Diode Circuit

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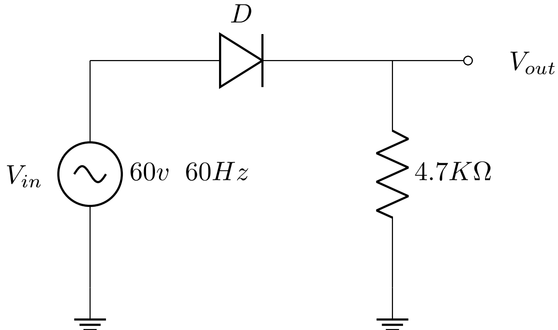
Question 1. What is the peak output voltage if the diode is ideal? The average value? the dc Value? sketch

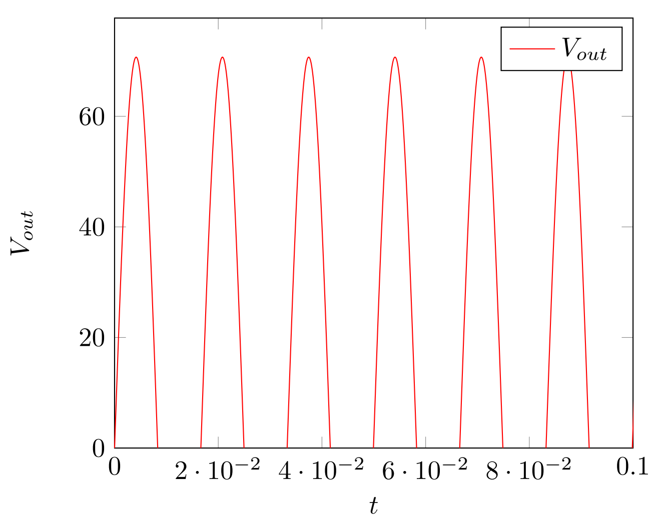
Answer to Question 1



Assuming diode is Ideal
V_{rms}= $V_p/\sqrt{2}$ Since it is forward biased
V_{pp} = V_{rms}*$\sqrt{2}$
V_{pp} = 60V*$\sqrt{2}$
V_{pp} = 70.71V, Peak load voltage = 70.71V

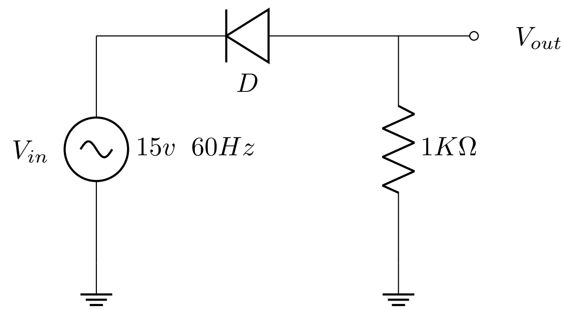
Average value of diode, or DC value of Half wave Signal
V_{dc} = V_{pp}/π = 70.71V/π = 22.50V
f_{out}= f_{in} for half wave signal
ω= 2*π*f = 2*π*60hz
V_{in}= V_{pp} * Sin(2*π*f*t)
Since only positive part of the AC voltage is affect for V_{out}

V_{out} to time graph



Question 2. What is the peak output voltage below if the diode is ideal? The average value? the dc Value? sketch

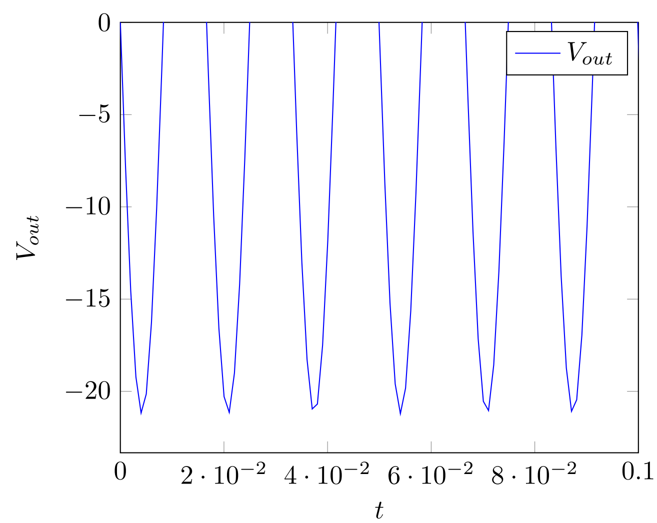
Answer to Question 2



Assuming diode is Ideal
V_{rms}= - $V_p/\sqrt{2}$ (Considering it is reversed bias)
V_p = -V_{rms}*$\sqrt{2}$, $V_p = -15V * \sqrt{2}$
V_p = -21.21V , Peak load voltage = -21.21V

Average value of diode, or DC value of Halfwave Signal
V_{dc} = V_p / π = -21.21V / π = -6.75V
f_{out}= f_{in} for half wave signal
ω= 2*π*f = 2*π*60Hz
V_{in}= V_p * Sin(2*π*f*t)
Since only negative part of the AC voltage is affect for V_{out}

V_{out} to time graph



Question 3 . If a transformer has a turn ratio of 6:1, N_1:N_2 = 6:1 what is the turns secondary voltage? The peak secondary voltage? Assume a primary voltage of $120V_{rms}$

Answer to Question 3

Since the transformer has turn ratio of 6:1, the secondary voltage is $120V_{rms}$/6, which is $20V$.
The peak voltage is $20V*\sqrt{2}$ which is 28.3V

Question 4 . A center-tapped transformer with 120 V input has a ratio of 4:1. What is the terms voltage across the upper half of the secondary winding? The peak voltage? What is the terms voltage across the lower half of the secondary winding?

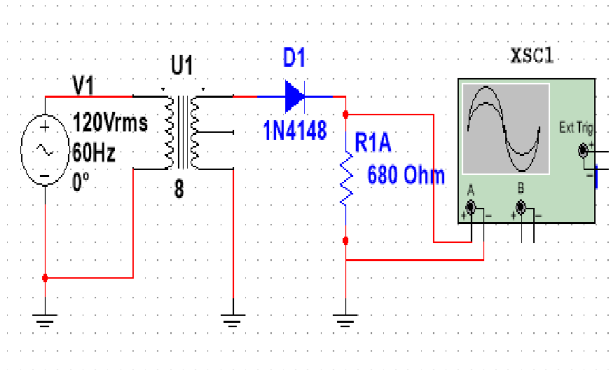
Answer to Question 4

Since the transformer has N_1:N_2 = 4:1, V_1 = 120V
4:1 the secondary voltage is $120V_{rms}$/4, which is $30V$.

Upper half of the secondary winding is half of the rms secondary voltage.
V_2 =$V_{secondary}$/2 =30V/2 =15V
The rms voltage across upper half of secondary winding is V_2 =15V

The peak voltage is
V_{pp}= V_{rms}*$\sqrt{2}$= 15*$\sqrt{2}$ = 21.21V

Question 5 . What is the peak output voltage in Fig. 4-38 if the diodes are ideal? The average value? The dc value? Sketch the output waveform.
Question 6. Repeat the preceding problem using the second approximation.



Answer to Question 5

Ideal diode

Because transformer has turn ratio of N_1:N_2 = 8:1, secondary voltage(V_2) is V_1/8
V_2 = V_1/8 = 120V/8 =15V
Peak secondary voltage= $V_{secondpp}$ = 15V*$\sqrt{2}$ = 21.216V

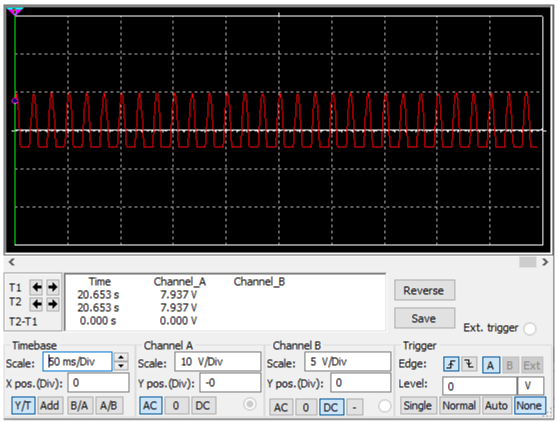
V_{dc} = V_l/π = 21.22V/π =6.754537V

Answer to Question 6

Second approximation model

Voltage drop across diode = 0.7V
V_2 = V_1/8 = 15V
Peak of secondary voltage $V_{secondpp}$ = 15V*$\sqrt{2}$ = 21.216V
Because of diode V_l = 21.22V-0.7V =20.52V
V_{dc} = V_l/π = 20.52V/π =6.535V

Oscilloscope Output



Question 7.A half-wave signal with a peak of 20V is the input to a choke-input filter. If X_L $1K\Omega$ and X_c = 25Ω, what is the approximate peak to peak ripple across the capacitor?

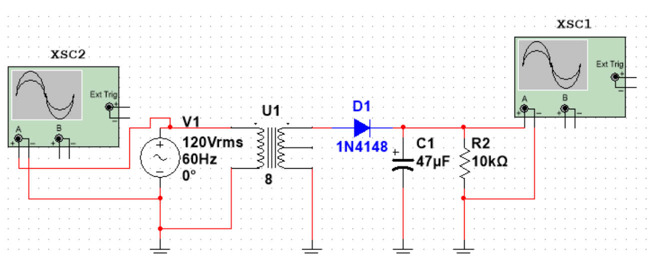
Answer to Question 7

V_p = 20V
X_l = $1K\Omega$
X_c = 25Ω
V_l = 20V

The circuit acts as voltage divider circuit

$V_c \approx V_l{*}X_c/X_l$
V_c = 20V * 25/1000
V_c = 0.5V
V_c = 0.5V peak to peak ripple voltage across the capacitor

Question 8 .What is the dc output voltage and ripple in below? Sketch the output waveform.



Answer to Question 8

V_1= 120V

N_1 : N_2 = 8:1
R_L=10$k\Omega$
C = 47uF

Rms secondary voltage
V_2= N2/N1*V_1 = 1/8*120 = 15V
V_p =V_2 *$\sqrt{2}$ =15V *$\sqrt{2}$= 21.21V

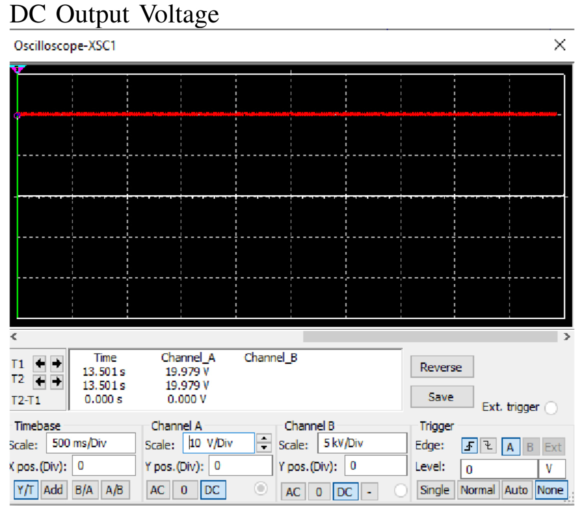
Assumming diode is ideal, V_p = V_{out} = V_l = 21.21V

Dc load current is needed for calculating peak to peak voltage
I_l = V_l/ R_l = 21.21V/10$k\Omega$ = 2.12mA

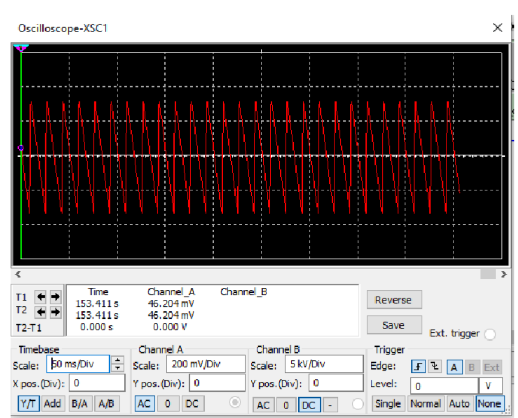
The ripple formula for capacitor-input filter approximating ripple voltage.

Ripple voltage ≈ I_l * x_c = 2.12mA * 1/(60hz*47uF)
V_l =752mV peak to peak

DC Output Voltage

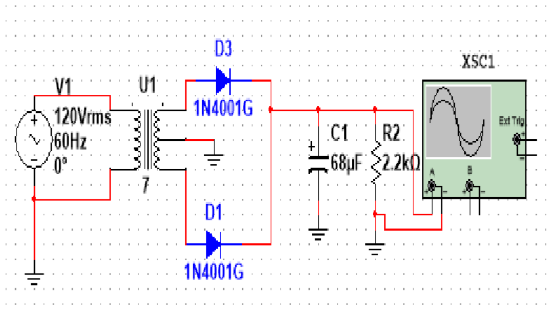


Ripple voltage Peak to peak



Question 9 Calculate the dc output voltage and ripple

Answer to Question 9



For calculations
V_1= 120V
N_1 : N_2 = 7:1
R_L=2.2$k\Omega$
C = 68uF

rms secondary voltage
V_2= N_2/N_1*V_1 = 1/7*120 = 17.14V

V_p =V_2 *$\sqrt{2}$ = 24.24V

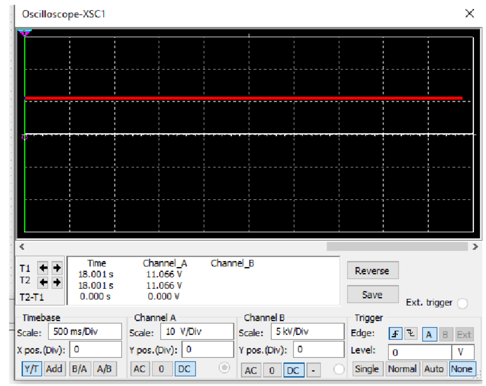
Assumming diode is ideal, and for Full wave rectifier, half of this voltage is input to each half wave section. Assuming small ripple and ideal diode.
V_l = V_p/2 = 12.12V

Dc load current is needed for calculating peak to peak voltage
I_l = V_l/ R_l = 12.12V/2.2$k\Omega$ = 5.5mA

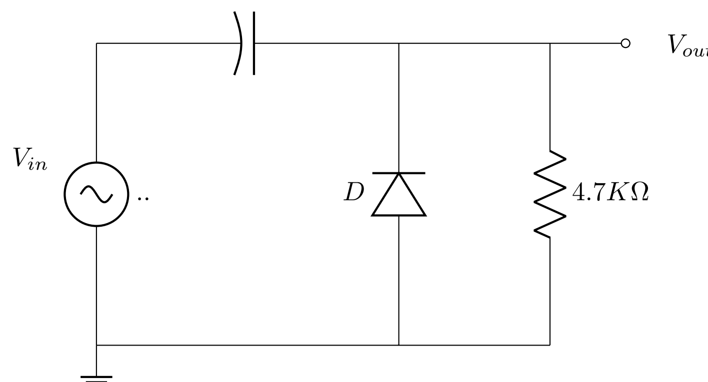
The ripple formula for capacitor-input filter approximating ripple voltage.

Ripple voltage $\approx$ $I_l/f * c$ = 5.5mA * 1/(120hz*68uF)
V_l =1.35V peak to peak

Oscilometer output



Question 10 Sketch the output waveform. What is the maximum positive voltage? The maximum negative?



Answer to Question 10

Positive clamper Circuit

Clamper adds a DC voltages to the signal. The positive clamper shifts the ac reference level up to a dc level. An AC source drives the input side of the clamper. The thevinen voltage of the clamper output is the superposition of a dc source and an ac source. The ac signal has a dc voltage V_p added to it.

Assuming diode is ideal

On the first negative half cycle of input voltage, the diode turns on. at the negative peak voltage the capacitor has fully charged 15V with polarity reversed. then the capacitor retains almost all of its charge of its charge during subsequent cycles.

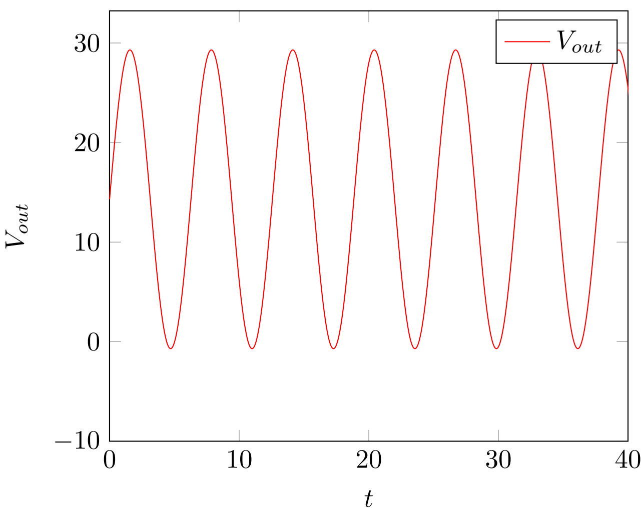
Beyond negative voltage, the diode turns off. at this time the capacitor remains fully charged. the output voltage will appear as 30V using superposition. than v_{out} = 30 V, and 0V when it is negative cycle. this is because all the current

goes through diode when it is negative cycle.
Thus, minimum voltage would be 0V and maximum voltage would be 30V

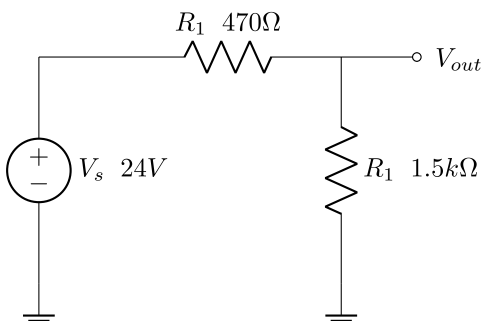
Real Diode

Since the diode drops 0.7V when conducting, the capacitor voltage does not quite reach v_p. For this reason clamper is not perfect and the negative peaks have a reference level of -0.7V

V_{out} to time graph



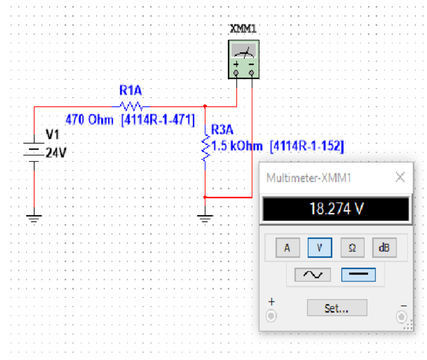
Question 11 If the zener diode is disconnected, what is the load voltage.



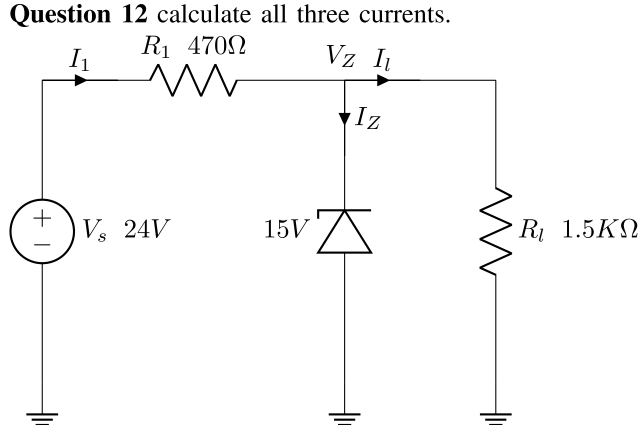
Answer to Question 11

V_{out} = V_{in}*$R_l/(R_1 + R_l)$ = 24V*1.5kΩ/(470Ω+1.5Ω) = 18.274V

Multisim Voltage Output



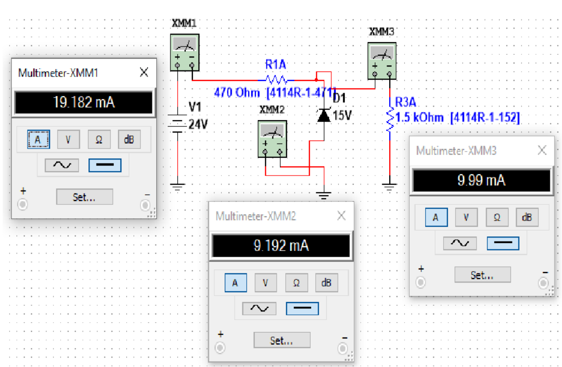
Question 12 calculate all three currents.



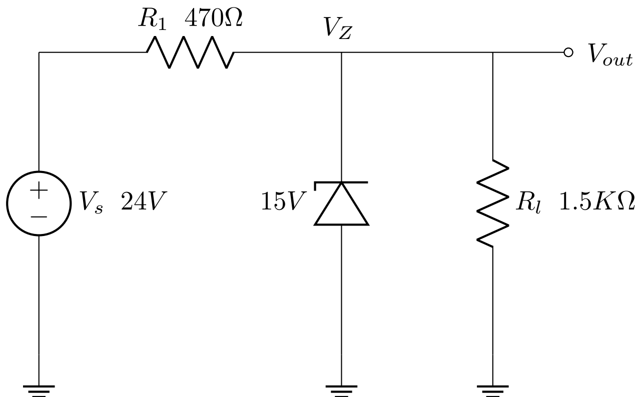
Answer to Question 12

$I_1 = (V_s - V_z)/R_1$ = 24V-15V/470Ω = 19.2 mA
$I_l = V_z/R_l$ = 15V/1.5KΩ = 10mA
$I_z = I_1 - I_l$ =19.2mA -10mA = 9.2mA

Multisim voltage output



Question 13 The zener diode has a zener resistance of 14Ω. If the power supply has a ripple of 1v pp, what is the ripple across load resistor.



Answer to Question 13

R_z = 12Ω
R_s = 460Ω
$V_{ripplein}$ = 1v pp
$V_{rippleout}$ = $V_{ripplein} * R_z/(R_z + R_s)$
$V_{rippleout}$ = 1vpp* 12 Ω/(460Ω+12Ω) = 28.9 mV pp

Question 14 What is the current through the LED?

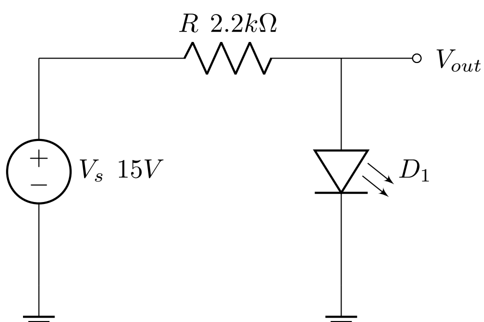
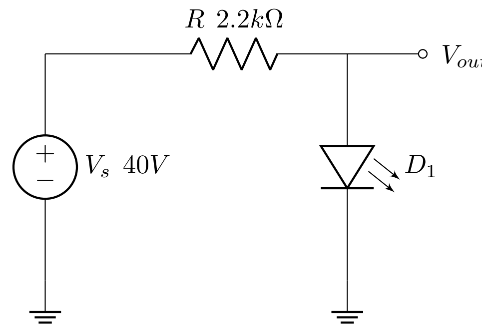


Fig 5-42

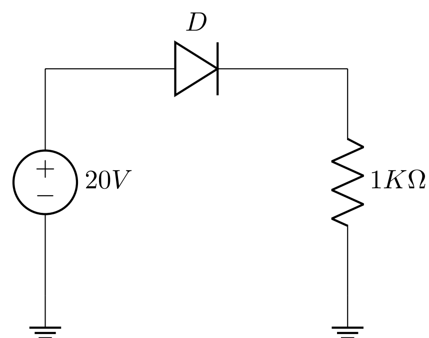
Voltage drop on LED = v_d = 2V
V_s = 15V
R = 2.2 kΩ
I = (V_s - v_d)/R = (15V-2V)/2.2 kΩ = 5.91mA

Question 15 if the supply voltage increases to 40V, what is the LED current?

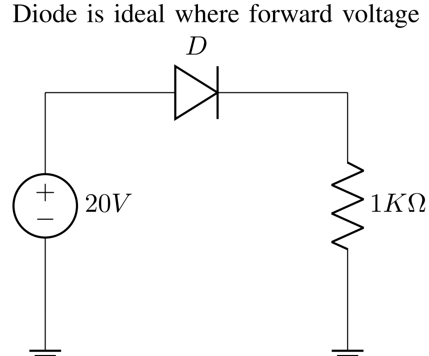


voltage drop on LED = V_d = 2V
V_s = 40V
R = 2.2 kΩ
I = (V_s - v_d)/R = (40V-2V)/2.2 kΩ = 17.28mA

Question 16 Calculate the load current, load voltage, load power, and total power. Assume the diode is ideal where forward voltage of diode is 0V.



Answer to Question 16
Diode is ideal where forward voltage of diode is 0V.



Load current = I_l = 20V/1$K\Omega$ = 20mA
Load voltage = V_l = 20mA*1$K\Omega$ = 20V

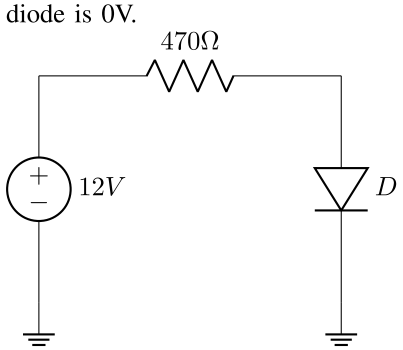
Load power = P_l= $I_l * V_l$= 20V* 20mA = 400mW
Total power = $P_l + P_d$

Since diode is ideal forward voltage of diode is 0V, so the power through diode is

P_d = V_d * I = 0V * 20mA = 0W

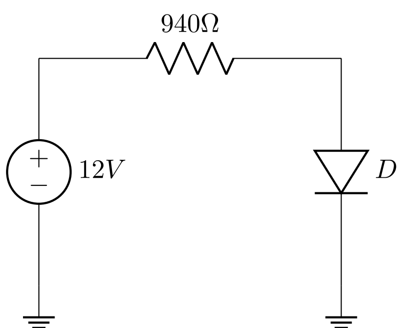
Total power= P_l + P_d = 400mW + 0W = 400mW

Question 17 If the resistor is double, what is the load current?Assume the diode is ideal where forward voltage of diode is 0V.



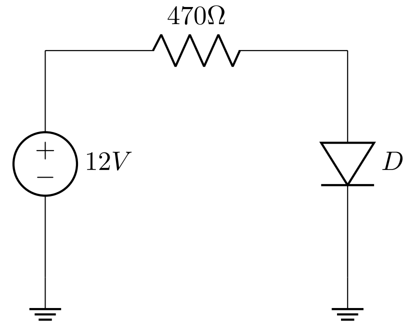
Answer to Question 17

Since the resistor value is double new resistor value, new resistor value is 2*470Ω, which is 940Ω



Load current = V_s/R
12V/940Ω = 12.8mA

Question 18 Calculate load current, load voltage, load power, diode power, and total power.



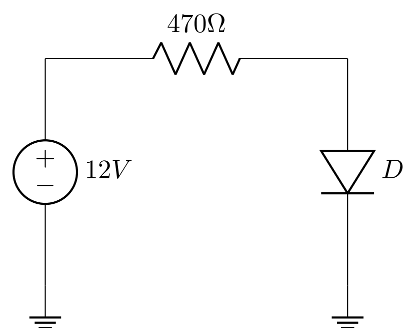
Answer to Question 18

In second approximation, the diode is not ideal. Assuming that temperature is in 25°C, the forward voltage of diode is 0.7V

Since $V_s > 0.7$V, it is forward bias
V_l= V_s - V_d
V_l = 12V - 0.7V
V_l = 11.3V

Load current = I_L = V_l/R_l = 11.3V/470Ω = 24.04mA
Load power = P_L = I_L*V_L= 11.3V* 24.04mA = 271.68 mW
Diode Power = P_d = V_d * I_d = 0.7V * 24.04mA = 16.828mW
Total Power = Load power + Diode Power =
271.68 mW + 16.828mW = 288.508mW.

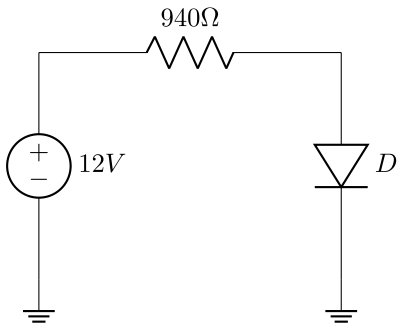
Question 19 If the resistor is double, what is the load current?



Answer to Question 19

Resistor value is doubled so new resistor value is 940Ω

Modified Circuit



Diode is not ideal in second approximation. Assuming that temperature is in 25C, the forward voltage of diode is 0.7V

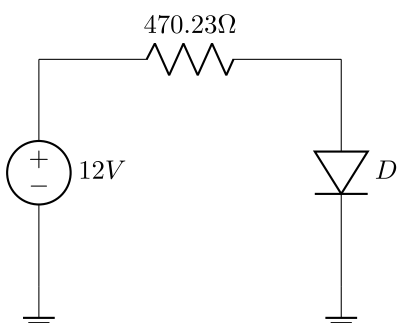
V_s= 12V
Since $V_s > 0.7$V, diode is in forward bias
V_l= V_s - V_d
V_l = 12V - 0.7V
V_l = 11.3V

Load current = I_L = V_l/R_l = 11.3V/940Ω = 12.02mA

Question 20 Calculate the load current, load voltage, load power, diode power, and total power. R_B = 0.23Ω

Answer to Question 20

Since bulk resistance is in series in 470Ω the equivalent resistance is 470.23Ω



Diode is not ideal in third approximation. Assuming that temperature is in 25C, the forward voltage of diode is 0.7V

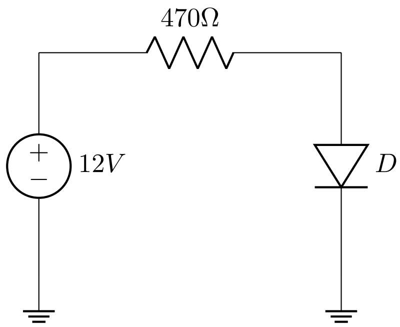
Since $V_s > 0.7$V, it is forward bias
V_l = V_s - V_d
V_l = 12V - 0.7V
V_l = 11.3V

Load current = I_L = V_l/R_l = 11.3V/470.23Ω = 24.0309mA
Load power = P_L = I_L*V_L= 11.3V* 24.0309mA = 271.5492mW

I_L=I_d because they are in series

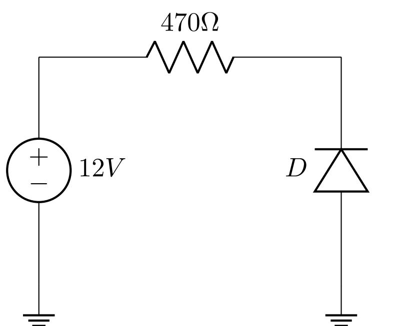
Diode Power = P_d = V_d*I_d = 0.7V * 24.0309mA = 16.8216mW
Total Power = Load power + Diode Power = 271.5492mW + 16.8216mW
= 288.37mW.

Question 21 If the diode polarity is reversed, what is the diode current? The diode voltage?



Answer to Question 21

Diode polarity is reversed. So modified circuit is



Since diode polarity is reversed. The diode is in reverse biased. This means the diode will act as open circuit. As diode being open circuit. the current through the circuit is 0A. Since there is no current flowing, the voltage of bus above the diode is 12V, and below the bus of the diode is 0 v(Since it is grounded).

Thus, the voltage across diode is 12V. and current through diode is 0A because it acts as open circuit when it is reversed biased.