Half-wave Rectifier with no filter

$$V_{L\,mean} = \frac{V_{max}}{\pi}$$

$$I_{L\,mean} = \frac{V_{L\,mean}}{R_L}$$

$$V_{o\,rms} = \frac{V_{max}}{2}$$

$$i_{o\,rms} = \frac{V_{o\,rms}}{R_L}$$

$$\text{Form Factor (FF)} = \frac{V_{o\,rms}}{V_{L\,mean}}$$

$$\text{Rippl Factor (RF)} = \sqrt{\frac{V_{o\,rms}^2 - V_{L\,mean}^2}{V_{L\,mean}^2}}$$

$$\text{Rectification Efficiency} = \frac{I_{L\,mean} V_{L\,mean}}{i_{o\,rms} V_{o\,rms}}$$

Full-wave Rectifier with no filter

$$V_{L\,mean} = \frac{2V_{max}}{\pi}$$

$$I_{L\,mean} = \frac{V_{L\,mean}}{R_L}$$

$$V_{o\,rms} = \frac{V_{max}}{\sqrt{2}}$$

$$i_{o\,rms} = \frac{V_{o\,rms}}{R_L}$$

$$FF = \frac{V_{o\,rms}}{V_{L\,mean}}$$

$$RF = \sqrt{\frac{V_{o\,rms}^2 - V_{L\,mean}^2}{V_{L\,mean}^2}}$$

$$\text{Rectification Efficiency} = \frac{I_{L\,mean} V_{L\,mean}}{i_{o\,rms} V_{o\,rms}}$$

Half-wave Rectifier with Filter

$$V_{r(p-p)} = \frac{V_{dc}}{1.25 R_L C F}$$

$$V_{dc} = \frac{V_{max}}{1 + \frac{1}{2.5 R_L C F}}$$

$$V_{rms} = \frac{V_{r(p-p)}}{2\sqrt{3}}$$

$$\text{Ripple Factor } (r) = \frac{1}{2.5\sqrt{3} R_L C F}$$

Full-wave Rectifier with Filter

$$V_r = \frac{V_{dc}}{2 R_L C F}$$

$$V_{dc} = \frac{V_{max}}{1 + \frac{1}{4 R_L C F}}$$

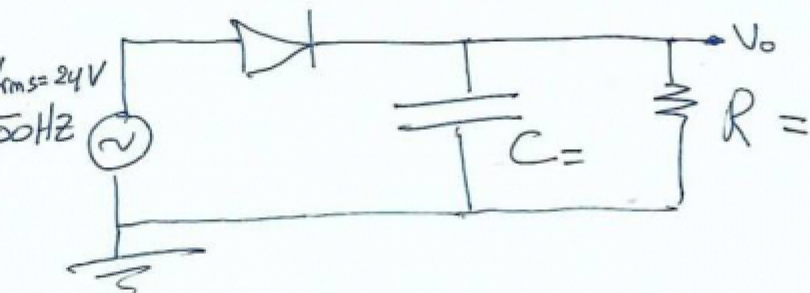
$$V_{rms} = \frac{V_{r(p-p)}}{2\sqrt{3}}$$

$$\text{Ripple Factor } (r) = \frac{1}{4\sqrt{3} R_L C F}$$

Medical Electronic Systems: Tutorials 1 ①

Tut_01 (Ex2 (H.W): P.7 Module 3

For the half-wave rectifier circuit shown in figure, change C to 200 μF and load resistor R to 500 Ω, and determine V_{dc}, $V_{r(p.p)}$, $V_{r(p)}$ and ripple factor (r).



$$V_{dc} = \frac{V_{max}}{1 + \frac{1}{2.5 RCF}}$$

$$V_{max} = \sqrt{2}\, V_{rms} = 1.414\,(24V) = 33.94V$$

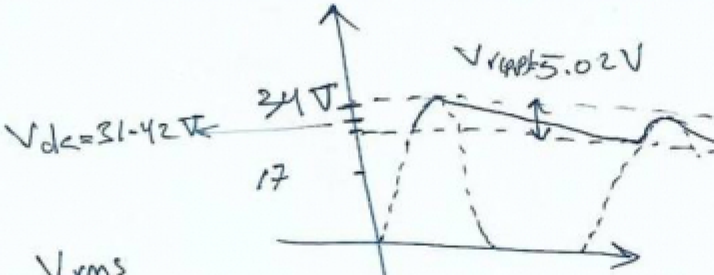
$$V_{dc} = \frac{33.94V}{1 + \frac{1}{2.5\times(500\Omega)\times(200\times10^{-6}F)(50Hz)}}$$

$$V_{dc} = \frac{33.94V}{1 + \frac{1}{12.5}} = 31.42\ V$$

$$V_{r(p.p)} = \frac{V_{dc}}{1.25 RCF} = \frac{31.42V}{1.2\,(500\Omega)(200\times10^{-6}F)(50)}$$

$$V_{r(p.p)} = \frac{31.42V}{6.25} = 5.02\ V$$

$$V_{r(P)} = \frac{V_{r(P.P)}}{2} = \frac{5.02\,V}{2} = 2.52\,V$$ Tutorial 1 (2)



Half Rectifier w
Filter capacit

$$\text{ripple factor } (r) = \frac{V_{rms}}{V_{dc}}$$

$$r = \frac{1}{2.5\sqrt{3}\, RCF}$$

$$r = \frac{1}{2.5\sqrt{3}\,(500\Omega)\,(200\times10^{-6})\,(50)}$$

$$r = \frac{1}{4.33 \times 5} = \frac{1}{21.65}$$

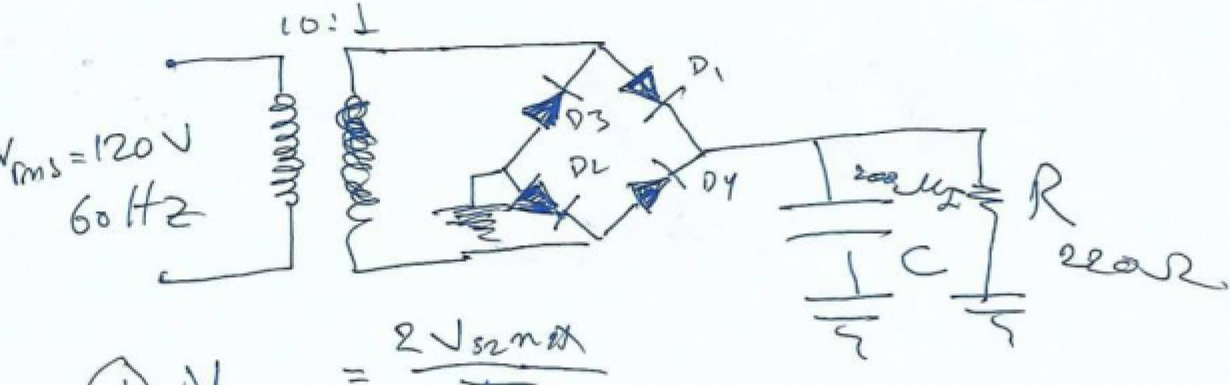
$$r = 0.046$$
$$= 4.6\,\%$$

Tut_02 (EX5 (H.W)) Module 3 P. 11 Tutorial 1 (3)

For the fullwave rectifier circuit shown in figure

1) For only resistive load, Calculate V_L mean, I_L mean, Vorms, iorms and ripple factor

2) If you add a capacitor C = 200 μF with the circuit, determine Vr(p.p), Vdc, and ripple factor



(1) $V_{L mean} = \frac{2 V_{s2 max}}{\pi}$

$V_{s1 max} = \sqrt{2}\, V_{rms} = 1.414 * 120 V$
$= 169.7 V$

$\frac{V_{s1 max}}{V_{s2 max}} = \frac{n_1}{n_2}$, $V_{s2 max} = V_{s1 max} \frac{n_2}{n_1}$

Tutorial 1. (4)

$$V_{s2max} = 169.7 * \frac{1}{10}$$
$$= 16.97\,V$$

$$V_{Lmean} = \frac{2 * 16.97\,V}{\pi} = 10.8\,V$$

$$I_{Lmean} = \frac{V_{Lmean}}{R} = \frac{10.8\,V}{220\,\Omega} = 49\,mA$$

$$V_{orms} = \frac{V_{s2max}}{\sqrt{2}} = \frac{16.97\,V}{\sqrt{2}} = 11.99\,V$$
$$\approx 12\,V$$

$$i_{orms} = \frac{V_{orms}}{R} = \frac{12\,V}{220\,\Omega} = 54\,mA$$

~~Ripple factor~~ = $\cancel{P_{dc}}$ = $\cancel{\frac{I_{mean}\,V_{mean}}{i_{orms}\,V_{orms}}}$ = $\cancel{\frac{49\,mA * 10.8\,V}{54\,mA * 12\,V}}$

Rectifier Efficiency $\cancel{P_{ac}}$

$\cancel{0.816}$

$\cancel{81.6\%}$

$$\text{Ripple factor} = \sqrt{\frac{V_{orms}^2 - V_{Lmean}^2}{V_{Lmean}^2}} = \sqrt{\frac{(12)^2 - (10.8)^2}{(10.8)^2}}$$
$$= \sqrt{\frac{144 - 116.64}{116.64}} = \sqrt{0.234} = 0.484$$

Ripple factor = 48.4 %

Tutorial 1 (5)

(2) $$V_{dc} = \frac{V_{s2max}}{1+\frac{1}{4RCF}} = \frac{16.97\text{ V}}{1+\frac{1}{4(220\Omega)(200\mu F)(60Hz)}}$$

$$V_{dc} = \frac{16.97\text{ V}}{1+\frac{1}{1936\times10^{-2}}} = \frac{16.97\text{ V}}{1+\frac{1}{19.36}}$$

$$V_{dc} = \frac{16.97\text{ V}}{1+0.051} = 16.146\text{ V}$$

$$\text{ripple factor} = \frac{1}{4\sqrt{3}\,RCF}$$

$$= \frac{1}{4\sqrt{3}(220\Omega)(200\mu F)(60Hz)}$$

$$= \frac{1}{4\sqrt{3} * 19.36} = \frac{1}{134.13}$$

$$r = 0.0074 = 0.74\,\%$$

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$$V_r(p.p) = \frac{V_{dc}}{2\,RCF} = 3.\ V.$$ Tutorial 1

Medical Electronic Systems:

Tutorials 2

Ex 6 (H-W) P.12 Module 3

A Full-wave bridge rectifier supplies a load with 50V dc, 100mA using 100 μF of filtering capacitor. Assume ideal diodes and $V_s = V_{smax} \sin 314t$, determine $V_{r(P.P)}$, V_{smax}, and V_{srms}.

Solution:

For full-wave rectifier with filter

$$V_{dc} = \frac{V_{max}}{1 + \frac{1}{4R_LCF}}$$

$$I_{dc} = \frac{V_{dc}}{R_L}$$

$$R_L = \frac{V_{dc}}{I_{dc}} = \frac{50V}{100mA} = 0.5K\Omega$$

$\sin 314t = \sin \omega t$

$\omega = 314$

$2\pi f = 314$

$$f = \frac{314}{2 * 3.14} = \frac{314\,00}{2 * 314} \quad 1$$

$$f = \frac{100}{2} = 50Hz$$

$$\therefore \; V_{smax} = V_{dc}\left[1 + \frac{1}{4R_LCF}\right]$$

$$= 50V\left[1 + \frac{1}{4 * 500\Omega * 100 * 10^{-6}F * 50}\right]$$

$$V_{smax} = 50V\left[1 + \frac{1}{10}\right]$$

$$= 50 * 1.1 = 55V$$

(2)

Medical Electronic systems: Tutorial 2

Module 3

$$V_{r(p.p)} = \frac{V_{dc}}{2R_L C F} = \frac{50\,V}{2 * 500\,\Omega * 100 * 10^{-6}\,F * 50}$$

$$V_{r(p.p)} = \frac{50\,V}{5} = 10\,V$$

$$V_{s\,rms} = \frac{V_{r(p.p)}}{2\sqrt{3}} = \frac{10\,V}{2\sqrt{3}} = \frac{5\,V}{\sqrt{3}} = 2.9\,V$$

تكملة حل السؤال EX6 (H.w) في صفحة واحد

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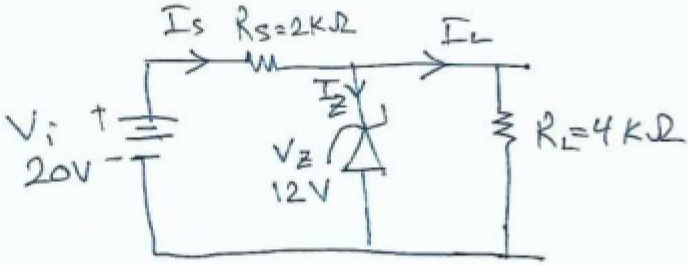
Medical Electronic Systems

Tutorial 2

Ex 3 (H-W) P.8 Module 4

For the zener circuit below, determine V_L, I_L, ~~V_s~~ I_s and I_Z



Solution

الخطوة الاولى ايجاد فولتية الحمل للتأكد

من أن zener في حالة ON

$$V_L = \frac{R_L}{R_L + R_s} V_i$$

$$V_L = \frac{4K\Omega}{2K\Omega + 4K\Omega} * 20V = \frac{2}{3} * 20V = \frac{40V}{3}$$

$$V_L = 13.33\ V$$

$\because$ $V_Z\ (12V) < V_L\ (13.33V)$

$\therefore$ Zener is ON

$\therefore$ $V_L = V_Z = 12\ V$

$$I_L = \frac{V_L}{R_L} = \frac{V_Z}{R_L} = \frac{\overset{3}{\cancel{12}}V}{\underset{1}{\cancel{4}}K\Omega} = 3mA$$

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Tutorial 2

Medical Electronic Systems

EX3 (H.W) تكملة حل سؤال

using Kirchhoffs valltage law

$$V_i - V_s - V_L = 0$$

$$V_s = V_i - V_L$$

$$= 20V - 12V$$

$$V_s = 8V$$

$$I_s = \frac{V_s}{R_s} = \frac{8V}{2k\Omega} = 4\,mA$$

$$I_s = I_Z + I_L$$ (using current division law)

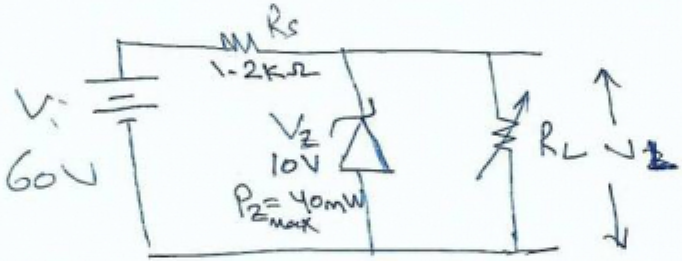
$$I_Z = I_s - I_L = 4\,mA - 3\,mA = 1\,mA$$

Medical Electronic System

Tutorial 2

Ex5 (H.W) P.11 Module 4

For the zener circuit below, determine the range of R_L and I_L.



solution

المقصود بعبارة Range of R_L and I_L هو ايجاد

R_{Lmin} I_{Lmin}

R_{Lmax} I_{Lmax}

$$R_{Lmin} = \frac{V_Z}{V_i - V_Z} R_S = \frac{10V}{(60-10)V} * 1.2K\Omega$$

$$R_{Lmin} = \frac{1.2K\Omega}{5} = 240\Omega$$

اعتمادا على قانون ohm's Law

$$R = \frac{V}{I}$$

والعلاقة العكسية بين المقاومة والتيار

$$\therefore R_{Lmin} = \frac{V_Z}{I_{Lmax}} \Rightarrow I_{Lmax} = \frac{V_Z}{R_{Lmin}} = \frac{10V}{240\Omega} = 41.66\,mA$$

$$\therefore I_{Lmax} = 41.66\,mA$$ ~~So I_{Lmax} = 41.66mA~~

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Tutorial 2

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EX5 (H.W) P.11 Module 4

تكملة حل السؤال

الآن لإيجاد I_{Lmin} فان علاقة تقسيم التيار في الدائرة الكهربية هي

$$I_s = I_Z + I_L$$

لما يمر في الدائرة I_{Lmin} في حالة R_{Lmax}

فان التيار zener يصبح I_{Zmax}

$$\therefore I_s = I_{Zmax} + I_{Lmin}$$

$$I_{Lmin} = I_s - I_{Zmax}$$

$$I_s = \frac{V_s}{R_s} \Rightarrow \frac{V_s = V_i - V_Z}{R_s} = \frac{(60-10)V}{1.2K\Omega} = \frac{50V}{1.2K\Omega}$$

$$I_s = 41.66\ mA$$

$$\therefore I_{Zmax} = \frac{P_{Zmax}}{V_Z}$$

$$\therefore I_{Zmax} = \frac{40\ mW}{10V} = 4mA$$

$$\therefore I_{Lmin} = 41.66mA - 4mA = 37.66\ mA$$

$$\therefore R_{Lmax} = \frac{V_Z}{I_{Lmin}} = \frac{10\ V}{37.66\ mA} \simeq 265\ \Omega$$

Medical Electronic Systems

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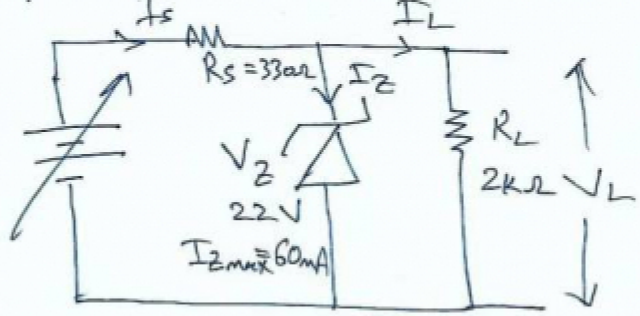
Tutorials 2

Ex 7 (H-W), P. 14 Module 4

Repeat with $R_s = 330\,\Omega$ and $R_L = 2K\Omega$ and $V_Z = 22V$



Solution:

المقصود من السؤال Ex 6

بعبارة determine the range of V_i and V_s

$V_{i\,min}$ $V_{s\,min}$

$V_{i\,max}$ $V_{s\,max}$

$$V_{i\,min} = \frac{R_L + R_s}{R_L} V_Z = \frac{2K\Omega + 330\,\Omega}{2K\Omega} * 22V$$

$$= \frac{2330\,\Omega}{2000\,\Omega} * 22V = 25.63\ V$$

$$V_{i\,min} - V_{s\,min} - V_Z = 0$$

$$V_{s\,min} = V_{i\,min} - V_Z = 25.63 - 22\ V$$

$$V_{s\,min} = 3.63V$$

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Ex7 (H.W), P. 14 Module 4

تكملة حل السؤال

$$I_L = \frac{V_L}{R_L} = \frac{V_Z}{R_L} = \frac{\cancel{22}^{\,11}\,V}{\cancel{2}\,k\Omega} = 11\,mA$$

$$I_{s\,max} = I_{Z\,max} + I_L$$

$$I_{s\,max} = 60\,mA + 11\,mA = 71\,mA$$

$$V_{s\,max} = I_{s\,max}\,R_S = 71\,mA * 330\,\Omega$$

$$V_{s\,max} = 23.43\,V$$

$$V_{i\,max} = V_{s\,max} + V_Z = 23.43\,V + 22\,V$$

$$V_{i\,max} = 45.43\,V$$