Homework #1

Problems 1.15, 1.23, 1.24, 1.28, and 1.30

Problem 1.15a

Through repeated application of Thévenin's theorem, find the Thévenin equivalent of the circuit in Fig. P1.15 between node 4 and ground, and hence find the current that flows through a load resistance of 3 kΩ connected between node 4 and ground.

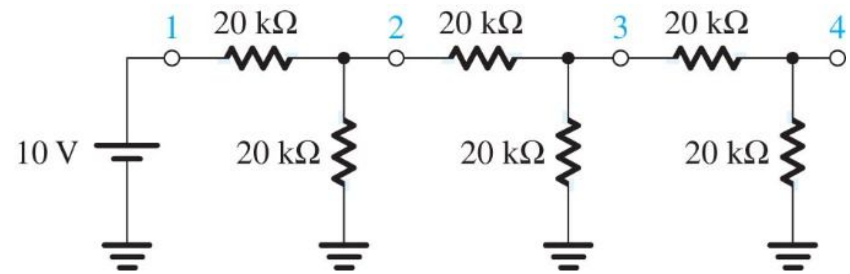
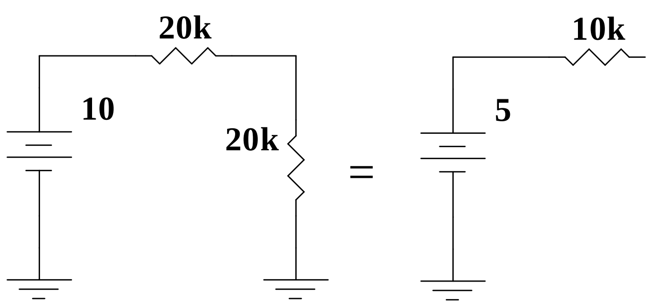
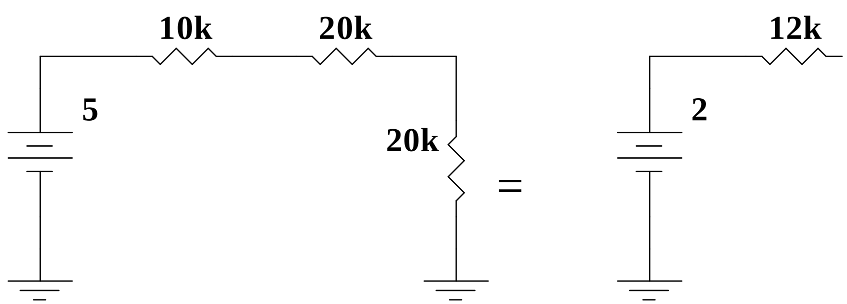


Figure P1.15



At node 2 we have 5V with 10 kΩ series resistance.



At node 3 we have 5V in with 30 kΩ series and 20 kΩ shunt resistance which yields 2V with 12 kΩ series resistance

Problem 1.15b

Through repeated application of Thévenin's theorem, find the Thévenin equivalent of the circuit in Fig. P1.15 between node 4 and ground, and hence find the current that flows through a load resistance of 3 kΩ connected between node 4 and ground.

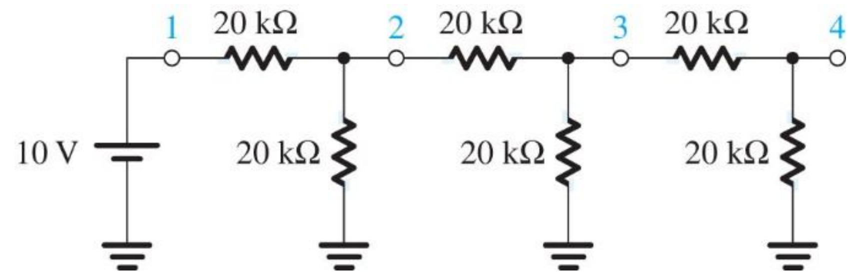
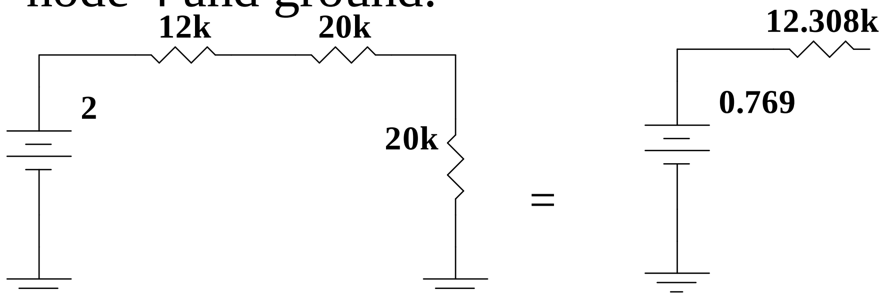
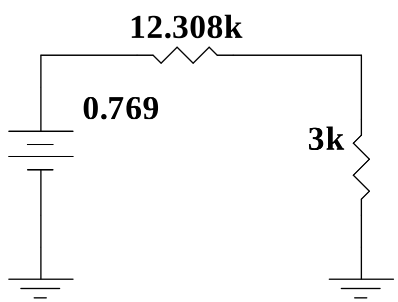


Figure P1.15





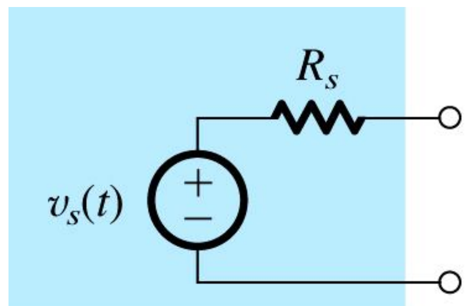
At node 4 we have 2V in with 32 kΩ series and 20 kΩ shunt resistance which yields 0.77V with 12.3 kΩ series resistance

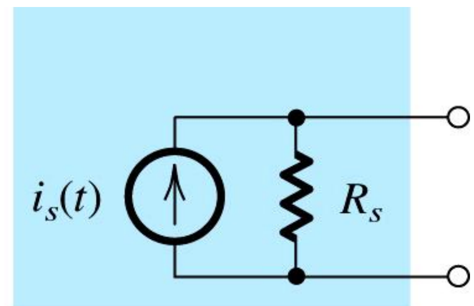
When a 3 kΩ load resistance is added we get the following current

$$I = \frac{0.77\text{V}}{12.3\text{k}\Omega + 3\text{k}\Omega} = 0.050\text{mA}$$

Problem 1.23

Any given signal source provides an open-circuit voltage, v_{oc}, and a short-circuit current i_{sc}. For the following sources, calculate the internal resistance, R_s; the Norton current, i_s; and the Thevenin voltage, v_s.





(a) $v_{oc} = 1$ V, $i_{sc} = 0.1$ mA

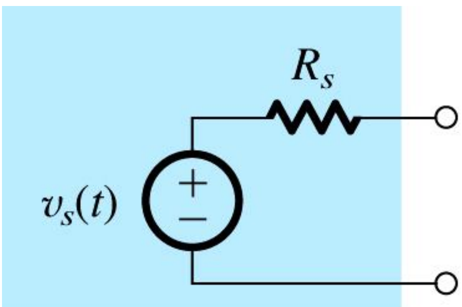
$v_s = v_{oc} = 1$ V; $i_s = i_{sc} = 0.1$ mA, $R_s = v_{oc}/i_{sc} = 10$ kΩ

(b) $v_{oc} = 0.1$ V, $i_{sc} = 1$ μA

$v_s = v_{oc} = 0.1$ V; $i_s = i_{sc} = 1$ μA, $R_s = v_{oc}/i_{sc} = 100$ kΩ

Problem 1.24

A particular signal source produces an output of 40 mV when loaded by a 100-kΩ resistor and 10 mV when loaded by a 10-kΩ resistor. Calculate the Thevenin voltage, Norton current, and source resistance.



$$v_o = v_s \frac{R_L}{R_L + R_S} \Rightarrow v_s = v_o \frac{R_L + R_S}{R_L} = v_o \left(1 + \frac{R_S}{R_L}\right)$$

$$v_s = 40\text{mV}\left(1 + \frac{R_S}{100\text{k}\Omega}\right) = 10\text{mV}\left(1 + \frac{R_S}{10\text{k}\Omega}\right)$$

$$R_s = 50\text{k}\Omega$$

$$v_s = 40\text{mV}\left(1 + \frac{50\text{k}\Omega}{100\text{k}\Omega}\right) = 10\text{mV}\left(1 + \frac{50\text{k}\Omega}{10\text{k}\Omega}\right) = 60.0\text{mV}$$

$$i_s = \frac{v_s}{R_s} = \frac{60\text{mV}}{50\text{k}\Omega} = 1.2\mu\text{A}$$

Problem 1.28

To familiarize yourself with typical values of angular frequency ω, conventional frequency f, and period T, complete the entries in the following table:

case	ω (rad/s)	*f* (Hz)	*T* (s)
a		$5\text{x}10^{9}$	
b	$2\text{x}10^{9}$		
c			$1\text{x}10^{-10}$
c		60	
e	$6.28\text{x}10^{4}$		
f			$1\text{x}10^{-5}$

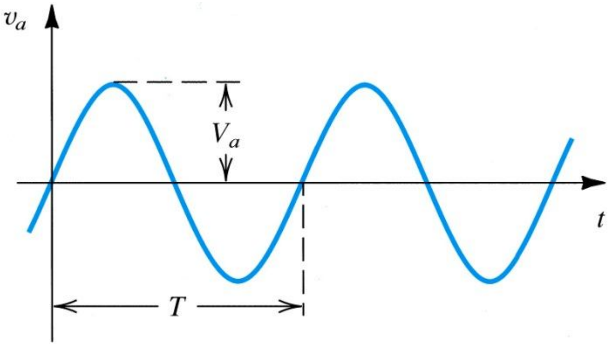
$$\omega = 2\pi f \qquad f = {}^{\omega}/_{2\pi} \qquad T = {}^{1}/_{f} = {}^{2\pi}/_{\omega}$$

Problem 1.28

To familiarize yourself with typical values of angular frequency ω, conventional frequency *f*, and period *T*, complete the entries in the following table:

case	ω (rad/s)	*f* (Hz)	*T* (s)
a	3.14E+10	5.00E+09	2.00E-10
b	2.00E+09	3.18E+08	3.14E-09
c	6.28E+10	1.00E+10	1.00E-10
c	3.77E+02	60.00	1.67E-02
e	6.28E+04	9.99E+03	1.00E-04
f	6.28E+05	1.00E+05	1.00E-05

$\omega = 2\pi f$ $f = {}^{\omega}/_{2\pi}$ $T = {}^{1}/_{f} = {}^{2\pi}/_{\omega}$



Problem 1.30

$$v_a(t) = V_a sin(\omega t)$$

Give expressions for the sine-wave voltage signals having:

(a) 10-V peak amplitude and 1-kHz frequency

$$v_a(t) = 10\sin(2\pi 1000t)$$

(b) 120-V_{rms}, and 60-Hz frequency

$$v_a(t) = 120\sqrt[2]{2}\sin(2\pi 60t)$$

(c) 0.2-V peak-to-peak and 2000-rad/s frequency

$$v_a(t) = 0.1\sin(2000t)$$

(d) 100-mV peak and 1 ms period

$$v_a(t) = 0.1\sin(2\pi 1000t)$$