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Problems on Rectifiers

Important mathematical expressions on rectifiers:

1. Half wave rectifier

$$v_i(t) = V_m \sin\omega t$$
$$i_i(t) = I_m \sin\omega t$$

Where, V_m and I_m are instantaneous values or peak values of input voltage and current respectively, ω is the input signal frequency in rad/sec. ω = 2πf, f is the frequency of the input signal in Hz.

Case(i): If diode and transformer are ideal. i.e., $R_f = R_s = 0$.

Given V_m, find I_m

$$I_{DC} = \frac{I_m}{\pi}$$

$$V_{DC} = \frac{V_m}{\pi} \text{ or } I_{DC} x R_L$$

$$I_{rms} = \frac{I_m}{2}$$

$$V_{rms} = \frac{V_m}{2} \text{ or } I_{rms} x R_L$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{V_{rms}^2 - V_{DC}^2}}{V_{DC}} = 1.21(\text{Ideally})$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = 40.6\% \text{ (Ideally)}$$

$$PIV = V_m$$

Case(ii): Non-Zero R_f and $R_s = 0$.

Given V_m, find I_m

$$I_m = \frac{V_m}{R_F + R_L}$$

$$I_{DC} = \frac{I_m}{\pi}$$

$$V_{DC} = I_{DC} x (R_L + r_f)$$

$$I_{rms} = \frac{I_m}{2}$$

$$V_{rms} = I_{rms} x (R_L + R_f)$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 x R_L}{I_{rms}^2 (R_f + R_L)} x100$$

$$PIV = V_m$$

$V_{DC} = I_{DC} x(R_L + R_s)$

$I_{rms} = \frac{I_m}{2}$

$V_{rms} = I_{rms} x(R_L + R_s)$

Case(iii): non-zero R_s and R_f=0. Given V_m, find I_m

$I_m = \frac{V_m}{R_s + R_L}$

$I_{DC} = \frac{I_m}{\pi}$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 \, xR_L}{I_{rms}^2 (R_s + R_L)} x100$$

$$PIV = V_m$$

Case(iv): non-zero R_f and R_s.

Given V_m, find I_m

$$I_m = \frac{V_m}{R_F + R_s + R_L}$$

$$I_{DC} = \frac{I_m}{\pi}$$

$$V_{DC} = I_{DC} x(R_f + R_s + R_L)$$

$$I_{rms} = \frac{I_m}{2}$$

$$V_{rms} = I_{rms} x(R_f + R_s + R_L)$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 \, xR_L}{I_{rms}^2 (R_f + R_s + R_L)} x100$$

$$PIV = V_m$$

Half wave rectifier with C filter

time constant $T_d = CxR_L$ Discharging

$$\text{Ripple factor}(\gamma) = \frac{1}{2\sqrt{3} f R_L C} => \frac{V_r(p-p)}{V_{DC}}$$

$$V_r(p-p) = \frac{V_p}{f R_L C}$$

$$V_{DC} = \left(1 - \frac{1}{2 f R_L C}\right) V_p$$

Where, V_p is the rectified unfiltered output voltage across the load.

2. Full wave rectifier (2 diodes, with center tap transformer)

$v_i(t) = V_m \sin\omega t$ $i_i(t) = I_m \sin\omega t$

Where, V_m and I_m are instantaneous values or peak values of input voltage and current respectively, ω is the input signal frequency in rad/sec. $\omega = 2\pi f$, f is the frequency of the input signal in Hz.

Case(i): If diode and transformer is ideal. i.e., $R_f=R_s=0$.

Given V_m, find I_m

$$I_m = \frac{V_m}{R_L}$$

$$I_{DC} = \frac{2I_m}{\pi}$$

I_{rms}

V_{DC}

$\frac{2V_m}{\pi}$ xR_L

or I

$$= \frac{I_m}{\sqrt{2}}$$

$$V_{rms} = \frac{V_m}{\sqrt{2}} \text{ or } I_{rms} xR_L$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{V_{rms}^2 - V_{DC}^2}}{V_{DC}} = 0.48(\text{Ideally})$$

$$\text{Efficiency }(\eta) = \frac{P_{DC}}{P_{AC}} x100 = 81.2\% \text{ (Ideally)}$$

$$PIV = 2V_m$$

Case(ii): Non-Zero R_f and R_s=0. Given V_m, find I_m

$$I_m = \frac{V_m}{R_F + R_L}$$

$$I_{DC} = \frac{2iI_m}{\pi}$$

$$V_{DC} = I_{DC} x(R_L + r_f)$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$V_{rms} = I_{rms} x(R_L + R_f)$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

$$\text{Efficiency }(\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 xR_L}{I_{rms}^2 (R_f + R_L)} x100$$

$$PIV = 2V_m$$

Case(iii): non-zero R_s and R_f=0.
Given V_m, find I_m

$$I_m = \frac{V_m}{R_s + R_L}$$

$$I_{DC} = \frac{2I_m}{\pi}$$

$$V_{DC} = I_{DC} x(R_L + R_s)$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$V_{rms} = I_{rms} x(R_L + R_s)$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

$$\text{Efficiency }(\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 xR_L}{I_{rms}^2 (R_s + R_L)} x100$$

$$PIV = 2V_m$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

Case(iv): non-zero R_f and R_s. Given V_m, find I_m

$$I_m = \frac{V_m}{R_F + R_s + R_L}$$

$$I_{DC} = \frac{2I_m}{\pi}$$

$$V_{DC} = I_{DC} x (R_f + R_s + R_L)$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$V_{rms} = I_{rms} x (R_f + R_s + R_L)$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 x R_L}{I_{rms}^2 (R_f + R_s + R_L)} x100$$

$$PIV = 2V_m$$

Full wave rectifier with C filter

Discharging time constant $T_d = C x R_L$

$$\text{Ripple factor}(\gamma) = \frac{1}{4\sqrt{3} f R_L C} => \frac{V_{r(p-p)}}{V_{DC}}$$

$$V_r(p-p) = \frac{V_p}{2fR_L C}$$

$$V_{DC} = (1 - \frac{1}{2fR_L C})(\frac{V_p}{2})$$

Where, V_p is the rectified unfiltered output voltage across the load.

3. Full wave rectifier (4 diodes, without center-tap transformer and bridge type connection of diodes)

$v_i(t) = V_m \sin \omega t$ $i_i(t) = I_m \sin \omega t$

Where, V_m and I_m are instantaneous values or peak values of input voltage and current respectively, ω is the input signal frequency in rad/sec.

ω = 2πf, f is the frequency of the input signal in Hz.

Case(i): If diode and transformer is ideal. i.e., $R_f = R_s = 0$.

Given V_m, find I_m

$$I_{DC} = \frac{2I_m}{\pi}$$

$$V_{DC} = \frac{2V_m}{\pi} \text{ or } I_{DC} x R_L$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$V_{rms} = \frac{V_m}{\sqrt{2}} \text{ or } I_{rms} x R_L$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{V_{rms}^2 - V_{DC}^2}}{V_{DC}} = 0.48(\text{Ideally})$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = 81.2\% \text{ (Ideally)}$$

$$PIV = V_m$$

$V_{rms} = I_{rms} x (R_L + 2R_f)$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 \; xR_L}{I_{rms}^2 (2R_f + R_L)} x100$$

Case(ii): Non-Zero R_f and R_s=0. Given V_m, find I_m

$$I_m = \frac{{}_m}{2R_F + R_L}$$

$$I_{DC} = \frac{2I_m}{\pi}$$

$$V_{DC} = I_{DC} x (R_L + 2R_f)$$

$$I_{rms} = \frac{i_m}{\sqrt{2}}$$

v

$PIV = v_m$

Case(iii): non-zero r_s and r_f=0.

Given v_m, find I_m

$$I_m = \frac{V_m}{R_s + R_L}$$

$$I_{DC} = \frac{2I_m}{\pi}$$

$$V_{DC} = I_{DC} x (R_L + R_s)$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$V_{rms} = I_{rms} x (R_L + R_s)$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 xR_L}{I_{rms}^2 (R_s + R_L)} x100$$

$PIV = V_m$

Case(iv): non-zero R_f and R_s.

Given v_m, find Im

$$I_m = \frac{v_m}{2R_F + R_s + R_L}$$

$$I_{DC} = \frac{2I_m}{\pi}$$

$$V_{DC} = I_{DC} x (2R_f + R_s + R_L)$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$V_{rms} = I_{rms} x (2R_f + R_s + R_L)$$

$$\text{Ripple factor}(\gamma) = \frac{\sqrt{I_{rms}^2 - I_{DC}^2}}{I_{DC}}$$

$$\text{Efficiency } (\eta) = \frac{P_{DC}}{P_{AC}} x100 = \frac{I_{DC}^2 xR_L}{I_{rms}^2 (2R_f + R_s + R_L)} x100$$

$PIV = V_m$

Full wave rectifier with C filter

Discharging time constant $T_d = CxR_L$

$$\text{Ripple factor}(\gamma) = \frac{1}{4\sqrt{3} f R_L C} => \frac{V_{r(p-p)}}{V_{DC}}$$

$$V_r(p-p) = \frac{V_p}{2fR_L C}$$

$$V_{DC} = \left(1 - \frac{1}{2fR_L C}\right)\left(\frac{V_p}{2}\right)$$

Where, V_p is the rectified unfiltered output voltage across the load.

Note:

1. If primary voltage of the transformer is given with turns ratio, calculate the secondary voltage and then convert rms value into peak value (instantaneous value).

Example:

vp=230V with turns ratio 12:1(Np:Ns) w.k.t.

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

Therefore, $V_s = \frac{N_s}{N_p} x V_p => (\frac{1}{12}) x230 => 19.167$ V

Vs is the rms value of the secondary of the transformer.
Hence, convert into peak value.

$V_m = \sqrt{2}$ x V_s

2. If the rms value of the secondary voltage of the transformer is given, then convert into peak value.

Example:

If Vs is 200V-0V

Vs=200V and $v_m = \sqrt{2}$ x V_s=>282.84V

3. For center tapped transformers Example 1:

vp=230 V with turns ratio 12:1:12 (Np:Ns:Np) w.k.t.

$\frac{V_p}{V_s} = \frac{N_p}{N_s}$

Therefore, $V_s = \frac{N_s}{N_p} x V_p => (\frac{1}{12}) x230 => 19.167$ V

Vs is the rms value of the secondary of the transformer. Hence, convert into peak value.

$v_m = \sqrt{2} x \frac{V_s}{2}$

NOTE: in the above expression, peak value is the $\sqrt{2}V_s$ divided by two, because the secondary voltage would be divided into two halves at upper part and lower part of the secondary of the center tap transformer.

Example 2:

If Vs is given as 200V-0V-200V

Vs=200V and $v_m = \sqrt{2}$ x V_s=>282.84V

Example 3:

If Vs is given as 200V rms

NOTE: Vs is the total secondary voltage.

$$V_m = \sqrt{2} x \frac{V_s}{2} => 141.2V$$

Example 4:

If Vs is given as 50V-0-50V peak value Then, $V_m = 50V$

Example 5:

If Vs is given$_V$ $_s$as 100$_{100}$ V peak value

Then, $V_m = \Rightarrow \frac{}{2} \Rightarrow 50V$
2

Example 6:
If Vs is given as 100V peak to peak rms value

Then, $V_m = \frac{\sqrt{2}V_s}{4} \Rightarrow 25V$

Example 7:
If Vs is given as 100V peak to peak value
Then, $V_m = \frac{V_s}{4} \Rightarrow 25\ V$

4. If the peak to peak rms value of the secondary voltage of the transformer is given, then convert into peak value.

Example1:
If Vs is 300V peak to peak rms value

$$V_m = \frac{\sqrt{2}V_s}{2} => 212.13V$$

Example2:

If Vs is 300V peak to peak instantaneous value V_s is given

$$V_m = \frac{V_s}{2} => 150\ V$$

NOTE:

1. In half wave rectifier, there is only one pulse for every complete one cycle, hence, frequency of the output signal is same as the frequency of the input signal.
2. In full wave rectifier, there are two pulses for every complete one cycle, hence, the frequency of the output signal is two times that of the frequency of the input signal.

Solved Examples

P1. An ideal diode in an Half wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor.

Given data:

HWR, $V_m = 50$ V, $R_L = 1K\Omega$

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$I_m = \frac{V_m}{R_L} => 50mA$$

$$I_{DC} = \frac{I_m}{\pi} => 15.92mA$$

$$V_{DC} = \frac{V_m}{\pi} => 15.92V$$

$$I = \frac{I_m}{} => 25mA$$

rms 2

$$V_{rms} = 25V$$

$$Efficiency(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 253.44mW$$

$$P_{ac} = I_{rms}^2 * R_L => 625mW$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.405 \text{ or } 40.05\%$$

$$Ripple\ factor(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 1.21$$

P2. A diode with forward resistance of 25 Ohms in an Half wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor.

Given data:

To find: Solution:

H

$V_m = 50\ V, R_L = 1K\Omega, R_f = 25\ Ohms$

$I_{DC}, V_{DC}, I_{rms}, V_{rms}, \eta$ and γ

$$I_m = \frac{V_m}{R_f + R_L} => 48.78mA$$

$$I_{DC} = \frac{I_m}{\pi} => 15.53mA$$

W

R

$$V_{DC} = I_{DC} * R_L => 15.53V$$
$$I_{rms} = \frac{I_m}{2} => 24.39mA$$
$$V_{rms} = I_{rms}(R_f + R_L) = 24.99V$$
$$Efficiency(\eta) = \frac{P_{DC}}{P_{ac}}$$
$$P_{DC} = I_{DC}^2 * R_L => 241.18mW$$
$$P_{ac} = I_{rms}^2 * (R_L + R_f) => 609.74mW$$
$$\eta = \frac{P_{DC}}{P_{ac}} => 0.3955 \text{ or } 39.55\%$$
$$Ripple\ factor(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$
$$\gamma = 1.211$$

P3. A diode with forward resistance of 25 Ohms in an Half wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

HWR, $V_m = 50$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$I_m = \frac{V_m}{R_f + R_s + R_L} => 47.61mA$$
$$I_{DC} = \frac{I_m}{\pi} => 15.16mA$$
$$V_{DC} = I_{DC} * R_L => 15.16V$$
$$I_{rms} = \frac{I_m}{2} => 23.58mA$$
$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 24.76V$$
$$Efficiency(\eta) = \frac{P_{DC}}{P_{ac}}$$
$$P_{DC} = I_{DC}^2 * R_L => 229.82mW$$
$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => 583.81mW$$
$$\eta = \frac{P_{DC}}{P_{ac}} => 0.3936 \text{ or } 39.36\%$$
$$Ripple\ factor(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$
$$\gamma = 1.19$$

P4. A diode with forward resistance of 25 Ohms in an Half wave rectifier circuit energized by a secondary voltage of 35.35V rms sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of

1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

Solution: _

To find:

H DC, I_{rms}, V_{rms}, η and γ

W

R $\mathbf{V_m = \sqrt{2}V_s => 50V}$

,

V

$_{s(rms)} = 35.35V$, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms

I
D
C
,
V

$$I_m = \frac{V_m}{R_f + R_s + R_L} => 47.61mA$$

$$I_{DC} = \frac{I_m}{\pi} => 15.16mA$$

$$V_{DC} = I_{DC} * R_L => 15.16V$$

$$I_{rms} = \frac{I_m}{2} => 23.58mA$$

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 24.76V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 229.82mW$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => 583.81mW$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.3936 \text{ or } 39.36\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 1.19$$

P5. A diode with forward resistance of 25 Ohms in an Half wave rectifier circuit is energized by a secondary voltage of 70.7V peak to peak rms sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

HWR, $V_{s(rms)P-P} = 70.7$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms **To find:**

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$\mathbf{V_m} = \frac{\sqrt{2}\mathbf{V_s}}{\mathbf{2}} => \mathbf{50V}$$

$$I_m = \frac{V_m}{R_f + R_s + R_L} => \mathbf{47.61mA}$$

$$I_{DC} = \frac{I_m}{\pi} => \mathbf{15.16mA}$$

$$V_{DC} = I_{DC} * R_L => \mathbf{15.16V}$$

$$I_{rms} = \frac{I_m}{2} => \mathbf{23.58mA}$$

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = \mathbf{24.76V}$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => \mathbf{229.82mW}$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => \mathbf{583.81mW}$$

$$\eta = \frac{P_{DC}}{P_{ac}} => \mathbf{0.3936\ or\ 39.36\%}$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\boldsymbol{\gamma} = \mathbf{1.19}$$

P6. A diode with forward resistance of 25 Ohms in an Half wave rectifier circuit is energized by a transformer of turns ration 5:1 and primary voltage of 176.75V sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

HWR, $V_P(rms) = 176.75$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$V_{s(rms)} = \frac{V_P}{5} \quad (\text{Since } \frac{N_1}{N_2} = \frac{V_P}{V_s})$$

$$V_{s(rms)} = 35.35 \text{ Volts}$$

$$V_m = \sqrt{2}V_s => 50V$$

$$I_m = \frac{V_m}{R_f + R_s + R_L} => 47.61mA$$

$$I_{DC} = \frac{I_m}{\pi} => 15.16mA$$

$$V_{DC} = I_{DC} * R_L => 15.16V$$

$$I_{rms} = \frac{I_m}{2} => 23.58mA$$

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 24.76V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 229.82mW$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => 583.81mW$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.3936 \text{ or } 39.36\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 1.19$$

P7. A diode with forward resistance of 25 Ohms in an Half wave rectifier circuit is energized by a 50sin314t supply. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms. Also find the frequency of the output signal and PIV.

Given data:

$$\text{HWR}, v_i = 50\sin\omega t \text{ V}, R_L = 1K\Omega, R_f = 25 \text{ Ohms}, R_s = 25 \text{ Ohms}, \omega = 314 \frac{rad}{sec}.$$

To find:

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 24.76V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 229.82mW$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => 583.81mW$$

$I_{DC}, V_{DC}, I_{rms}, V_{rms}, \eta$ and γ

Solution:

$$\mathbf{v_i = v_m sin\omega t => 50 sin\omega t}$$

$$\mathbf{V_m = 50V}$$

$$I_m = \frac{V_m}{R_f + R_s + R_L} => 47.61mA$$

$$I_{DC} = \frac{I_m}{\pi} => 15.16mA$$

$$V_{DC} = I_{DC} * R_L => 15.16V$$

$$I_{rms} = \frac{I_m}{2} => 23.58mA$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.3936 \text{ or } 39.36\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 1.19$$
$$\omega = 2\pi f_{in}$$
$$f_{in} = 50Hz$$

$$f_{out} = f_{in} => \mathbf{50Hz.}$$
$$PIV = V_m => 50V$$

P8. An HWR generates 30W DC power from 120W of AC input power.
(i) What is the rectification efficiency?
(ii) What happens to remaining 50 watts?
Given data:

$P_{DC} = 30$ Watts $\qquad P_{ac} = 120$ Watts

To find: η, reason for lost of remaining 90W **Solution:**

$$\eta = \frac{P_{DC}}{P_{ac}} => 25\%$$

25% rectification efficiency does not implies that, the remaining 90W power is wasted in the circuit. Out of 120W, 60W for positive half cycle and remaining 60W for negative half cycle. Also the internal resistance of the circuit affects the delivered output. Actually, power efficiency is $\frac{30w}{60w}$ => 50%.

That is, half wave rectifier accepts only 60W input power and converts into 30W DC. Therefore, it is appropriate to say that efficiency of rectification is 25% and not 50% which is power efficiency.

P9. Design an HWR circuit by using a transformer of turns ratio 10:1 to supply 5V DC voltage to 1K Ohms load resistor, the diode has 25 ohms internal forward resistance and 25 Ohms of transformer resistance. Given data:

$N_1 : {}_2 = \quad {}_{DC} = \quad {}_f = \quad {}_s = \quad {}_L = N \quad 10:1, V\ 5V, R \quad R \quad 25\Omega, R\ 1K\Omega$

$$V_{ac} = V_P$$

To find:

Solution:

$$5 = \sqrt{2}\left(\frac{V_P}{10}\right)\frac{1000}{25 + 25 + 1000}$$

$$V_P = 37.123V(rms)$$

$$V_{DC} = I_{DC} * R_L$$

$$I_{DC} = \frac{I_m}{\pi}$$

$$V_{DC} = \frac{I_m}{\pi} * R_L$$

$$I_m = \frac{V_m}{R_f + R_S + R_L}$$

$$V_{DC} = V_m * \frac{R_L}{R_f + Rs + R_L}$$

$$V_m = \sqrt{2}V_s$$

$$V_s = \frac{V_P}{10} \left(\text{Since, } \frac{N_1}{N_2} = \frac{V_P}{V_S}\right)$$

$$V_{DC} = \sqrt{2}\left(\frac{V_P}{10}\right)\frac{R_L}{R_f + R_s + R_L}$$

P10. A half wave rectifier circuit is energized by an AC supply of frequency 50Hz. Find the ripple voltage and ripple factor, if the load of 1K ohms connected across a capacitor of 100uF. Peak value of the unfiltered rectified output is 15 Volts.

Given data:

$R_L = 1K\Omega, C = 100\mu F, f = 50Hz, V_p$

$= 15V$ **To find:**

$V_{r(p-p)}, \gamma$

Solution:

$$V_{r(p-p)} = \frac{V}{fR_L C} => 3V$$

$$\text{Ripple factor}(\gamma) = \frac{1}{2\sqrt{3}fR_L C} => 0.0577$$

P11. An ideal diode in a 2 diodes /center tapped transformer Full wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor.

Given data:

$CTT - FWR, V_m = 50\ V, R_L$

$= 1K\Omega$ **To find:**

$I_{DC}, V_{DC}, I_{rms}, V_{rms}, \eta$ and γ

Solution:

$$I_m = \frac{V_m}{R_L} => 50mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 31.84mA$$

$$V_{DC} = \frac{2V_m}{\pi} => 31.84V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 35.35mA$$

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

$$V_{rms} = 35.35V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 1.0137W$$

$$P_{ac} = I_{rms}^2 * R_L => 1.249W$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.811 \text{ or } 81.1\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.4823$$

P12. A diode with forward resistance of 25 Ohms in a center tapped transformer full wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor.

Given data:

FWR, $V_m = 50$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$I_m = \frac{V_m}{R_f + R_L} => 48.78mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 31.07mA$$

$$V_{DC} = I_{DC} * R_L => 31.07V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 34.49mA$$

$$V_{rms} = I_{rms}(R_f + R_L) = 35.35V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 965.34mW$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f) => 1.219W$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.7919 \text{ or } 79.19\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.4819$$

P13. A diode with forward resistance of 25 Ohms in a center tapped transformer full wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

FWR, $V_m = 50$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$I_m = \frac{V_m}{R_f + R_s + R_L} => 47.61mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 30.32mA$$

$$V_{DC} = I_{DC} * R_L => 30.32V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 33.66mA$$

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 35.34V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 919.3mW$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => 1.189W$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.773 \text{ or } 77.3\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1} \quad \gamma = 0.482$$

P14. A diode with forward resistance of 25 Ohms in a center tapped transformer full wave rectifier circuit energized by a secondary voltage of each half of the

transformer is 35.35V rms sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

FWR, $V_{s(rms)} = 35.35$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms **To find:**

$I_{DC}, V_{DC}, I_{rms}, V_{rms}, \eta$ and γ

Solution:

$$\mathbf{V_m = \sqrt{2}V_s => 50V}$$

$$I_m = \frac{V_m}{R_f + R_s + R_L} => 47.61\text{mA}$$

$$I_{DC} = \frac{2I_m}{\pi} => 30.32\text{mA}$$

$$V_{DC} = I_{DC} * R_L => 30.32\text{V}$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 33.66\text{mA}$$

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 35.34\text{V}$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 919.3\text{mW}$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => 1.189\text{W}$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.773 \text{ or } 77.3\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.482$$

P15. A diode with forward resistance of 25 Ohms in a center tapped transformer full wave rectifier circuit is energized by a secondary voltage of each half of the transformer is 70.7V peak to peak rms sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

HWR, $V_{s(rms)P-P} = 70.7$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms

To find:

$I_{DC}, V_{DC}, I_{rms}, V_{rms}, \eta$ and γ

Solution:

$$\mathbf{V_m = \frac{\sqrt{2}V_s}{2} => 50V}$$

$$I_m = \frac{V_m}{R_f + R_s + R_L} \Rightarrow 47.61\text{mA}$$

$$I_{DC} = \frac{2I_m}{\pi} \Rightarrow 30.32\text{mA}$$

$$V_{DC} = I_{DC} * R_L \Rightarrow 30.32\text{V}$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} \Rightarrow 33.66\text{mA}$$

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 35.34\text{V}$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L \Rightarrow 919.3\text{mW}$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) \Rightarrow 1.189\text{W}$$

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$$\eta = \frac{P_{DC}}{P_{ac}} => 0.773 \text{ or } 77.3\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.482$$

P16. A diode with forward resistance of 25 Ohms in a center tapped transformer full wave rectifier circuit is energized by a transformer of turns ration 5:1 and primary voltage of 353.5V sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

HWR, $V_P(rms) = 176.75$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms **To find:**

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$\mathbf{V_{s(rms)} = \frac{V_P}{5} \left(Since \frac{N_1}{N_2} = \frac{V_P}{V_s}\right)}$$

$$\mathbf{V_{s(rms)} = 70.7\ Volts\ (total\ secondary\ voltage)}$$

$$\mathbf{V_{s(rms)} = 35.35\ \ Volts\ (for\ each\ half\ of\ the\ transformer)}$$

$$\mathbf{V_m = \sqrt{2}V_s => 50V}$$

$$I_m = \frac{V_m}{R_f + R_s + R_L} => 47.61\text{mA}$$

$$I_{DC} = \frac{2I_m}{\pi} => 30.32\text{mA}$$

$$V_{DC} = I_{DC} * R_L => 30.32\text{V}$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 33.66\text{mA}$$

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 35.34\text{V}$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 919.3\text{mW}$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => 1.189\text{W}$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.773 \text{ or } 77.3\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.482$$

P17. A diode with forward resistance of 25 Ohms in a center tapped transformer full wave rectifier circuit is energized by a 50sin314t supply. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms. Also find the frequency of the output signal and PIV.

Given data:

HWR, $v_i = 50\sin\omega t$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms, $\omega = 314 \frac{rad}{sec}$.

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$\mathbf{v_i = v_m \sin\omega t => 50\sin\omega t}$$

$$\mathbf{V_m = 50V}$$

$$I_m = \frac{V_m}{R_f + R_s + R_L} => 47.61mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 30.32mA$$

$$V_{DC} = I_{DC} * R_L => 30.32V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 33.66mA$$

$$V_{rms} = I_{rms}(R_f + R_s + R_L) = 35.34V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 919.3mW$$

$$P_{ac} = I_{rms}^2 * (R_L + R_f + R_s) => 1.189W$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.773 \text{ or } 77.3\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.482$$

$$f_{in} = \frac{\omega}{2\pi} => 50Hz.$$

$$f_{out} = 2f_{in} => 100Hz.$$

$$PIV = 2V_m => 100\ V$$

P18. A FWR generates 90W DC power from 120W of AC input power.
(i) What is the rectification efficiency?
(ii) What happens to remaining 30 watts?

Given data:

$P_{DC} = 90$ Watts

$P_{ac} = 120$ Watts

To find: η, reason for lost of remaining 90W **Solution:**

i) $\eta = \frac{P_{DC}}{P_{ac}} => 75\%$

ii) Rectification efficiency is 75% and the remaining 25% power wasted due to internal resistances of the diode as well as transformer.

P19. Design an FWR circuit by using a transformer of turns ratio 10:1 to supply 5V DC voltage to 1K Ohms load resistor, the diode has 25 ohms internal forward resistance and 25 Ohms of transformer resistance.

Given data:

$N_1 : N_2 = 10:1$, $V_{DC} = 5V$, $R_f = R_s = 25\Omega$, $R_L = 1K\Omega$

To find:

$V_{ac} = V_P$

Solution:

$$I_m = \frac{2V_m}{R_f + R_S + R_L}$$

$$V_{DC} = 2V_m * \frac{R_L}{R_f + Rs + R_L}$$

$$V_{DC} = I_{DC} * R_L$$

$$I_{DC} = \frac{2I_m}{\pi}$$

$$V_{DC} = \frac{2I_m}{\pi} * R_L$$

$$V_m = \frac{\sqrt{2}V_s}{2}$$

$$V_s = \frac{V_P}{10} \left(\text{Since}, \frac{N_1}{N_2} = \frac{V_P}{V_S}\right)$$

$$V_{DC} = \frac{2\sqrt{2}}{2}\left(\frac{V_P}{10}\right) \frac{R_L}{R_f + R_s + R_L}$$

$$5 = \sqrt{2}\left(\frac{V_P}{10}\right) \frac{1000}{25 + 25 + 1000}$$

$$V_P = 148.48V(\text{rms})$$

P20. A center tapped transformer full wave rectifier circuit is energized by an AC supply of frequency 50Hz. Find the ripple voltage and ripple factor, if the load of 1K ohms connected across a capacitor of 100uF. Peak value of the unfiltered rectified output is 15 Volts.

Given data:

$R_L = 1K\Omega$, $C = 100\mu F$, $f = 50Hz$, $V_p = 15V$

To find:

$$V_{r(p-p)}, \gamma$$

Solution:

$$V_{r(p-p)} = \frac{V}{2fR_L C} => 1.5V$$

$$\text{Ripple factor}(\gamma) = \frac{1}{4\sqrt{3}fR_L C} => 0.0288$$

P21. A bridge type full wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor.

Given data:

$BT - FWR$, $V_m = 50$ V, $R_L = 1K\Omega$

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$P_{DC} = I_{DC}^2 * R_L => 1.0137W$$

$$P_{ac} = I_{rms}^2 * R_L => 1.249W$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.811 \text{ or } 81.1\%$$

$$I_m = \frac{V_m}{R_L} => 50mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 31.84mA$$

$$V_{DC} = \frac{2V_m}{\pi} => 31.84V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 35.35mA$$

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

$$V_{rms} = 35.35V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.4823$$

P22. A diode with forward resistance of 25 Ohms in a bridge type full wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor.

Given data:

FWR, $V_m = 50$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$I_m = \frac{V_m}{2R_f + R_L} => 47.61mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 30.32mA$$

$$V_{DC} = I_{DC} * R_L => 30.32V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 33.66mA$$

$$V_{rms} = I_{rms}(2R_f + R_L) = 35.34V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 919.3mW$$

$$P_{ac} = I_{rms}^2 * (R_L + 2R_f) => 1.189W$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.773 \text{ or } 77.3\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.482$$

P23. A diode with forward resistance of 25 Ohms in a bridge type full wave rectifier circuit energized by a 50V peak sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

FWR, $V_m = 50$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$V_{DC} = I_{DC} * R_L => 29.62V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 32.88mA$$

$$V_{rms} = I_{rms}(2R_f + R_s + R_L) = 35.34V$$

$$Efficiency(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$I_m = \frac{V_m}{2R_f + R_s + R_L} => 46.51mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 29.62mA$$

$$P_{DC} = I_{DC}^2 * R_L => 877.34mW$$
$$P_{ac} = I_{rms}^2 * (R_L + 2R_f + R_s) => 1.162W$$
$$\eta = \frac{P_{DC}}{P_{ac}} => 0.755 \text{ or } 75.5\%$$
$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$
$$\gamma = 0.4819$$

P24. A diode with forward resistance of 25 Ohms in a bridge type full wave rectifier circuit energized by a secondary voltage of 35.35V rms sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

FWR, $V_{s(rms)} = 35.35$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms **To find:** I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$\mathbf{V_m = \sqrt{2}V_s => 50V}$$

$$I_m = \frac{V_m}{2R_f + R_s + R_L} => 46.51mA$$
$$I_{DC} = \frac{2I_m}{\pi} => 29.62mA$$

$$V_{DC} = I_{DC} * R_L => 29.62V$$
$$I_{rms} = \frac{I_m}{\sqrt{2}} => 32.88mA$$

$$V_{rms} = I_{rms}(2R_f + R_s + R_L) = 35.34V$$
$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$
$$P_{DC} = I_{DC}^2 * R_L => 877.34mW$$
$$P_{ac} = I_{rms}^2 * (R_L + 2R_f + R_s) => 1.162W$$
$$\eta = \frac{P_{DC}}{P_{ac}} => 0.755 \text{ or } 75.5\%$$
$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$
$$\gamma = 0.4819$$

P25. A diode with forward resistance of 25 Ohms in a bridge type full wave rectifier circuit is energized by a secondary voltage of 70.7V peak to peak rms sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor.

Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

HWR, $V_{s(rms)P-P} = 70.7$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$\mathbf{V_m = \frac{\sqrt{2}V_s}{2} => 50V}$$

$$I_m = \frac{V_m}{2R_f + R_s + R_L} => 46.51mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 29.62mA$$

$$V_{DC} = I_{DC} * R_L => 29.62V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 32.88mA$$

$$V_{rms} = I_{rms}(2R_f + R_s + R_L) = 35.34V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 877.34mW$$

$$P_{ac} = I_{rms}^2 * (R_L + 2R_f + R_s) => 1.162W$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.755 \text{ or } 75.5\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.4819$$

P26. A diode with forward resistance of 25 Ohms in a bridge type full wave rectifier circuit is energized by a transformer of turns ration 5:1 and primary voltage of 176.75V sinusoidal signal. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor. Assume the internal resistance of the secondary of the transformer is 25 Ohms.

Given data:

HWR, $V_P(rms) = 176.75$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms

To find:

I_{DC}, V_{DC}, I_{rms}, V_{rms}, η and γ

Solution:

$$\mathbf{V_{s(rms)} = \frac{V_P}{5} \left(Since\ \frac{N_1}{N_2} = \frac{V_P}{V_s}\right)}$$

$$V_{s(rms)} = 35.35\ \text{Volts}$$

$$V_m = \sqrt{2}V_s \Rightarrow 50V$$

$$I_m = \frac{V_m}{2R_f + R_s + R_L} \Rightarrow 46.51mA$$

$$I_{DC} = \frac{2I_m}{\pi} \Rightarrow 29.62mA$$

$$V_{DC} = I_{DC} * R_L \Rightarrow 29.62V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} \Rightarrow 32.88mA$$

$$V_{rms} = I_{rms}(2R_f + R_s + R_L) = 35.34V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L \Rightarrow 877.34mW$$

$$P_{ac} = I_{rms}^2 * (R_L + 2R_f + R_s) \Rightarrow 1.162W$$

$$\eta = \frac{P_{DC}}{P_{ac}} \Rightarrow 0.755 \text{ or } 75.5\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1} \quad \gamma = 0.4819$$

P27. A diode with forward resistance of 25 Ohms in a bridge type full wave rectifier circuit is energized by a 50sin314t supply. Find the DC current and voltage, rms current and voltage across a load of 1 K ohms, also find efficiency and ripple factor.

Assume the internal resistance of the secondary of the transformer is 25 Ohms. Also find the frequency of the output signal and PIV.

Given data:

HWR, $v_i = 50\sin\omega t$ V, $R_L = 1K\Omega$, $R_f = 25$ Ohms, $R_s = 25$ Ohms, $\omega = 314\ \frac{rad}{sec}$.

To find:

$I_{DC}, V_{DC}, I_{rms}, V_{rms}, \eta$ and γ

Solution:

$$\mathbf{v_i = v_m \sin\omega t => 50\sin\omega t}$$

$$\mathbf{V_m = 50V}$$

$$I_m = \frac{V_m}{2R_f + R_s + R_L} => 46.51mA$$

$$I_{DC} = \frac{2I_m}{\pi} => 29.62mA$$

$$V_{DC} = I_{DC} * R_L => 29.62V$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} => 32.88mA$$

$$V_{rms} = I_{rms}(2R_f + R_s + R_L) = 35.34V$$

$$\text{Efficiency}(\eta) = \frac{P_{DC}}{P_{ac}}$$

$$P_{DC} = I_{DC}^2 * R_L => 877.34mW$$

$$P_{ac} = I_{rms}^2 * (R_L + 2R_f + R_s) => 1.162W$$

$$\eta = \frac{P_{DC}}{P_{ac}} => 0.755 \text{ or } 75.5\%$$

$$\text{Ripple factor}(\gamma) = \sqrt{\left(\frac{I_{rms}}{I_{DC}}\right)^2 - 1}$$

$$\gamma = 0.4819$$

$$f_{in} = \frac{\omega}{2\pi} => 50Hz.$$

$$f_{out} = 2f_{in} => 100Hz.$$

$$PIV = V_m => 50\ V$$

P28. The four diodes used in a bridge rectifier circuit have forward resistances which may be considered constant at 1Ω and infinite reverse resistance. The alternating supply voltage is 240 V r.m.s. and load resistance is 480 Ω. Calculate (i) mean load current and (ii) power dissipated in each diode.

Given data:

$$R_f = 1\ Ohm, V_s = 240V\ (rms), R_L = 480\ Ohms, BT - FWR$$

To find:

$$I_{DC}, P_{diss}(across\ each\ diode)$$

Solution:

$$V_m = \sqrt{2}\,V_s => 339.41V$$

$$I_m = \frac{V_m}{2R_f + R_L} => 0.704A$$

$$I_{DC} = \frac{2I_m}{\pi} => 0.448A$$

$$P_{diss}(across\ each\ diode) = I_{rms}^2(of\ single\ diode) * R_f$$

$$I_{rms}^2(single\ diode) = \frac{I_m}{2}(since, each\ diode\ conducts\ only\ half\ cycle)$$

$$I_{rms} = 0.352A$$

$$P_{diss}(across\ each\ diode) = 0.123W$$

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