3-φ Bridge converters

- 3-φ S.C.
- 3-φ F.C.
- 3-φ D.C.

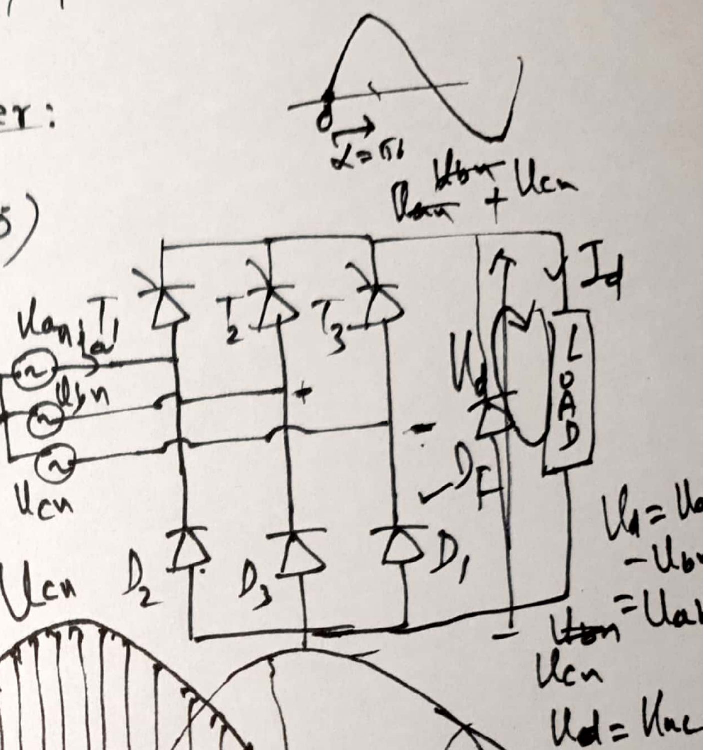
3-φ Semi-converter:

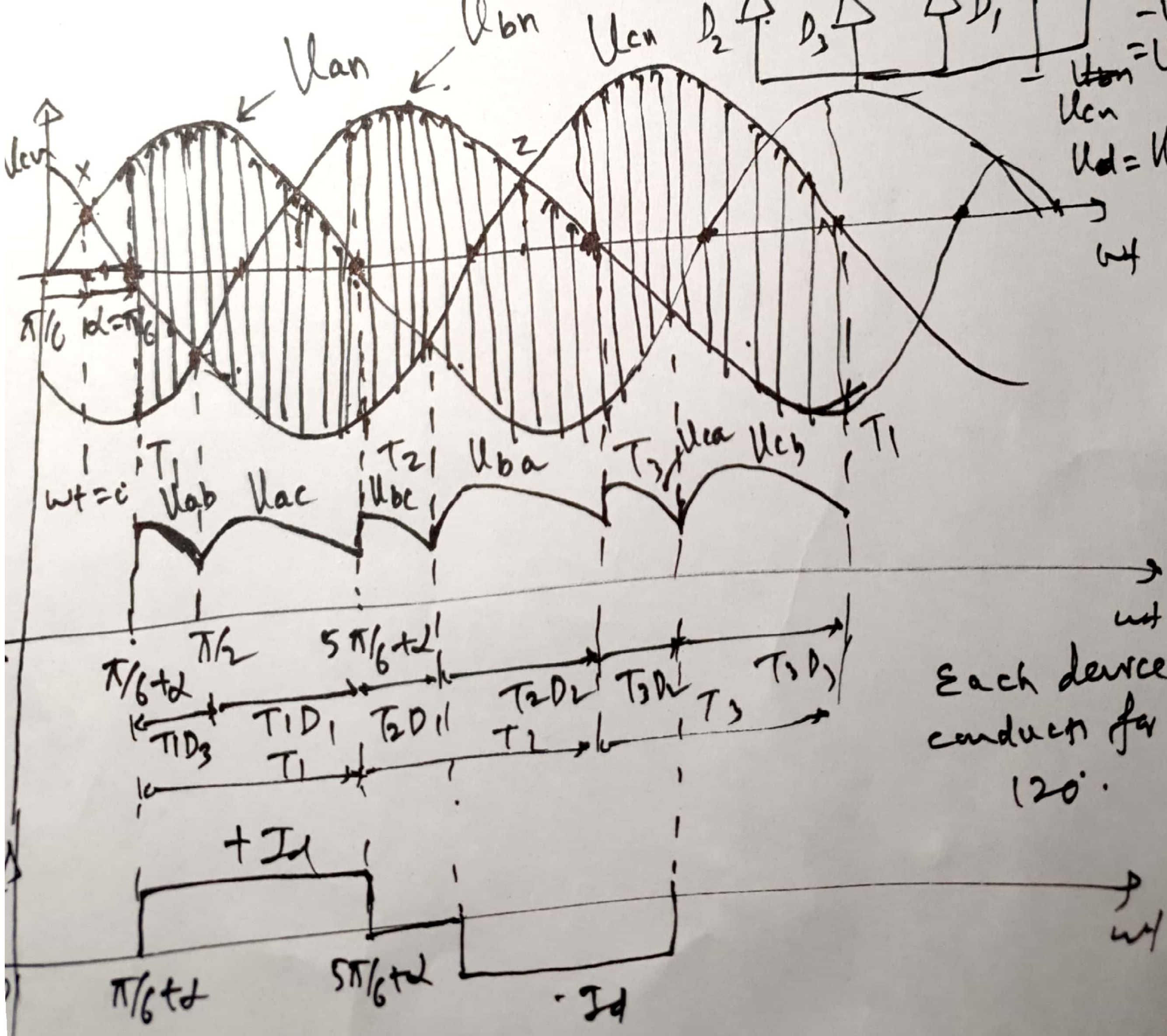
Case (a): Let $\alpha \le \pi/3$ (60°)

Let $\alpha = \pi/6$ (30°)

$i_a = +I_d$ when T_1 conducts

$= -I_d$ when D_2 conducts





Each device conducts for 120°.

Expression for converter Average o/p voltage:

Average DC o/p voltage,

$$V_d = \frac{1}{2\pi/3}\left\{\int_{\pi/6+\alpha}^{\pi/2} V_{ab}\, d(\omega t) + \int_{\pi/2}^{5\pi/6+\alpha} V_{ac}\, d(\omega t)\right\}$$

Let $V_{an} = V_m \sin\omega t$ &

$V_{bn} = V_m \sin(\omega t - 2\pi/3)$

$V_{cn} = V_m \sin(\omega t + 2\pi/3)$

$\therefore V_{ac} = V_{an} - V_{cn} = V_m \sin\omega t - V_m \sin(\omega t + 2\pi$

$V_{ac} = V_m[\sin\omega t - \sin\omega t \cos 120° - \cos\omega t \sin 120°$

$= V_m\left[\sin\omega t + \frac{1}{2}\sin\omega t - \frac{\sqrt{3}}{2}\cos\omega t\right]$

$= V_m\left[\frac{3}{2}\sin\omega t - \frac{\sqrt{3}}{2}\cos\omega t\right]$

$\Rightarrow \boxed{V_{ac} = \sqrt{3} V_m \sin(\omega t - \pi/6)}$

Ily, $\boxed{V_{ab} = V_{an} - V_{bn} = \sqrt{3} V_m \sin(\omega t + \pi/6)}$

$$\therefore V_d = \frac{3}{2\pi}\left\{ \int_{\pi/6+\alpha}^{\pi/2} \sqrt{3} V_m \sin(\omega t + \pi/6)\, d(\omega t) + \int_{\pi/2}^{5\pi/6+\alpha} \sqrt{3} V_m \sin(\omega t - \pi/6)\, d(\omega t) \right\}$$

$$\Rightarrow V_d = \frac{3\sqrt{3} V_m}{2\pi}\left\{ \Big| -\cos(\omega t + 30^\circ) \Big|_{30^\circ+\alpha}^{90^\circ} + \Big| -\cos(\omega t - 30^\circ) \Big|_{90^\circ}^{150^\circ+\alpha} \right\}$$

$$= \frac{3\sqrt{3} V_m}{2\pi}\left\{ -\cos(120^\circ) + \cos(60^\circ+\alpha) - \cos(120^\circ+\alpha) + \cos(60^\circ) \right\}$$

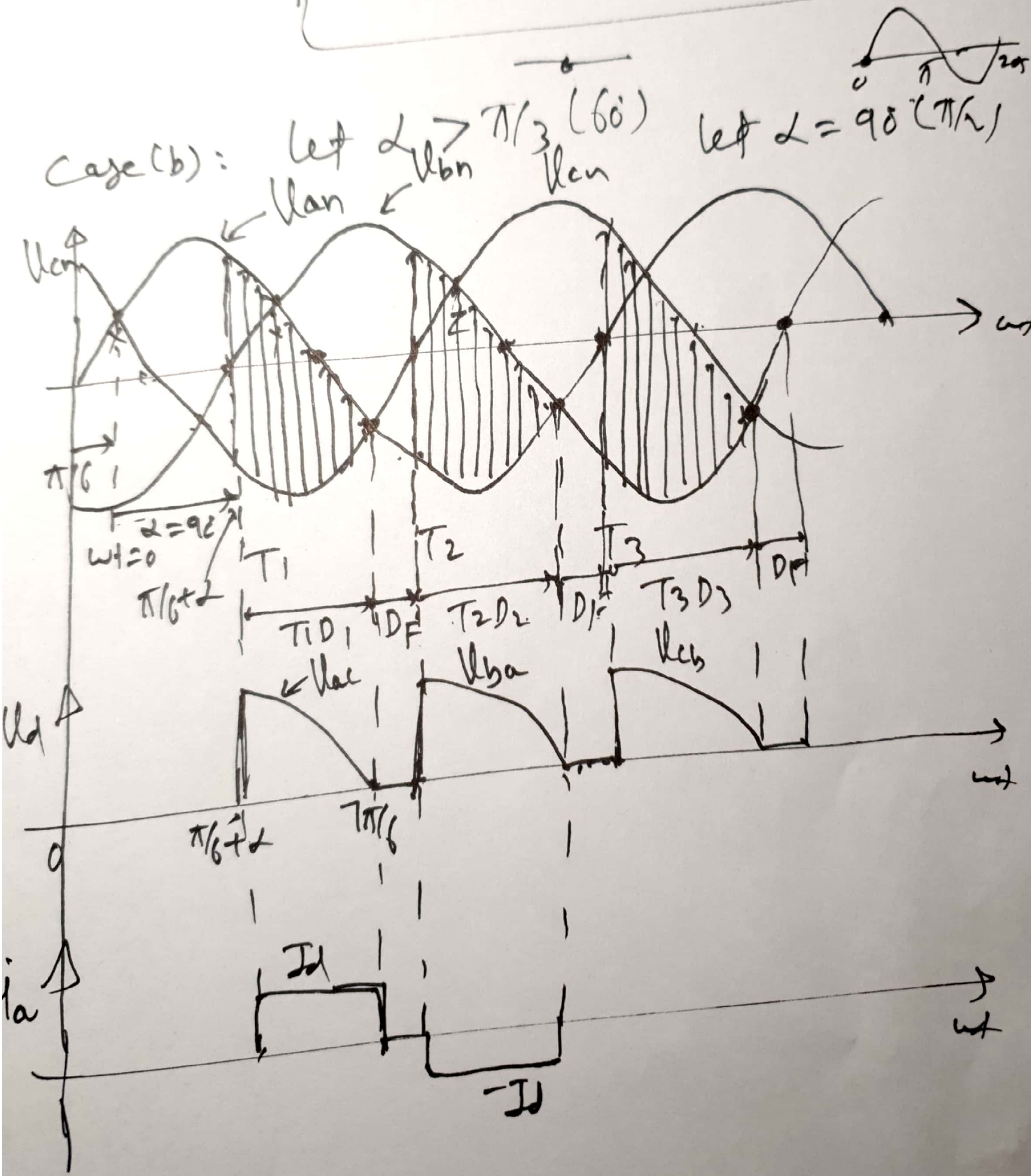
$$= \frac{3\sqrt{3} V_m}{2\pi}\left\{ \frac{1}{2} + \cos 60^\circ \cos\alpha - \sin 60^\circ \sin\alpha - \cos 120^\circ \cdot \cos\alpha + \sin 120^\circ \sin\alpha + \cos 60^\circ \right\}$$

$$= \frac{3\sqrt{3} V_m}{2\pi}\left\{ \frac{1}{2} + \frac{1}{2}\cos\alpha - \frac{\sqrt{3}}{2}\sin\alpha + \frac{1}{2}\cos\alpha + \frac{\sqrt{3}}{2}\sin\alpha + \frac{1}{2} \right\}$$

$$\therefore \boxed{V_d = \frac{3\sqrt{3}V_m}{2\pi}\left[1 + \cos\alpha\right]}$$

$$\boxed{\text{For } \alpha = 0^\circ, \; V_{do} = \frac{3\sqrt{3}V_m}{\pi}}$$

Case (b): let $\alpha > \pi/3$ (60°) let $\alpha = 90^\circ$ ($\pi/2$)



Converter Average o/p voltage,

$$V_d = \frac{1}{2\pi/3}\int_{\pi/6+\alpha}^{7\pi/6} v_{ac}\, d(\omega t) = \frac{3}{2\pi}\int_{\pi/6+\alpha}^{7\pi/6} \sqrt{3}V_m \sin(\omega t - \pi/6)\cdot d(\omega t)$$

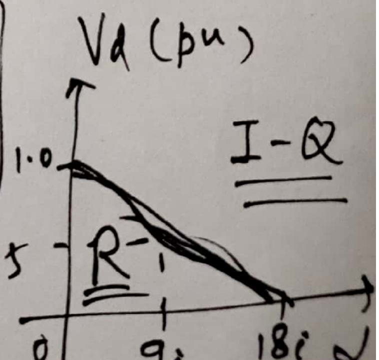
$$V_d = \frac{3\sqrt{3}V_m}{2\pi}\int_{\alpha+30}^{210} \sin(\omega t - 30)\, d(\omega t)$$

$$= \frac{3\sqrt{3}V_m}{2\pi}\Big|-\cos(\omega t - 30)\Big|_{\alpha+30}^{210}$$

$$= \frac{3\sqrt{3}V_m}{2\pi}\left[-\cos(210-30) + \cos(\alpha + 30 - 30)\right]$$

$$= \frac{3\sqrt{3}V_m}{2\pi}\left[-\cos 180 + \cos\alpha\right]$$

$$\Rightarrow \boxed{V_d = \frac{3\sqrt{3}V_m}{2\pi}(1+\cos\alpha)}$$



For $\alpha = 0$, $V_d = \frac{3\sqrt{3}V_m}{\pi} = 1.0\,pu$

For $\alpha = 90$, $V_d = \frac{3\sqrt{3}V_m}{2\pi} = \frac{1}{2} = 0.5\,pu$

For $\alpha = 180$, $V_d = 0$

Case (a) : $\alpha < \pi/3$

Case (b) : $\alpha > \pi/3$

$\alpha = \pi/3$

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