جامعة الفرات الاوسط التقنية
المعهد التقني سماوة
قسم التقنيات الكهربائية

المحاضرة الثالثة

POWER ELECTRONICS

المرحلة الثانية

2023 – 2022

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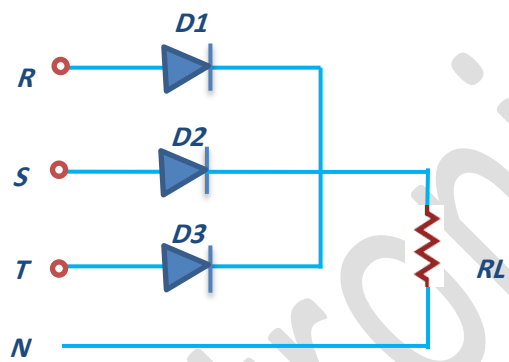
الاختبار القبلي

- *Defend the overlap case in the output of 3-phase rectifier.*
- *Calculate the DC component of the load current in term of V_m for 3-ph (HW).*
- *Draw the input and output of 3-ph full wave rectifier.*

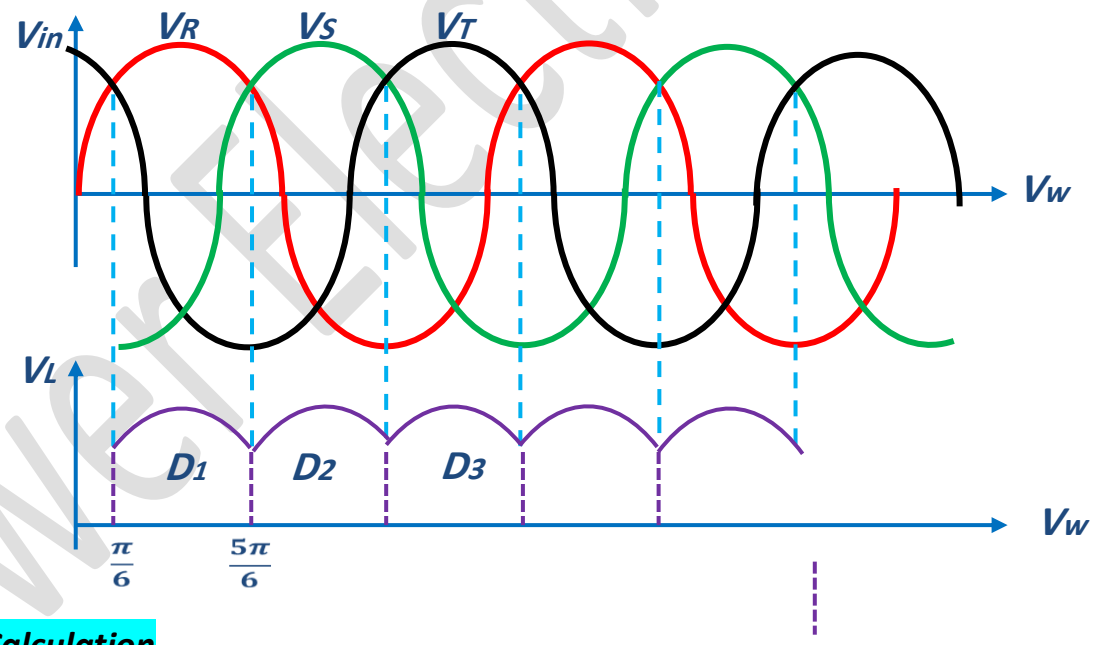
❖ *Three-phase rectifier*

A- Half Wave

- ***Practical circuit***



- ***input– output wave form***



- ***D.C Component Calculation***

$$I_{dc} = \frac{1}{T}\int_0^T I(\theta)\, d\theta \quad \text{.....} \quad T = \frac{5\pi}{6} - \frac{\pi}{6} = \frac{4\pi}{6} = \frac{2\pi}{3}$$

$$I_{dc} = \frac{1}{2\pi/3}\left[\int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} I(\theta)\, d\theta\right] = \frac{3}{2\pi}\left[\int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} I_m \sin\theta\, d\theta\right] = \frac{3I_m}{2\pi}\left[\int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} \sin\theta\ d\theta\right]$$

$$= \frac{3I_m}{2\pi}[\cos\theta]$$

$$= \frac{3I_m}{2\pi}\left[-\cos\frac{5\pi}{6} - (-\cos\frac{\pi}{6})\right] = \frac{3I_m}{2\pi}\left[\frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{2}\right] = \frac{3\sqrt{3}}{2\pi} I_m$$

$$\boxed{I_{dc} = \frac{3\sqrt{3}}{2\pi} I_m} \quad \text{.....} \quad \textit{Equ. (5)}$$

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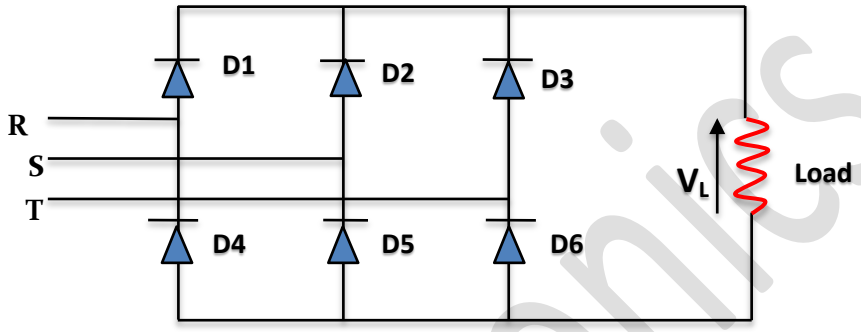
- ***R.M.S Component Calculation***

Home work

- ***Output Frequency :*** $f_o = 3f_{in}$

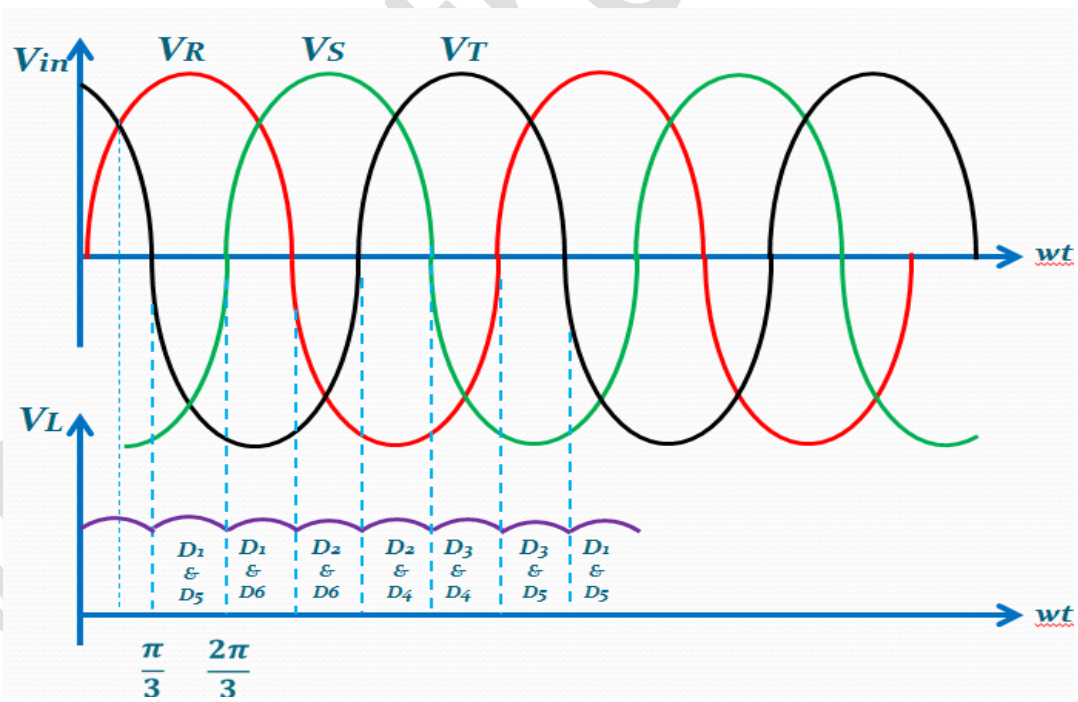
B- Full Wave

- ***practical circuit***



(Bridge)

- ***Input output wave form***



- ***D.C Component Calculation***

$$I_{dc} = \frac{1}{T}\int_0^T I(\theta)\, d\theta \quad \text{.....} \quad T = \frac{2\pi}{3} - \frac{\pi}{3} = \frac{\pi}{3}$$

$$I_{dc} = \frac{1}{\pi/3}\left[\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} I(\theta)\, d\theta\right] = \frac{3}{\pi}\left[\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} I_m \sin\theta\, d\theta\right] = \frac{3I_m}{\pi}\left[\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} \sin\theta\ d\theta\right] = \frac{3I_m}{\pi}[\cos\theta]$$

$$= \frac{3I_m}{\pi}\left[-\cos\frac{2\pi}{3} - (-\cos\frac{\pi}{3})\right] = \frac{3I_m}{\pi}\left[\frac{1}{2} + \frac{1}{2}\right]$$

$$\boxed{I_{dc} = \frac{3}{\pi} I_m} \quad \text{.....} \quad \textit{Equ. (6)}$$

- ***R.M.S Component Calculation***

$$Vrms = \sqrt{\frac{1}{T}\int_0^T v^2(\theta)d\theta}$$

$$= \sqrt{\frac{1}{\frac{\pi}{3}}\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} v^2(\theta)d\theta}$$

$$Vrms^2 = \frac{3}{\pi}\left[\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} Vm^2(\sin\theta)^2 d\,\theta\right]$$

$$= \frac{3Vm^2}{\pi}\left[\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} (\sin\theta)^2 d\,\theta\right]$$

$$= \frac{3Vm^2}{\pi}\left[\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} \left(\frac{1-\cos 2\theta}{2}\right) d\,\theta\right]$$

$$= \frac{3Vm^2}{2\pi}\left[\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} d\theta - \int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} \cos 2\theta\, d\theta\right]$$

$$Vrms^2 = \frac{3Vm^2}{2\pi}\left[\theta| + \frac{\sin 2\theta}{2}|\right]$$

$$= \frac{3Vm^2}{2\pi}\left[\left(\frac{2\pi}{3} - \frac{\pi}{3}\right) + \left(\frac{\sin 2\frac{2\pi}{3} - \sin\frac{2\pi}{3}}{2}\right)\right]$$

$$\text{Vrms} = 0.294\text{Vm}$$

- ***Output Frequency :*** $f_o = 6f_{in}$

- ***PIV=Vm*** ***.....for full wave or half wave .***

Home work

1. *Calculate the power Conversion efficiency for 3-phace rectifier full wave.*
2. *Calculate the Ripple Factor for 3-phace rectifier full wave.*

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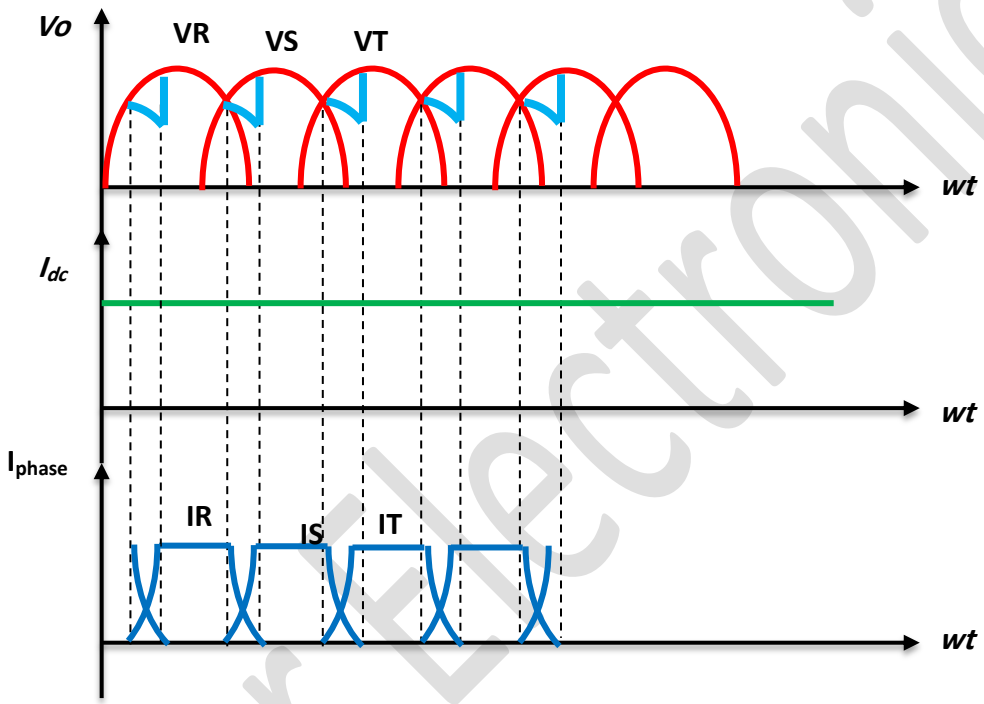
Over Lap

The waveform in the previous circuit are drawn in the ideal condition (neglected the rectifier and transformer impedance).But in the practical circuit, there is voltage drop because the rectifier and transformer impedance. And the leakage reactance of the transformer caused large voltage in the load .the load current when translate from phase to another will be lag and divider between two phase (such as R and S).The time of dividing called commutation.

The effect of the overlap:



الاختبار البعدي

- *Drive an Expiration to calculate the R.M.S for 3- phase full wave Rectifier.*
- *3- phase bridge rectifier is used to transform the A.C current to D.C current .If that source voltage (220 V)in the frequency of (50Hz) calculate :*
  1. *DC load voltage.*
  2. *R.M.S load current.*
  3. *Output frequency.*

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