Reference: Electronics Devices and Circuits 1 by Ravish Singh

Numerical 01

Example 5.1 Determine the ripple factor of an L-type choke input filter comprising a 10 H choke and 8 μF capacitor, used with a full wave rectifier. Compare with a simple 8 μF capacitor input filter at a load current of 50 mA and also 150 mA, assuming the dc voltage of 50 V.

Neglect the resistance of choke and assume supply of 50 Hz.

Solution :

$$L = 10\ H$$

$$C = 8\ \mu F$$

For choke input filter,

$$\text{Ripple factor, } r = \frac{1}{6\sqrt{2}\,\omega^2 LC}$$

$$= \frac{1}{6\sqrt{2} \times (2\pi \times 50)^2 \times 10 \times 8 \times 10^{-6}}$$

$$= 0.01492$$

For capacitor input filter, with $V_{dc} = 50$ V and $I_{dc} = 50$ mA,

$$R_L = \frac{V_{dc}}{I_{dc}} = \frac{50}{50 \times 10^{-3}} = 1\ k\Omega$$

$$r = \frac{1}{4\sqrt{3}\,fCR_L}$$

$$= \frac{1}{4\sqrt{3} \times 50 \times 8 \times 10^{-6} \times 10^3}$$

$$= 0.36$$

For $I_{dc} = 150$ mA and $V_{dc} = 50$ V

$$R_L = \frac{V_{dc}}{I_{dc}} = \frac{50}{150 \times 10^{-3}}$$

$$= 0.33\ k\Omega$$

$$r = \frac{1}{4\sqrt{3}\,fCR_L}$$

$$= \frac{1}{4\sqrt{3} \times 50 \times 8 \times 10^{-6} \times 0.33 \times 10^3}$$

$$= 1.093$$

Thus for a choke input filter, ripple factor is 1.093 independent of load R_L whereas for a capacitor input filter, as load current increases, ripple factor increases.

Numerical 02

Example 5.2 A full wave rectified voltage of 18 V peak is applied across a 500 μF capacitor. Calculate the ripple and dc voltage if the load current is 100 mA.

Solution :

$V_m = 18\ V$

$C = 500\ \mu F$

$I_{dc} = 100\ mA$

For capacitor filter,

$$V_{dc} = V_m - \frac{I_{dc}}{4fC}$$

$$= 18 - \frac{100 \times 10^{-3}}{4 \times 50 \times 500 \times 10^{-6}}$$

$$= 17\ V$$

$$R_L = \frac{V_{dc}}{I_{dc}} = \frac{17}{100 \times 10^{-3}} = 170\ \Omega$$

Ripple factor,

$$r = \frac{1}{4\sqrt{3}\, fCR_L}$$

$$= \frac{1}{4\sqrt{3} \times 50 \times 500 \times 10^{-6} \times 170}$$

$$= 0.03396$$

$$r = \frac{V_{r,\,rms}}{V_{dc}}$$

$$V_{r,\,rms} = 0.03396 \times 17$$

$$= 0.577\ V$$

Numerical 03

Example 5.3 A 100 μF capacitor when used as a filter has 15 V dc across it with a terminating load resistor of 2.5 kΩ. If the rectifier is a full wave and supply frequency is 50 Hz, what is the percentage of ripple in the output?

Solution :

$C = 100\ \mu F$

$V_{dc} = 15\ V$

$R_L = 2.5\ k\Omega$

$f = 50\ Hz$

For capacitor filter,

$$r = \frac{1}{4\sqrt{3}\, fCR_L}$$

$$= \frac{1}{4\sqrt{3} \times 50 \times 100 \times 10^{-6} \times 2.5 \times 10^{3}}$$

$$= 0.01154$$

% of ripple in the output $= 0.01154 \times 100$

$= 1.154\ \%$

Numerical 04

Example 5.5 A full wave rectifier circuit uses a capacitor filter with 500 μF capacitor and provides a load current of 200 mA at 8% ripple. Calculate

(i) dc voltage across the filter capacitor

(ii) the peak rectified voltage.

Assume the frequency of 50 Hz.

Solution :

$C = 500\ \mu F$

$I_{dc} = 200\ mA$

$f = 50\ Hz$

$r = 0.08$

For capacitor input filter,

Ripple factor $r = \frac{1}{4\sqrt{3}\, fCR_L}$

$$r = \frac{I_{dc}}{4\sqrt{3}\, fC\, V_{dc}}$$

$$V_{dc} = \frac{I_{dc}}{4\sqrt{3}\, fC\, r}$$

$$= \frac{200 \times 10^{-3}}{4\sqrt{3} \times 50 \times 500 \times 10^{-6} \times 0.08}$$

$$= 14.43\ V$$

$$V_{dc} = V_m - \frac{I_{dc}}{4fC}$$

$$V_m = V_{dc} + \frac{I_{dc}}{4fC}$$

$$= 14.43 + \frac{200 \times 10^{-3}}{4 \times 50 \times 500 \times 10^{-6}}$$

$$= 16.43\ V$$

Numerical 04

Example 5.6 A power supply uses a full wave rectifier and LC filter with L = 1.5 H and C = 500 μF. It supplies 1 A to a 15 Ω resistive load. Calculate the ripple voltage across the load.

Solution : For LC filter,

Ripple factor

$$r = \frac{1}{5\sqrt{2}\,\omega^2 LC} = \frac{1}{6\sqrt{2} \times (2\pi \times 50)^2 \times 1.5 \times 500 \times 10^{-6}}$$

$$= 1.59 \times 10^{-3}$$

$$r = \frac{V_{r,\,rms}}{V_{dc}}$$

$$V_{dc} = I_{dc}\, R_L = 1 \times 15 = 15 \text{ V}$$

$$1.59 \times 10^{-3} = \frac{V_{r,\,rms}}{15}$$

$$V_{r,\,rms} = 1.59 \times 10^{-3} \times 15 = 0.0238 \text{ V}$$