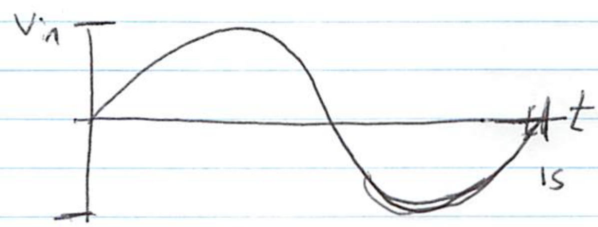
Electronics Chapter 3 homework

3.2, 3.4, 3.15, 3.17, 3.19, 3.20, 3.22, 3.23

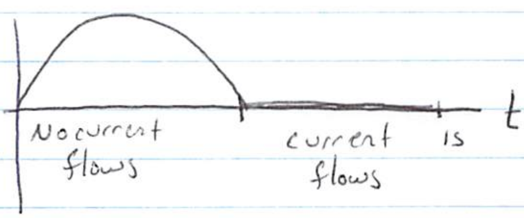
3.2 For each circuit the input signal is

$V_{in} = 1.0V \sin(2\pi \frac{rad}{s} t)$ $\omega = 2\pi \frac{rad}{s} \Rightarrow T = \frac{2\pi}{\omega} = 1s$

Amplitude = 1V



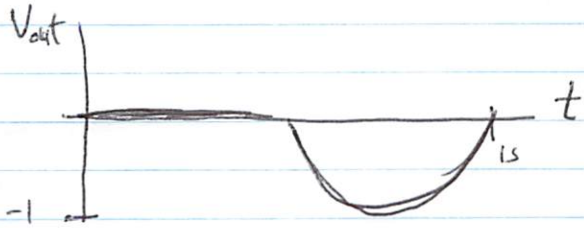
a) Vout



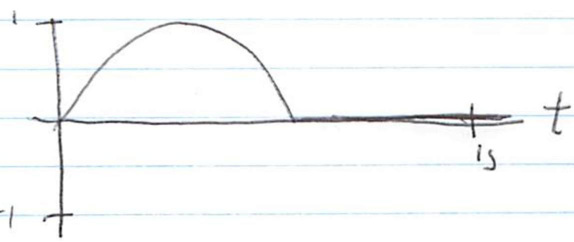
in each case

- the diode supports a voltage drop only if there is no current through it.
- the resistor has a voltage drop only when a current flows through it

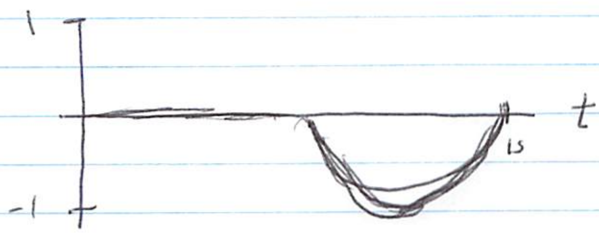
b)



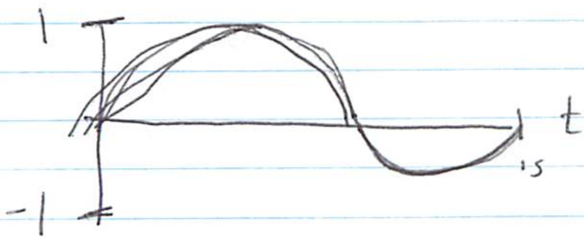
c)



d)

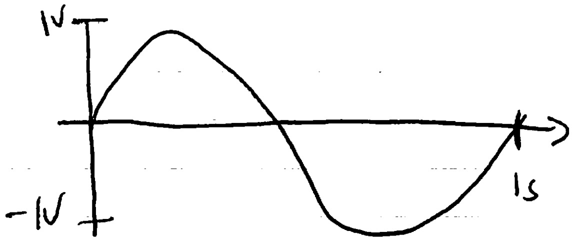


e)



when current flows the resistors form a voltage divider.

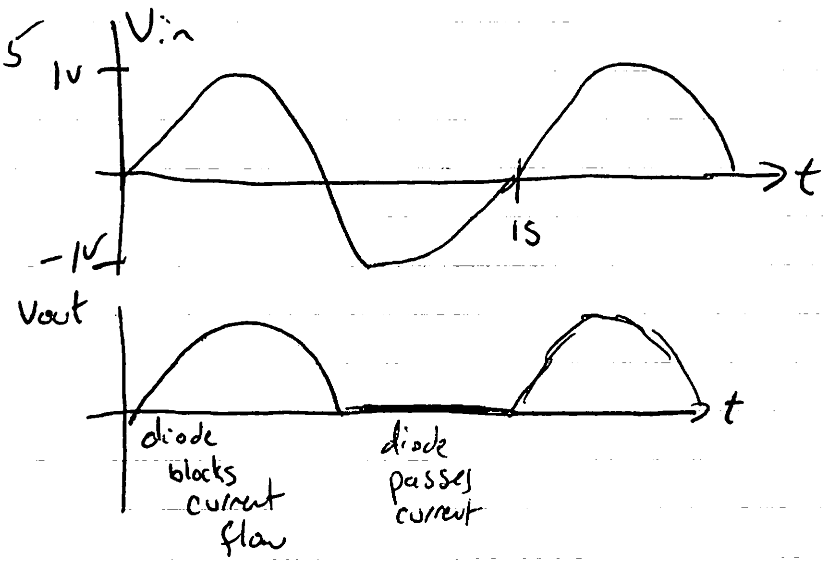
f)

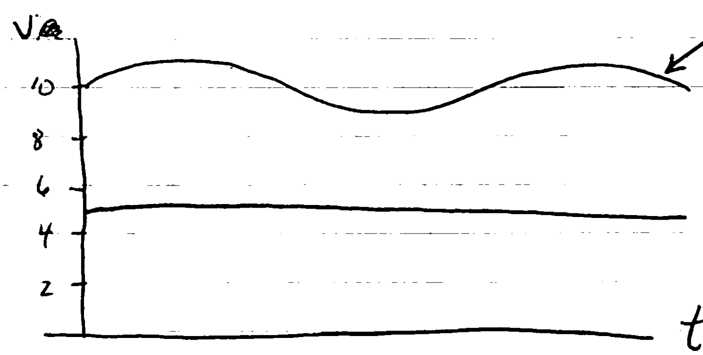


current never flows

3.4 A switch arcs when it opens an inductive load because the sudden change in current causes a large voltage spike by $V = L\frac{di}{dt}$ which is enough to break down the air between the switch contacts. The diode provides another path to close the circuit, one that is blocked during normal useage with the switch closed and only operates when the switch opens and the inductor is dissapating the magnetic energy stored in it.

3.15
a)

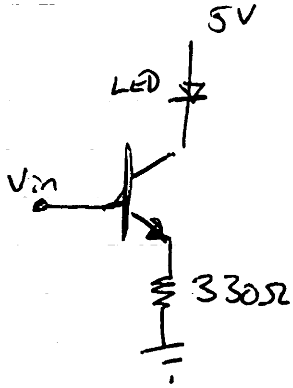




Vin

voltage in is consistently above $V_Z = 5.1V$ so $V_{out} = V_Z$

3.17



standard value is 0.2V in saturation mode

loop rule $5V = V_{LED} + V_{CE} + V_R$

$= 2V + 0.2V + V_R$

$V_R = 2.8V$

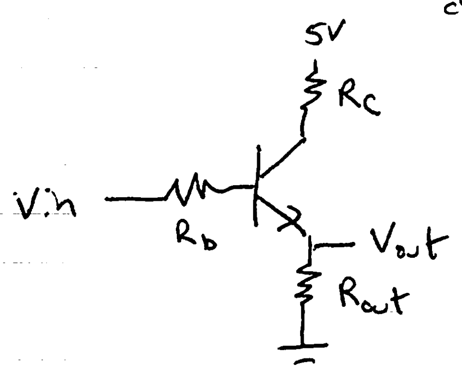
standard value is 0.7V in saturation mode.

loop rule $V_{in} = V_{be} + V_R$

$V_{in} = 0.7V + 2.8V = 3.5V$

raising V_{in} will not substantially change the behavior of the circuit.

3.19



loop rule $5V = V_{RC} + V_{CE} + V_{out}$

$= i_c R_c + 0.2V + i_e R_{out}$

loop rule $V_{in} = V_{Rb} + V_{BE} + V_{Rout}$

$= i_b R_b + 0.7 + i_c R_{out}$

node rule $i_e = i_b + i_c$ and $i_c = i_b \beta$

this implies $i_e = (1+\beta) i_b$

so

$\star$ $v_{in} = i_b R_b + 0.7V + (1+\beta) R_{out} i_b$

$= 0.7V + (R_b + R_{out} + \beta R_{out}) i_b$

and

$5V = \beta i_b R_c + 0.2V + (1+\beta) i_b R_{out}$

$i_b = \dfrac{4.8V}{(R_{out} + \beta(R_c + R_{out}))} = \dfrac{4.8V}{201k\Omega}$

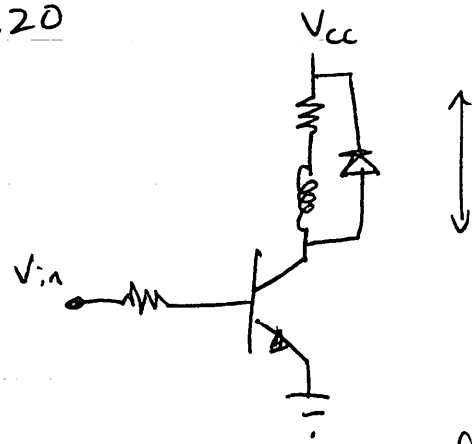
$= 0.024\,mA$

from $\star$

$V_{in} = 0.7V + (102k\Omega) i_b$

$= 3.14V$

3.20



In saturation $V_{CE} = 0.2V$

so $V_{CC} = 24V + 0.2V = 24.2V$ (24V ← Vload)

if we assume $\beta = 100$ then

$$i_B = \frac{1A}{\beta} = \frac{1A}{100} = 10mA$$

$$V_{in} = i_B R_b + V_{BE}$$

when on

$$5V = 10mA\ R_b + 0.7V$$

and

$$R_b = \frac{4.3V}{10mA} = 430\Omega.$$

3.22 in the fully on state, from graph

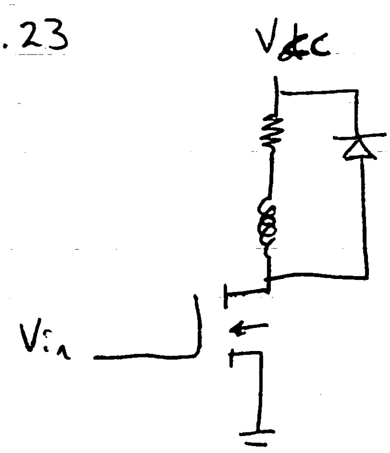
$V_{ds} = 0.2V$

$i_{ds} = 48mA$

and

$$V_{ds} = i_{ds} R_{ON} \Rightarrow R_{ON} = \frac{0.2V}{0.048A} = 4.2\Omega$$

3.23



No gate resistor needed.