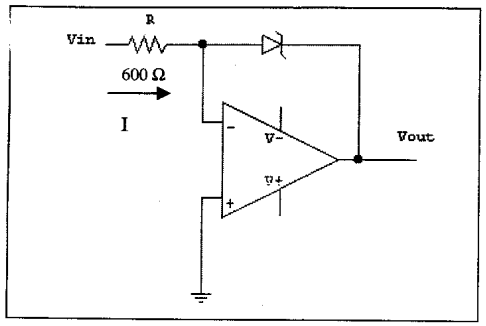
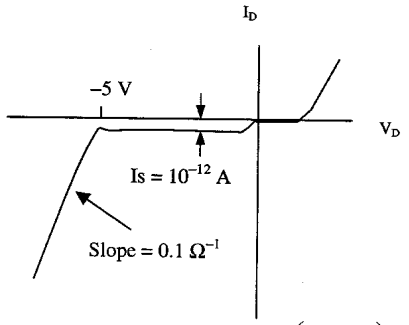
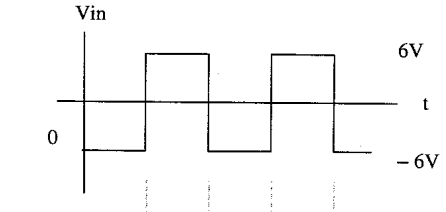
7. Given the following circuit diagram, the input voltage Vin and the I-V characteristics of the zener diode.



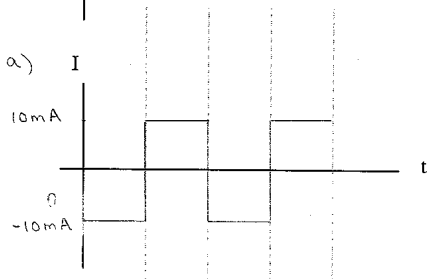


Diode equation : $I_D = Is \exp\left(\frac{V_D}{26mV}\right)$

a) Sketch the current I. Show your calculations clearly. (6 marks)
b) Sketch the output voltage Vout. Show your calculations clearly. (20 marks)

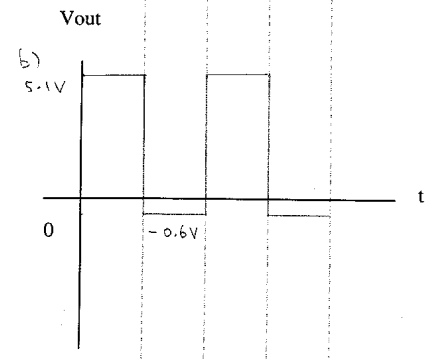


a) $I = \frac{Vin}{R} = \frac{6V}{600} = 10\,mA$ 2



4

b) $I = 10\,mA$
diode is forward biassed
$I = 10m = 1p\ e^{-\frac{Vo}{26m}}$
$\therefore Vo = -0.6\,V$ 8

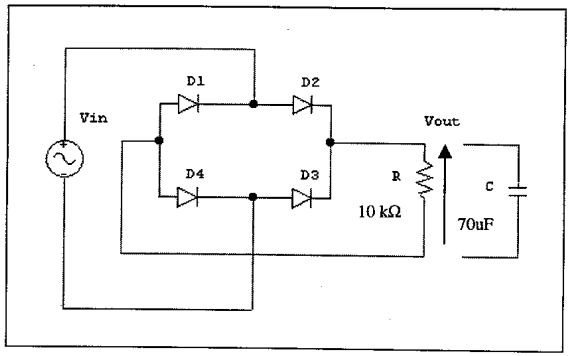


4

$I = -10\,mA$
diode is breakdown
$Vo = 5 + \frac{10m}{0.1} = 5.1\,V$ 8

8. Given the following ideal diode circuit diagram.

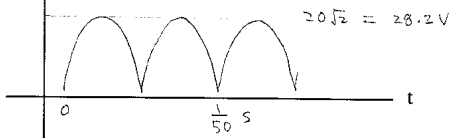
Vin = 20 Vrms
50Hz



a) Sketch the output voltage Vout. Show clearly the voltage and time intercepts. (5 marks)
b) Calculate the DC voltage V_{DC} across R ($V_{DC} = 2Vm / \pi$). (3 marks)
c) Find the peak inverse voltage (PIV) of the diode. (4 marks)
d) Show that the ripple voltage Vr = 0.4V after a capacitor of 70μF is connected across R. (6 marks)
Justify the assumption that you used. (3 marks)
e) Estimate the DC voltage across R after the capacitor is added. (4 marks)

Vout

a)



5

b) $V_{DC} = \frac{2Vm}{\pi} = \frac{2(28.2)}{\pi} = 18\,V$ 3

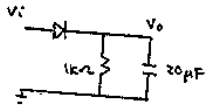
c) $PIV = Vm = 28.2\,V$ 4

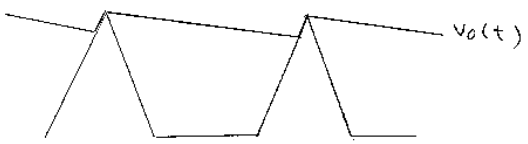
d) $Vr = \frac{Vm}{2fRC} = \frac{28.2}{2(50)\,10K\,(70\mu)} = 0.4\,V$ 6

$RC = 0.7\,s >> \frac{1}{50}\,s = T$ 3

e) $V_{DC} \approx Vm - \frac{Vr}{2} = 28.2 - 0.2 = 28\,V$ 4

9. In the ideal diode circuit, Vi is a 1 kHz triangular wave with 20V peak to peak (0V average).
(a) Sketch Vo(t). (6)
(b) Show that the ripple voltage is roughly 0.5V. (8)
(c) Show also that the peak inverse voltage (PIV) of the diode is 20V. (4)





6

$CR = 20\mu \cdot 1k = 20ms$

$\gg T = 1m$

$\therefore V_r = \frac{V_m T}{CR} = \frac{10\,V\,(1m)}{20m}$

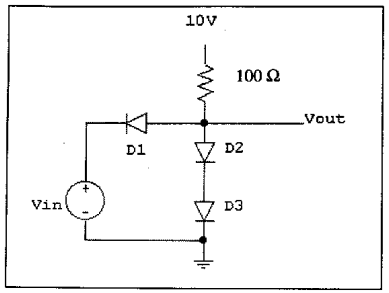
$= 0.5V$

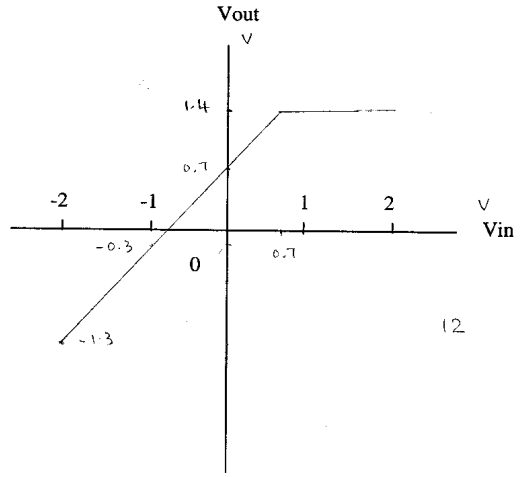
8

$PIV = 2V_m = 20V$

4

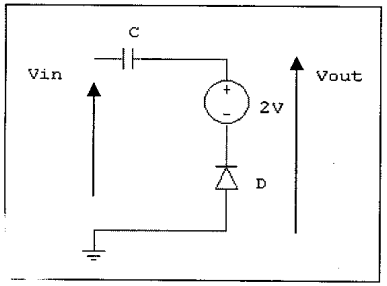
9. a) Plot the transfer curve Vout versus Vin for the following circuit ($-2V \le Vin \le 2V$). Assume $V_D = 0.7V$ when the diode is on. Show clearly the voltages. (12 marks)





12

b) Sketch Vin and Vout for the following circuit. Assume the diode is ideal. Show clearly the voltage and time intercepts. (12 marks)



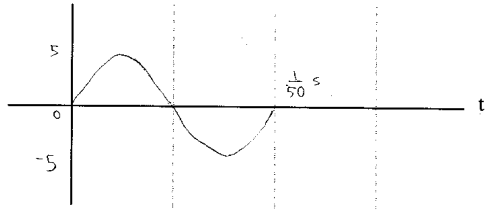
$\omega = 2\pi f$

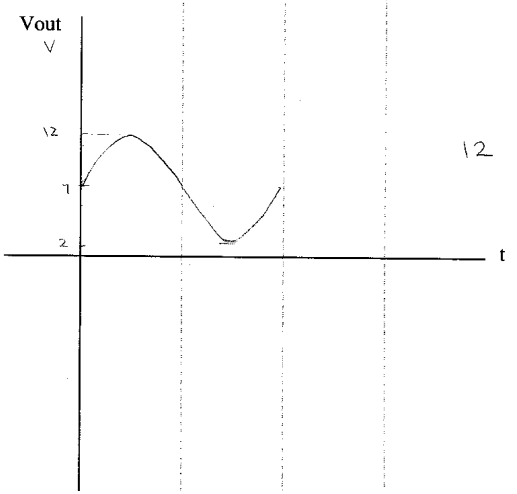
$= 100\pi$

$\therefore f = 50\,Hz$

$T = \frac{1}{50}\,s$

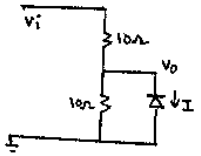
Vin = 5 sin 100π t V

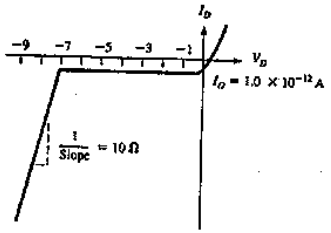




12

10. In the following diode circuit, the diode has the reverse characteristics as shown.
(a) Find Vo and I if Vi = 4V. (9)
(b) Show that I = 0.2A if Vi = 20V. (17)



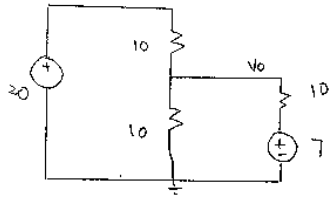


$V_i = 4V$

$V_o = 2V$ 5

$I = I_o = 1pA$ 4

$V_i = 20V$



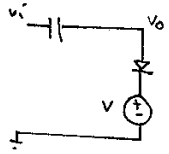
6

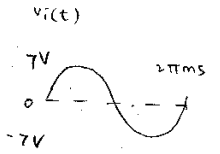
$\therefore \frac{20 - V_o}{10} = \frac{V_o - 7}{10} + \frac{V_o}{10}$

$\therefore V_o = 9V$ 8

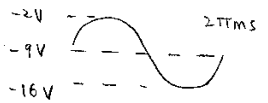
$\therefore I = \frac{9-7}{10} = 0.2A$ 3

6. (a) If Vi (t) = 7 sin 1000t V and V = -2V, sketch Vi(t) and Vo(t) for the following ideal diode circuit. Show clearly the voltages and time in your sketch. (12)



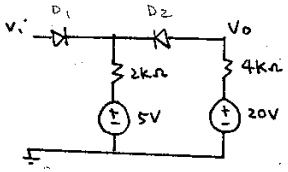


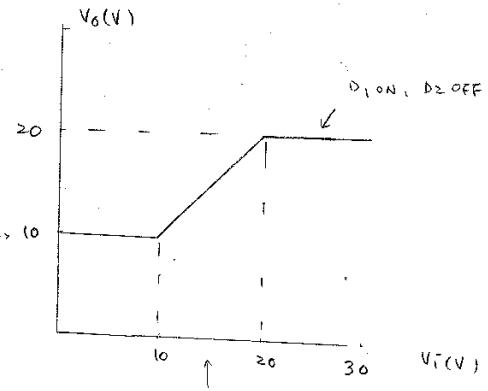
$V_o(t)$



12

(b) Plot Vo versus Vi for 0V ≤ Vi ≤ 30V for the following ideal diode circuit. Show clearly all the voltages in your sketch. (13)





13

D1 off, D2 ON
$V_o = 5 + (20-5)\frac{2k}{2k+4k}$ → 10

D1 ON, D2 ON
$V_o = V_i$