SEM. IV, paper- CC10

Two terminal devices and their applications

(Specially: **Efficiency of Rectifier**)

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Lecture-III

(A) Efficiency of Fullwave Rectifier :—

As $P_{dc} = I_{dc}^2 R_L$ — (I) [where R_L is the load resistance of Full wave rectifier ckt.]

For full wave rectifier,

$$I_{dc} = \frac{2 I_0}{\pi} \quad \text{— (II)}$$

using (II) in (I) we get,

$$P_{dc} = \left(\frac{2 I_0}{\pi}\right)^2 R_L$$

$$\Rightarrow P_{dc} = \frac{4 I_0^2}{\pi^2} R_L \quad \text{— (III)}$$

Now, $P_{ac} = I_{r.m.s}^2 (R_L + r_d)$ [$r_d \Rightarrow$ Diode resistance]

As $R_L \gg r_d$ so $R_L + r_d \approx R_L$

So

$$P_{ac} = I_{r.m.s}^2 R_L \quad \text{— (IV)}$$

For full wave rectifier

$$I_{r.m.s} = \frac{I_0}{\sqrt{2}} \quad \text{— (V)}$$

using (V) in (IV)

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$$P_{ac} = \left(\frac{I_0}{\sqrt{2}}\right)^2 R_L$$

$$\Rightarrow P_{ac} = \frac{I_0^2}{2} R_L \quad \text{— (VI)}$$

Now $P_{ac} = I_{rms}^2 (R_L + r_d)$

where r_d is diode resistance

When $R_L >> r_d$, then $R_L + r_d \approx R_L$

So, $P_{ac} = I_{rms}^2 R_L$ --- (iv)

Now $I_{rms} = \frac{I_0}{2}$ --- (v)

using (v) in (iv)

$$P_{ac} = \left(\frac{I_0}{2}\right)^2 R_L$$

$$\Rightarrow P_{ac} = \frac{I_0^2}{4} R_L \text{ --- (vi)}$$

As $\eta = \frac{P_{dc}}{P_{ac}}$ --- (vii)

using (iii) & (vi) in (vii), we get

$$\eta = \frac{\frac{I_0^2 R_L}{\pi^2}}{\frac{I_0^2 R_L}{4}}$$

$$\Rightarrow \eta = \frac{4}{\pi^2} = 0.406 = 40.6\%$$

Efficiency of Rectifier and Efficiency of half wave and Full wave rectifier :—

Efficiency of rectifier is defined as the ratio of DC power to the applied input AC power.

$$\text{Rectifier Efficiency} = \frac{\text{DC output power}}{\text{AC input power}}$$

$$\Rightarrow \eta = \frac{P_{dc}}{P_{ac}}$$

⊛ Efficiency of Half wave rectifier :—

In half wave rectifier,

$$P_{dc} = I_{dc}^2 R_L \quad \text{--- (i)}$$

[Where R_L is load resistance of half wave rectifier circuit]

But $I_{dc} = \frac{I_0}{\pi}$ — (ii) where I_0 is peak value of AC.

using (ii) in (i)

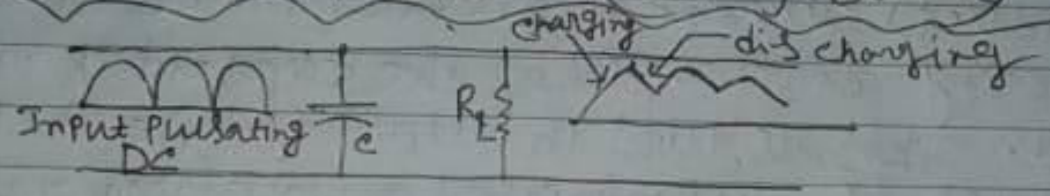
$$P_{dc} = \left(\frac{I_0}{\pi}\right)^2 R_L$$

$$\Rightarrow P_{dc} = \frac{I_0^2}{\pi^2} R_L \quad \text{--- (iii)}$$

As $\eta = \frac{P_{dc}}{P_{ac}} = \frac{\frac{4 I_0^2}{\pi^2} R_L}{\frac{I_0^2}{2} R_L} = \frac{8}{\pi^2}$

$\therefore \eta = 0.812 = 81.2\%$

Capacitor Filter (C-filter)



A capacitor-input filter is a filter ckt in which the first element is capacitor connected in parallel with the output of the rectifier in a linear power supply. The capacitor increases the dc voltage and decreases the ripple voltage components of the output. The capacitor is often reffered to as a smoothing capacitor. The capacitor is often followed by other alternating series and parallel ~~alternating~~ filter elements to further reduce ripple voltage, or adjust dc voltage. It may also be followed by a voltage ~~regulation~~ regulator which virtually eliminates any remaining ripple voltage and adjusts the DC voltage output very precisely to match the DC voltage required by the ckt.

Operation: — During the time the rectifier is conducting and the potential is higher than the charge across the capacitor, the capacitor will store energy form the transformer, when the output of the rectifier falls below the charge on the capacitor, the capacitor will discharge energy into the ckt. Since the rectifier conducts current only in the forward direction, any energy discharged by the capacitor will flow into the load. This results in output of a DC voltage upon which is superimposed a waveform reffered to as a sawtooth wave is a convenient linear approximation to the actual waveform which is exponential for both charge and discharge. The crests of the sawtooth wave will be more rounded when the dc resistance of the transformer secondary is higher. The time constant $R_L C$ will be large. ~~The reactance is very very less than than R_L~~. The discharge value depends on the time constant. The reactance of

i, c is very very less than R_L.