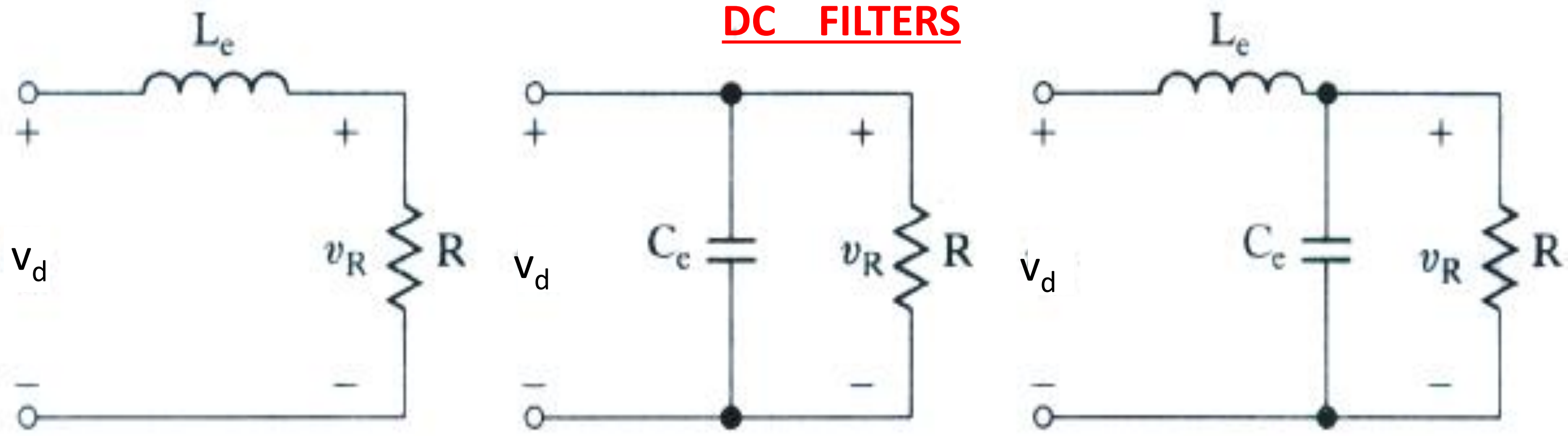
Rectifier circuit design

- **Determination of the rating of semiconductor diodes**
    - average current, rms current, peak current and peak inverse voltage
- **Design of filters at the output (dc side) to remove voltage harmonics. These filters are called dc filters.**

They are L, C and LC type

DC FILTERS



➢ **Design of filters at the input (ac side) to remove current harmonics. These filters are called ac filters.**

ac filters are usually of LC type.

- **DC FILTERS**
- **To design a dc filter circuit, knowledge of the magnitude and frequency of harmonics at the dc side is required.**
- **Output voltage is**

$$v_d(\omega t) = V_{dav} + \sum_{n=1,2,3,\ldots}^{\infty} (a_n \cos n\omega t + b_n \sin n\omega t)$$

$$V_{dav} =$$

$$\frac{1}{\pi}\int_0^{\pi} V_m \sin \omega t \; d\omega t = \frac{2V_m}{\pi}$$

$$a_n = \frac{1}{\pi/2}\int_0^{\pi} V_m \sin \omega t \cos n\omega t \; d\omega t$$

$$= \frac{4V_m}{\pi} \sum_{n=2,,4,6,\ldots}^{\infty} \frac{-1}{(n-1)(n+1)}, n = 2,4,6,\ldots$$

$$b_n = \frac{2}{\pi}\int_0^{\pi} V_m \sin \omega t \sin n\omega t \; d\omega t = 0$$

$$v_d(t) = \frac{2v_m}{\pi} - \frac{4v_m}{3\pi}\cos 2\omega t - \frac{4v_m}{15\pi}\cos 4\omega t - \frac{4v_m}{35\pi}\cos 6\omega t - \ldots$$

- **Output voltage of the full wave rectifier contains only even harmonics.**

- **Second harmonic at 100Hz is the most dominant harmonic.**

- **L filter to reduce ripple in output current**
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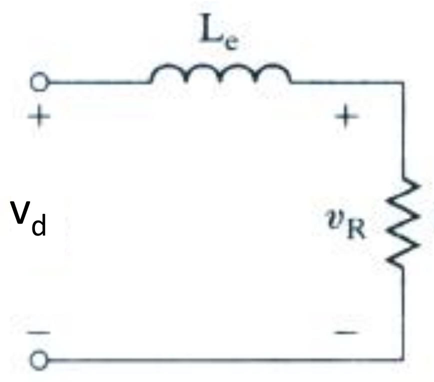
A single phase bridge rectifier is supplied from a 220V,50Hz source. Load resistance is 500 Ω. Calculate the value of series inductor L that limits the rms ripple current to be less than 5%of I_{dc}



$$v_d(t) = \frac{2v_m}{\pi} - \frac{4v_m}{3\pi}\cos 2\omega t - \frac{4v_m}{15\pi}\cos 4\omega t - \frac{4v_m}{35\pi}\cos 6\omega t - \ldots$$

$$i_d(t) = \frac{2v_m}{\pi R} - \frac{\dfrac{4v_m}{3\pi}\cos 2\omega t - \dfrac{4v_m}{15\pi}\cos 4\omega t - \dfrac{4v_m}{35\pi}\cos 6\omega t - \ldots}{\sqrt{R^2 + (n\omega L)^2}\angle \tan^{-1}\dfrac{n\omega L}{R}}$$

$$i_d(t) = \frac{2v_m}{R\pi} - \frac{4v_m}{\pi\sqrt{R^2 + (n\omega L)^2}}\left[\frac{1}{3}\cos(2\omega t - \theta_2) + \frac{1}{15}\cos(4\omega t - \theta_4) + \ldots\right.$$

$$\theta_n = \tan^{-1}\frac{n\omega L}{R}$$

DC value of output current

$$I_{dc} = \frac{2v_m}{\pi R}$$

RMS value of ripple current I_{ac}

$$I_{ac}^{\;2} = \frac{(4v_m)^2}{2\pi^2(R^2+(2\omega L)^2)}\left[\frac{1}{3}\right]^2 + \frac{(4v_m)^2}{2\pi^2(R^2+(4\omega L)^2)}\left[\frac{1}{15}\right]^2 + \ldots\ldots$$

Neglecting all harmonics other than predominant second harmonic

$$I_{ac}^{\;2} = \frac{(4v_m)^2}{2\pi^2(R^2 + (2\omega L)^2)}\left[\frac{1}{3}\right]^2$$

$$RF = \frac{I_{ac}}{I_{dc}} =$$

$$L =$$