Tutorial.

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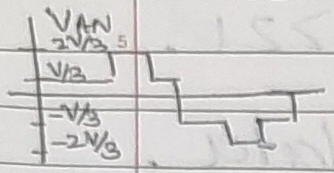
Q1. Star connected Resistive load of 15Ω/phase 420V DC source via 3phase full bridge source

(a) 180° conduction.

(i) RMS (load current) = 13.18 A.



$$i_{AN\,rms} = \frac{V_{AN\,rms}}{15} = \frac{1}{15}\sqrt{\left(\frac{V}{3}\right)^2\left[\frac{\pi}{3} + 4\times\frac{\pi}{3} + \frac{\pi}{3}\right]\times\frac{2}{2\pi}}$$

$$= \frac{1}{15}V\sqrt{3/9} = 13.18\,A.$$

(ii) RMS (Switch current) = 9.32 A.

$$(i_s)_{rms} = \frac{V}{45}\times\sqrt{2}\times\frac{1}{\sqrt{2}}\,A = 9.32\,A.$$

(iii) Load power = ~~70.83 kW~~ 7.84 kW.

$$\langle V_{dc}\, i_{AN}\rangle = 3\langle i_{AN}^2 R\rangle = 3R\langle i_{AN}^2\rangle = 3R\, i_{rms}^2 = 15\times(13.18)^2.$$

$$= 3\times 2605.69\ W.$$

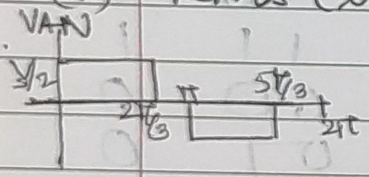
$$= 7.84\ kW$$

(iv) Avg (Source current) = 6.22 A.

$$V_{dc}(i_s)_{avg} = 2613.6\ ;\ (i_s)_{avg} = 6.22\,A.$$

(b) 120° conduction.

(i) RMS (load current) = 11.43 A.



$$i_{AN\,rms} = \frac{V_{AN\,rms}}{15} = \frac{1}{15}\sqrt{\frac{V^2}{4}\times\frac{2}{3}} = \frac{V}{15\sqrt{6}} = 11.43\,A.$$

(ii) RMS (switch current) = 6.6 A.

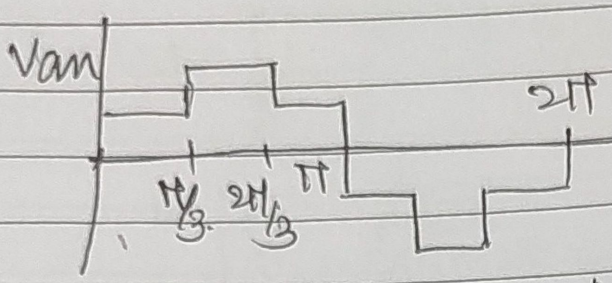
$$i_{s\,rms} = I_{AN\,rms}\times\frac{1}{\sqrt{3}} = 6.60\,A.$$

(iii) Load power = 5.88 kW.

$$3\times 15\times 11.43^2 = 5.879\ kW.$$

(iv) $(i_s)_{avg} = \frac{P}{V_{dc}} = \frac{5.88\times10^3}{420} = 13.997\,A.$

Q2. (a) 180° conduction



$V = L\frac{di}{dt}$.

$\frac{di}{dt} = \frac{V}{L} = \frac{V}{3L}$ $t \in (0, \pi/3)$

$\Delta i = \frac{V}{3L}\Delta t = \frac{V}{3L} \times \frac{\pi}{3\omega}$.

$i\left(\frac{\pi}{3\omega}\right) - i(0) = \frac{V\pi}{3\omega L}$.

$\frac{di}{dt} = \frac{2V}{3L}$ $t \in (\pi/3\omega, 2\pi/3\omega)$

$\Delta i = \frac{2V}{3L} \times \frac{\pi}{3\omega}$

$i\left(\frac{2\pi}{3\omega}\right) = \frac{2V\pi}{3\omega L} + \frac{V\pi}{3\omega L} + i(0)$.

$i(\pi) = \frac{2V\pi}{3\omega L} + \frac{2V\pi}{3\omega L} + i(0)$.

$\therefore i_{peak} = \frac{2V\pi}{3\omega L} = \underline{28.64\,A}$.

Q3. 3phase sinusoidal PWM inverter
DC link 500V.
Modulation index = 0.8.
RMS (fundamental line-line Voltage).

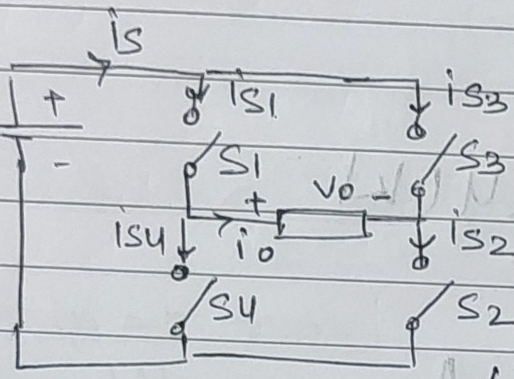
$V_{dc} = 500\ V$

$m_a = 0.8$

$V_{line-line} = \frac{1}{2}\sqrt{\frac{3}{2}}\, m_a V_{dc} = 0.612 \times 0.8 \times 500$

thus $V_{line-line} = 244.8\ V$

Q4.



$R = 10\Omega$
$L = 25\ mH$
$V_{dc} = 100\ V$
$f_{sw} = 60\ Hz.$
$T = 1/f = 0.0167\ s.$

(a) load current.

Q4. (4)

$\tau = L/R = \frac{0.025}{10} = 2.5 \times 10^{-3}$ $\quad T = 1/f = 0.0167$

(a) $I_{min} = -I_{max}$.

$$I_{max} = \frac{V_{dc}}{R}\left(\frac{1-e^{-T/2\tau}}{1+e^{-T/2\tau}}\right)$$

$$= 10\left(\frac{1-e^{-3.33}}{1+e^{-3.33}}\right) = 9.31A.$$

$I_{min} = -I_{max} = -9.31A.$

$$i_0(t) = \begin{cases} 10 + (-9.31-10)e^{-t/0.0025} \\ = 10 - 19.31e^{-t/2.5\times10^{-3}} & \text{for } t \in [0, T/20] \\ -10 + 19.31e^{-t+0.00835/0.0025} & \text{for } t \in [T/20, T/60] \end{cases}$$

Q6. (a) Sq wave o/p. $d = 90°$

$$V_{01} = \frac{4V_s}{\sqrt{2}\pi} = 207.10\,V.$$

$$Z_{01} = \sqrt{10^2 + (2\pi \times 50 \times 0.03)^2} = 13.74\,\Omega.$$

$$I_{01} = \frac{V_{01}}{Z_{01}} = 15.07\,A.$$

Power $= V_{01} I_{01} \times \cos\theta = $

$= 207.10 \times 15.07 \times 0.98 = 3058.57\,W$

(b) quasi square output.

$2d = 0.5 \times 180°$ $\quad d = 45°.$

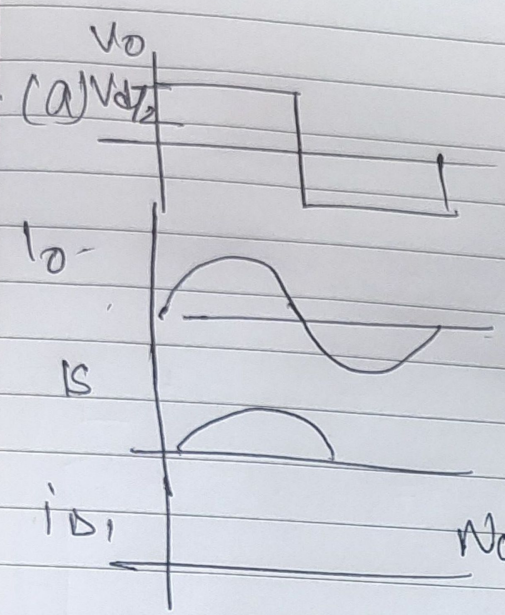
$$V_{01} = \frac{4V_s}{\sqrt{2}\pi} \sin\phi = 146.43\,V.$$

$Z_{01} = 13.74\,\Omega.$ $\quad I_{01} = 10.65\,A.$

Power $= V_{01} I_{01} \cos\theta = 148.43 \times 10.65 \times 0.98$

$= 1528.3\,W.$

Q5. (a)



(b) $P = I_{o1_{rms}}^2 R = \left(\frac{3.2}{\sqrt{2}}\right)^2 \times 2$

$= 5.36\,kW$

(c) for high switching freq., forced communication may be required