2) IC1 - a

\[
\frac{J_1}{1k} + \frac{J_4 - \text{Vout}_{1a}}{33k} = 0
\]

\[
J_1 \left(1 + \frac{1}{33}\right) = \frac{\text{Vout}_{1a}}{33}
\]

\[
\text{Vout}_{1a} = 34 \quad J_1 \Rightarrow A_{1a} = 34
\]

IC1 - b

By symmetry, this is the same as IC1 - a

\[A_{1b} = 34\]

IC2 - a

\[
10k
\]

\[
\text{Vout}_{1c} \quad 10k
\]

\[
0 - \frac{\text{Vout}_{1a}}{10k} + 0 - \frac{\text{Vout}_{1c}}{10k} = 0
\]

\[
\text{Vout}_{1c} = -\text{Vout}_{1a} \Rightarrow A_{2a} = -1
\]

IC2 - b

By symmetry again, this is the same as IC2 - a

\[A_{2b} = -1\]

IC3 - a

\[
100k
\]

\[
\text{Vout}_{1e} \quad 10k
\]

\[
\text{Vout}_{1f} \quad 47
\]

\[
\text{Vout}_{1g} \quad 10k
\]

\[
R_{23a} \quad 10k
\]

\[
\text{V}_{1} = \text{Vn} = 0
\]

\[
R_{14a} \quad 10k
\]

\[
J_2
\]

\[
0 - \frac{\text{Vout}_{1f}}{R_{14a} + 10k} + 0 - \frac{J_2}{R_{23a} + 10k} + 0 - \frac{\text{Vout}_{1g}}{10k} = 0
\]

\[
\text{Vout} = -100k \left(\frac{\text{Vout}_{1f} + J_2}{R_{14a} + 10k} \right)
\]

Gain from \(\text{Vout}_{1f}/\text{Vout}_{1a} = \frac{-100k}{R_{14a} + 10k}\)

Gain from \(J_2 = \frac{-100k}{R_{23a} + 10k}\)

For maximum signal amplitude

\[
R_{14a} / R_{14b} \rightarrow 0k \Rightarrow -10k \Rightarrow -10
\]

\[
R_{23a} / R_{23b} \rightarrow 0k \Rightarrow -100k \Rightarrow -10
\]

\[A_{3a} = -10\]
3) P10.35 ⇒ Ideal diode model, V ranges from -10 V to 10 V

a) \[ \text{Ideal diode diagram} \]

b) \[ \text{Ideal diode diagram} \]

c) \[ \text{Ideal diode diagram} \]

d) \[ \text{Ideal diode diagram} \]

4) 10.44

\[ V_m = 24 V, \quad f = 60 Hz, \quad R = 2 \Omega, \quad V_b = 12 V, \quad \text{Ideal diode} \]

⇒ Diode on when \( V_m \sin(\omega t) > V_b \)

\[ 24 \sin(\omega t) > 12 V \]

\[ \sin(\omega t) > \frac{1}{2} \Rightarrow \omega t > 30^\circ/\pi \]

\[ i(t) = \frac{24 \sin(\omega t) - 12 V}{2 \Omega} = 12 \sin(\omega t) - 6 \ A \]

\[ 2\pi f = \omega \Rightarrow \omega = 120\pi \]
4) \(C\) \((m^4)\)

The \(Q(t)\) is 
\[
\int_{10^6}^{12} 12 \sin (120\pi t) - 6 \, dt
\]
\[
= \left[ \frac{-12}{120\pi} \cos (120\pi t) - b \, t \right]_{10^6}^{12} = \frac{12 \sqrt{3} - 4b}{120\pi}
\]

Total Charge in 1 sec \(\Rightarrow Q(t) (60\sec)
\[
= \frac{12 \sqrt{3} - 4b}{2\pi} = \frac{6 \sqrt{3}}{\pi} - 2 \approx 1.30\pi \text{A}
\]

Time required for battery \(T = \frac{100}{1.30\pi} \approx 76.45\text{ hr}

5) 10, 46

a) \(V_{avg} = \frac{1}{T} \int_0^T v(t) \, dt\)
\[
T = \frac{2\pi}{\omega}
= \frac{\omega}{2\pi} \int_0^{2\pi/\omega} V_m \sin (\omega t) \, dt
= \frac{2V_m}{\omega} \cos (\omega t) \bigg|_0^{2\pi/\omega} = 0
\]

b) Half-wave rectified \(\Rightarrow\) only half period 
\[
V_{avg} = \frac{\omega}{2\pi} \int_0^{\pi/\omega} V_m \sin (\omega t) \, dt
= \frac{2V_m}{\omega} \cos (\omega t) \bigg|_0^{\pi/\omega} = \frac{2V_m}{\omega} = \frac{V_m}{\pi}
\]

c) Full-wave \(\Rightarrow\)
\[
2 \text{ times the half-wave version}
V_{avg} = \frac{2V_m}{\pi}
\]
b) $V_{avg} = 9 \text{V}, V_r = 2 \text{V}, I_{avg} = 100 \text{mA}$
Ideal diode, $f = 60 \text{Hz}$

Using equation from 3.464:

$$C_L = \frac{I_c T}{2 V_r} = \frac{(100 \text{mA})(\frac{1}{100})}{2 (2)} = 4.17 \mu \text{F}$$

7) 10.53

a) The maximum voltage on the capacitor is $V_m$, and the minimum voltage on the source is $-V_m \Rightarrow$ total reverse bias = $2V_m$.

b) Let's assume $D_2$ and $D_3$ are on, that means the max voltage at $V_C$ is $V_m$ and the max reverse bias is $V_m \Rightarrow$ by symmetry, this is true for all diodes.

8) 10.155

For $V_s(t) > 0$, $D_3$ turns on
shorts $\Rightarrow V_o(t) \rightarrow 0$

For $V_s(t) > 0$, we have 2 regions of operation $0 < V_s < 10$ and $V_s > 10$

For $0 < V_s < 10$, the 2nd stage diode is off and the $V_o(t) = V_s(t)$

For $V_s > 10$, the $D_1$ is on and $D_2$ has 10V across it for breakdown mode operation $V_o(t) \rightarrow 10\text{V}$
By looking at the combination of $C_1$ and $D_1$, we can see that the diode conducts if $V_{in} < 0$, therefore we know the minimum voltage at the output is 0 V. (Center point moved to $V_{in}$) $D_2$ and $C_2$ together forms a half-wave rectifier and thus $V_c(t) = 2V_{in}$. This is called a voltage - doubles because the load voltage is twice $V_{in}$. The PIV for both diodes are $2V_{in}$. 