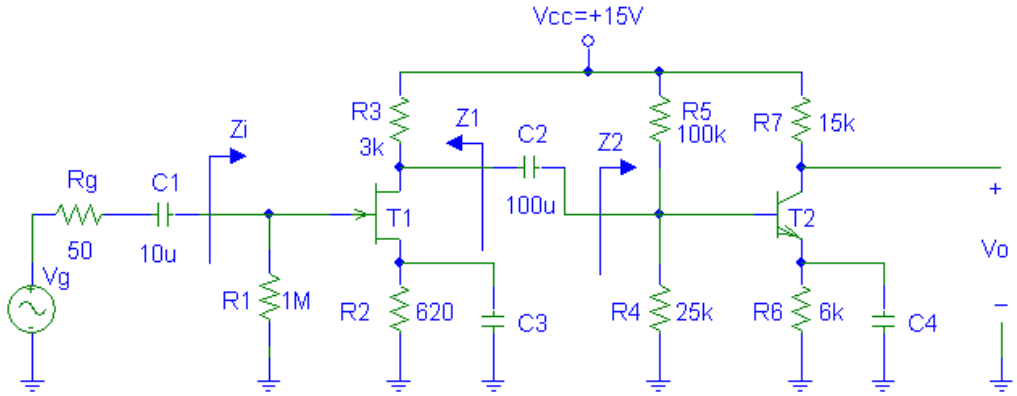
PROBLEM – SOLUTION



a) $V_{GS1} = -1.5$ V $I_{D1} = 2.4$ mA $V_{DS1} = 6.3$ V

b) $I_{C2} = 0.4$ mA $V_{CE2} = 6.6$ V $I_{B2} = 2\ \mu A << I_{R4,R5} = 120$ mA

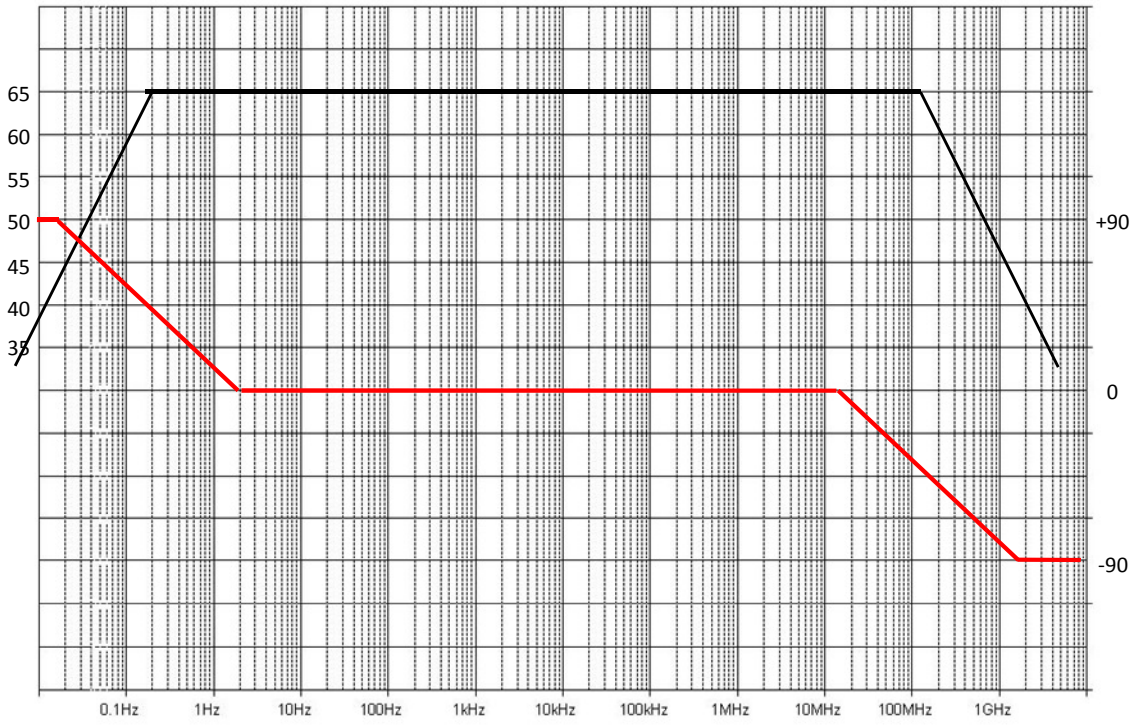
c) $Z1 = R3 = 3\ K\Omega$ $Z2 = R4\ //R5//r_\pi = 7.7\ K\Omega$ $Zi = R1 = 1M\Omega$

$Vo/Vg = [-g_{m2}R7]\cdot[-g_{m1}(R3//R4//R5//\ r_\pi)] = 1742.4$ V/V 64.8dB

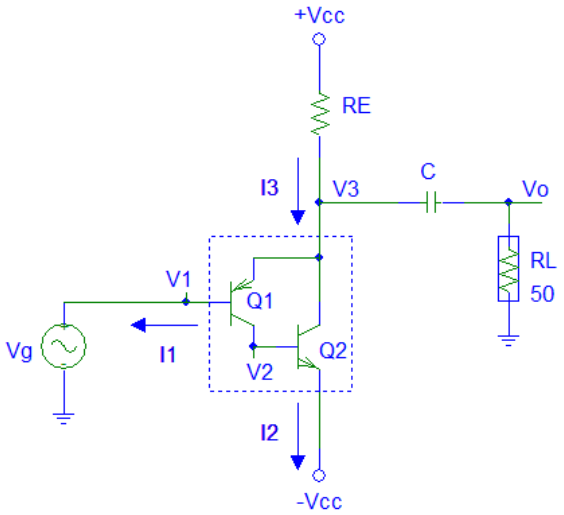
d) $\tau_1 = 50$ ps $\tau_2 = 1.1$ ns $f_H = 138$ MHz

e) $\tau_1 = 10$ s $\tau_2 = 1.07$ s $f_L = 0.16$ Hz

f) Asymptotic Bode plot (amplitude and phase)



QUESTION 1 – SOLUTION



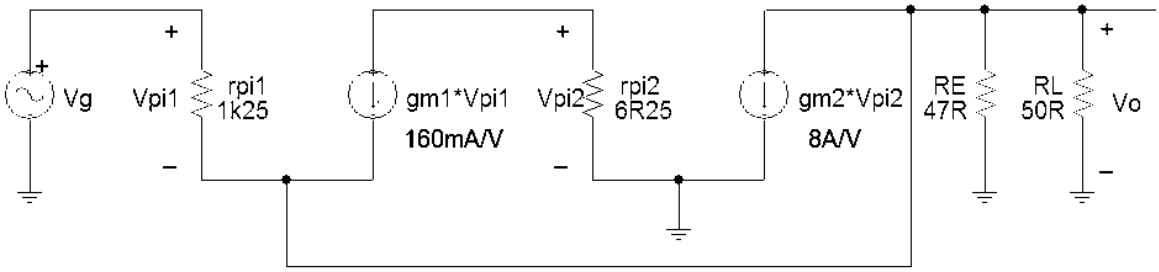
a) V1 = 0 V V2 = -9.3 V V3 = 0.6 V Vo = 0 V

b) RE = 47Ω

c) $I2 = \beta_{F1} \cdot (1+\beta_{F2}) \cdot I1$ I1 = 19.6 µA I2 ≈ I3 = 200 mA

d) $V_{EC1} = 9{,}9\ V > V_{EC\text{-}SAT}$ $V_{CE2} = 10{,}6\ V > V_{CE\text{-}SAT}$

e) $I_{C1} \approx 4$ mA gm1 = 160 mA/V rpi1 = 1.025 kΩ
$I_{C2} \approx 200$ mA gm2 = 8 Ω^{-1} rpi2 = 6.25 Ω

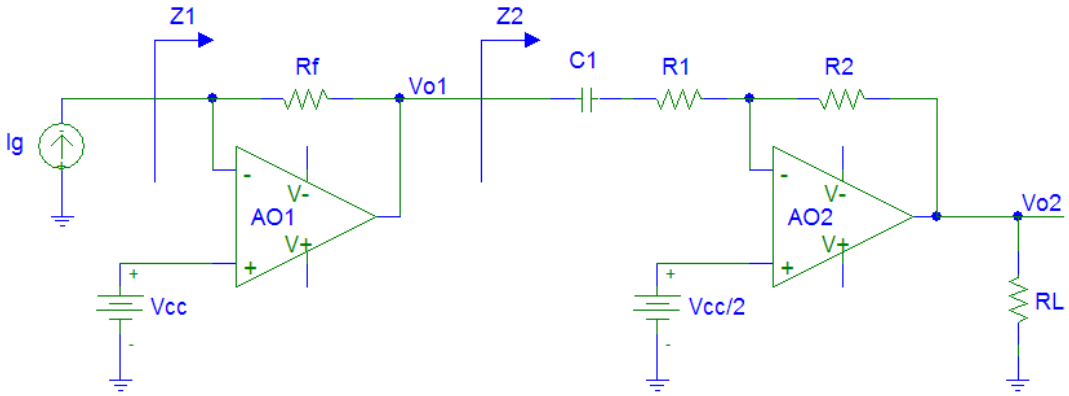


f) $Vg = V_{\pi 1} + Vo$

$$Vo = \frac{V_{\pi 1}}{r_{\pi 1}}\left(1+\beta_{01}+\beta_{01}\cdot\beta_{02}\right)\cdot\left(R_E \,//\, R_L\right) = \left(1+200+50\cdot 200\right)\frac{50\,//\,47\Omega}{1{,}25k\Omega}V_{\pi 1}$$

$Vo >> V_{\pi 1} \Rightarrow Vo/Vg \approx 1 \Rightarrow$ Exactly: Vo = 0.995·Vg

QUESTION 2 – SOLUTION

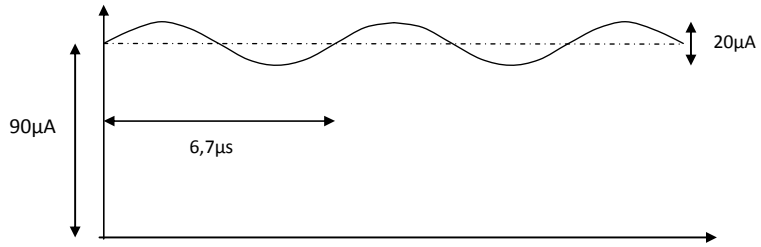


a) $Vo1 = Vcc \Rightarrow Vo1 = 5V$ $\quad Vo2 = Vcc/2 \Rightarrow Vo2 = 2{,}5V$

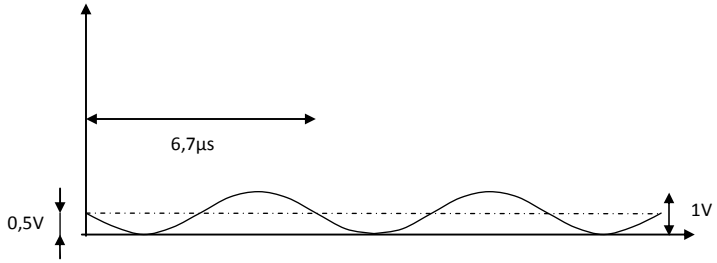
b) $Vo1 = -Rf \cdot Ig \Rightarrow Vo1/Ig = -Rf = -50K\Omega$ $\quad Z1 = 0\ \Omega$

c) $Vo2/Vo1 = -R2/R1 = -4{,}7\ V/V$ $\quad Z2 = R1 = 10\ K\Omega$

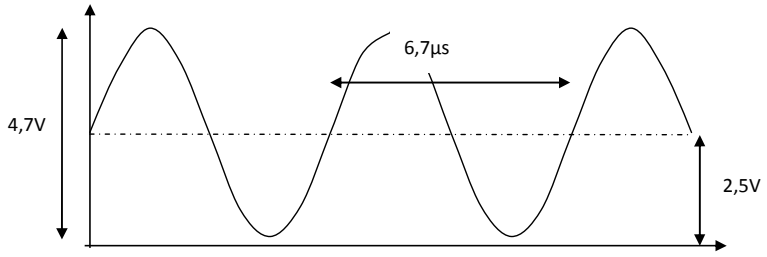
d) Ig:



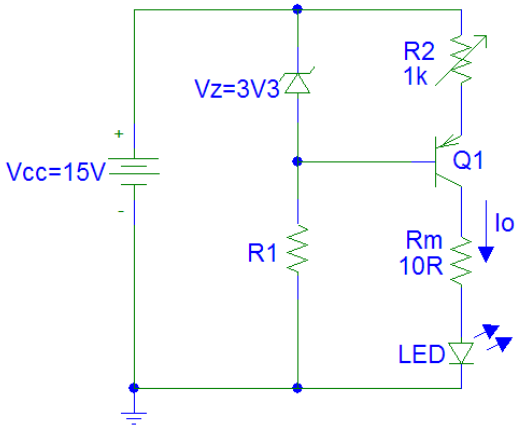
Vo1:



Vo2:



QUESTION 3 – SOLUTION

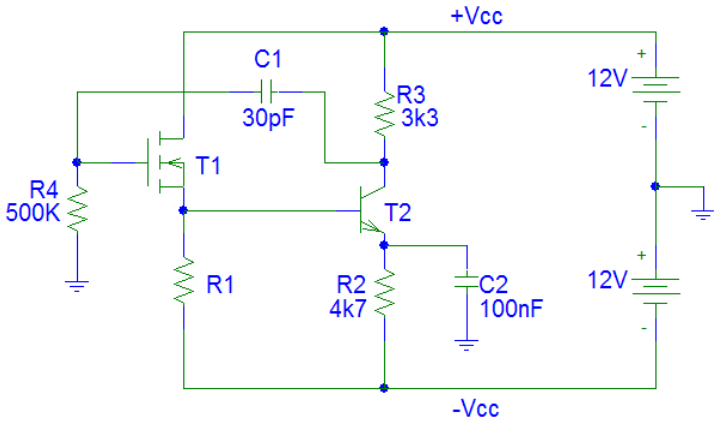


a) R1 = 585 Ω
b) Io = 2.6 mA $I_B = 17.3\ \mu A << Io < Iz$
c) $I_{CQ} = 2.6$ mA $V_{ECQ} = 10.77$ V $V_{EC} = V_{CC} - V_{LED\text{-}ON} - V_Z + V_{EB\text{-}ON} - I_C \cdot Rm$

d) $Io_{max} = 48.5\ mA < 62.5\ A < 100\ mA$

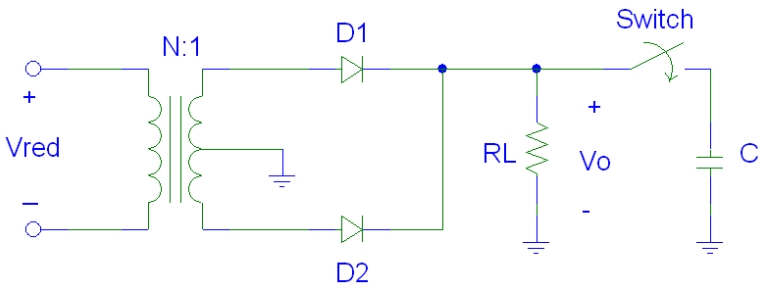
e) $R2_{min} = 53.6\ \Omega$ $V_{EC} = 10.32\ V > V_{EC\text{-}SAT}$

QUESTION 4 – SOLUTION



a) C1 and C2 open-circuit
b) R1 = 10 KΩ $V_{DS} = 14\ V > V_{DS\text{-}SAT} = (2V - 1V)$
c) $I_C = 2$ mA $V_{CE} = 8V$
d) $V_G = 0$ V $V_C = 5.4$ V
e) Common drain – common emitter
   Zo = R3 = 3.3 KΩ

QUESTION 5 – SOLUTION



DATA:

Vred = 220 Vrms; 50 Hz
Ideal diodes ($V_{D\text{-}ON}$ = 0V)
RL= 300 Ω

Figure 6.1

a) Rectifier – full wave – double wave. AC to DC conversion. DC voltage supply.

b) Va1 and Va2 are out of phase (180º phase shift), 12V peak and period 20 ms.
Vo is positive, amplitude 12V, period of the ripple 10 ms.

c) $PIV = 2 \cdot Vp = 24$ V

d) $Im = Vp/(\pi \cdot RL) = 12.73$ mA.

e) Ripple Vr: 1V peak-peak and period 10 ms.

f) $C = (T/2RL) \cdot (Vp/Vr) = 400$ µF

g) $Vom(\text{without C}) = 2 \cdot Vp/\pi = 7.64$ V
$Vom(\text{with C}) = Vp - Vr/2 = 11.5$ V

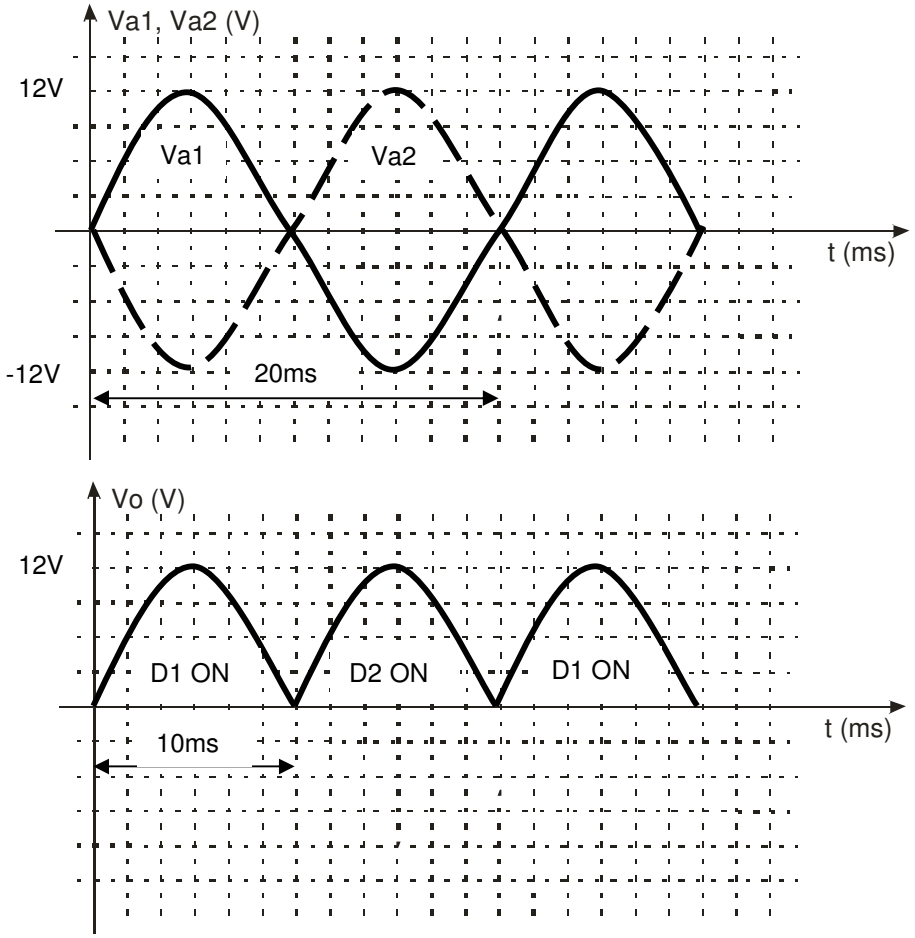


Figure 6.2

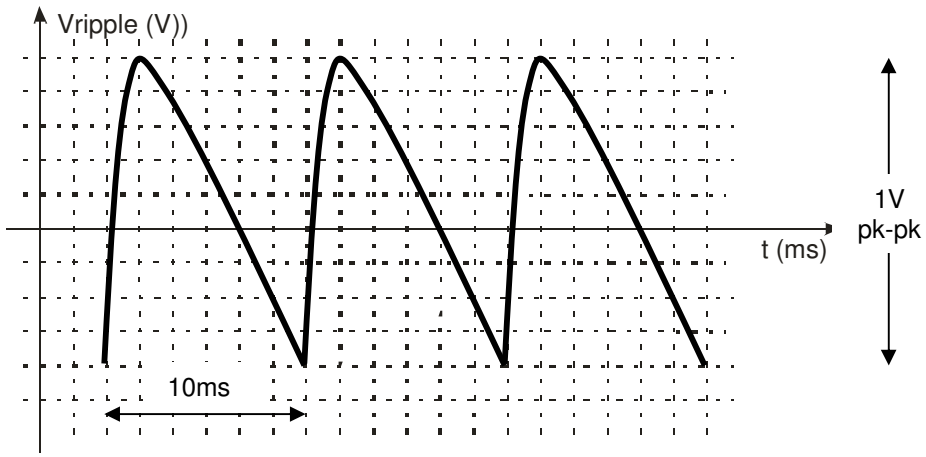


Figure 6.3