}{.026} = \underline{39\,mA/V} \text{ or } \underline{\underline{0.039\,A\,V^{-1}}}.$$

$$r_{be} = \beta/g_m \text{ (given)} = \frac{400}{.039} = \underline{\underline{10.2\,k\Omega}}$$

(ii).

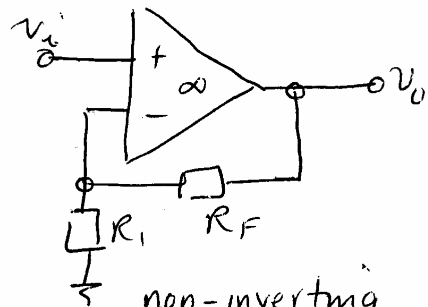


Q4. (a)



inverting amplifier

gain $= -R_F/R_1$

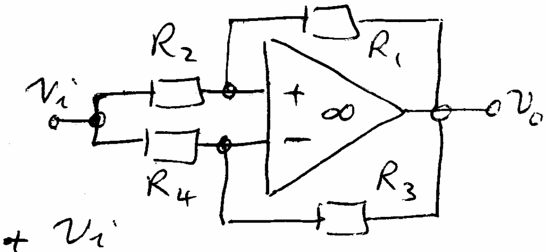


non-inverting amplifier

gain $= \dfrac{R_F + R_1}{R_1}$.

(b) (i) since $A_v \Rightarrow \infty$

$v^+ = v^-$



$$\therefore\ v^+ = (v_o - v_i)\frac{R_2}{R_2 + R_1} + v_i$$

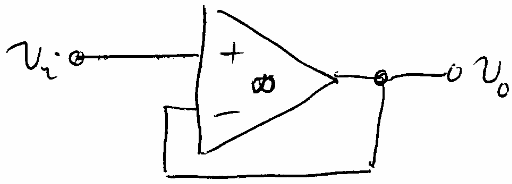
$$v^- = (v_o - v_i)\frac{R_4}{R_3 + R_4} + v_i$$

$$\text{so}\quad (v_o - v_i)\frac{R_2}{R_1+R_2} + \cancel{v_i} = (v_o - v_i)\frac{R_4}{R_3+R_4} + \cancel{v_i}$$

$$v_o\left[\frac{R_2}{R_1+R_2} - \frac{R_4}{R_3+R_4}\right] = v_i\left[\frac{R_2}{R_1+R_2} - \frac{R_4}{R_3+R_4}\right].$$

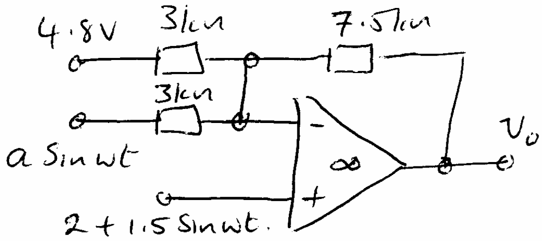
$$\text{or}\quad \underline{\underline{\frac{v_o}{v_i} = 1}}.$$

(ii) Simpler circuit is



(8)

(c). Since we are only interested in the ac component of the output, the d.c terms can be considered as grounds.



$$v_o\Big|_{\text{due to } a\sin\omega t} = a\sin\omega t \times \left(-\frac{7.5}{3}\right)$$

$$v_o\Big|_{\text{due to } 1.5\sin\omega t} = 1.5\sin\omega t \times \frac{7.5k\Omega + 3k//3k}{3k//3k}$$

$$= 1.5\sin\omega t \times \frac{9\,k\Omega}{1.5k\Omega}.$$

and the sum of these two components should be zero ...

$$-\frac{5}{2}a\cancel{\sin\omega t} + 1.5 \times 6 \times \cancel{\sin\omega t} = 0.$$

$$a = \frac{9 \times 2}{5} = \underline{\underline{3.6}}.$$