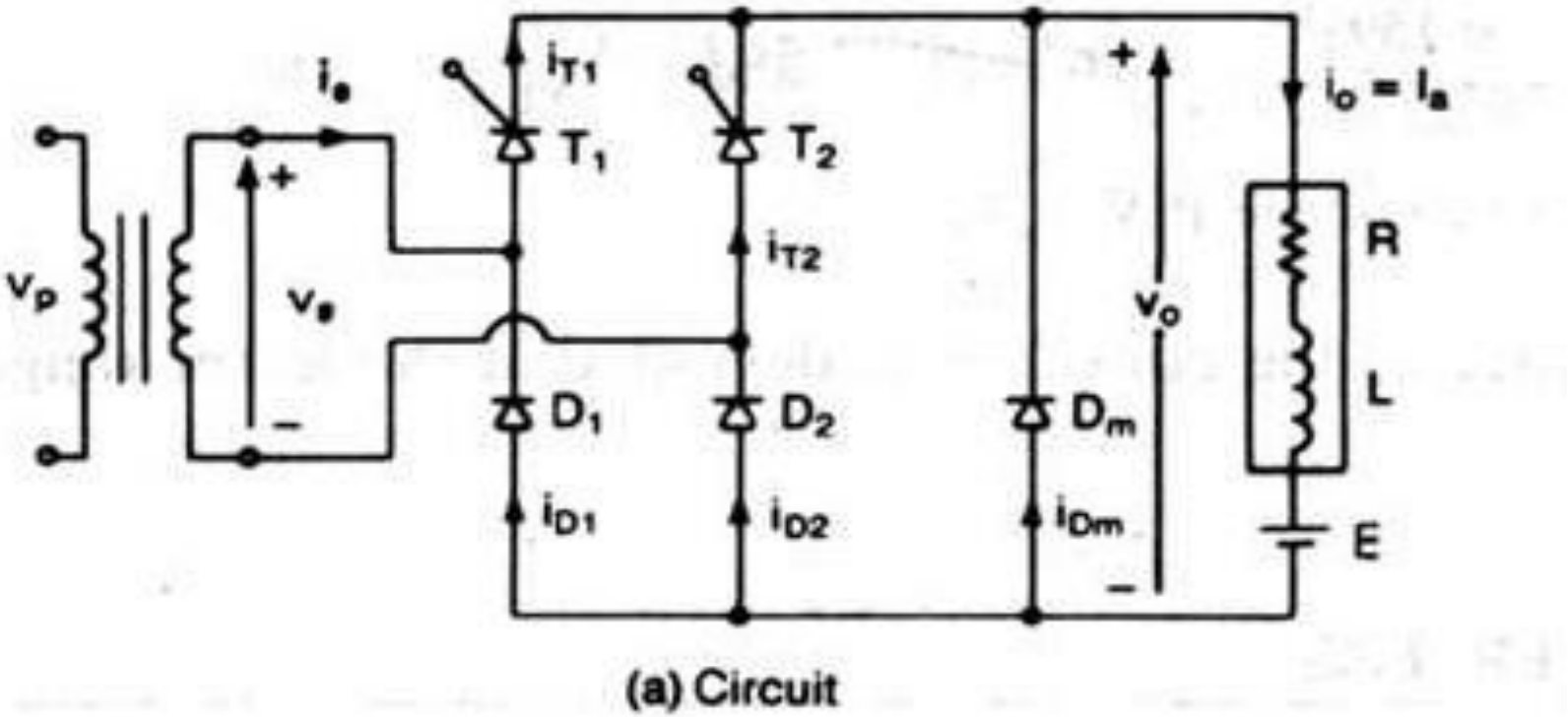
19EE502 / POWER ELECTRONICS AND DRIVES

V SEM EEE

Unit 2: DC CONVERTERS

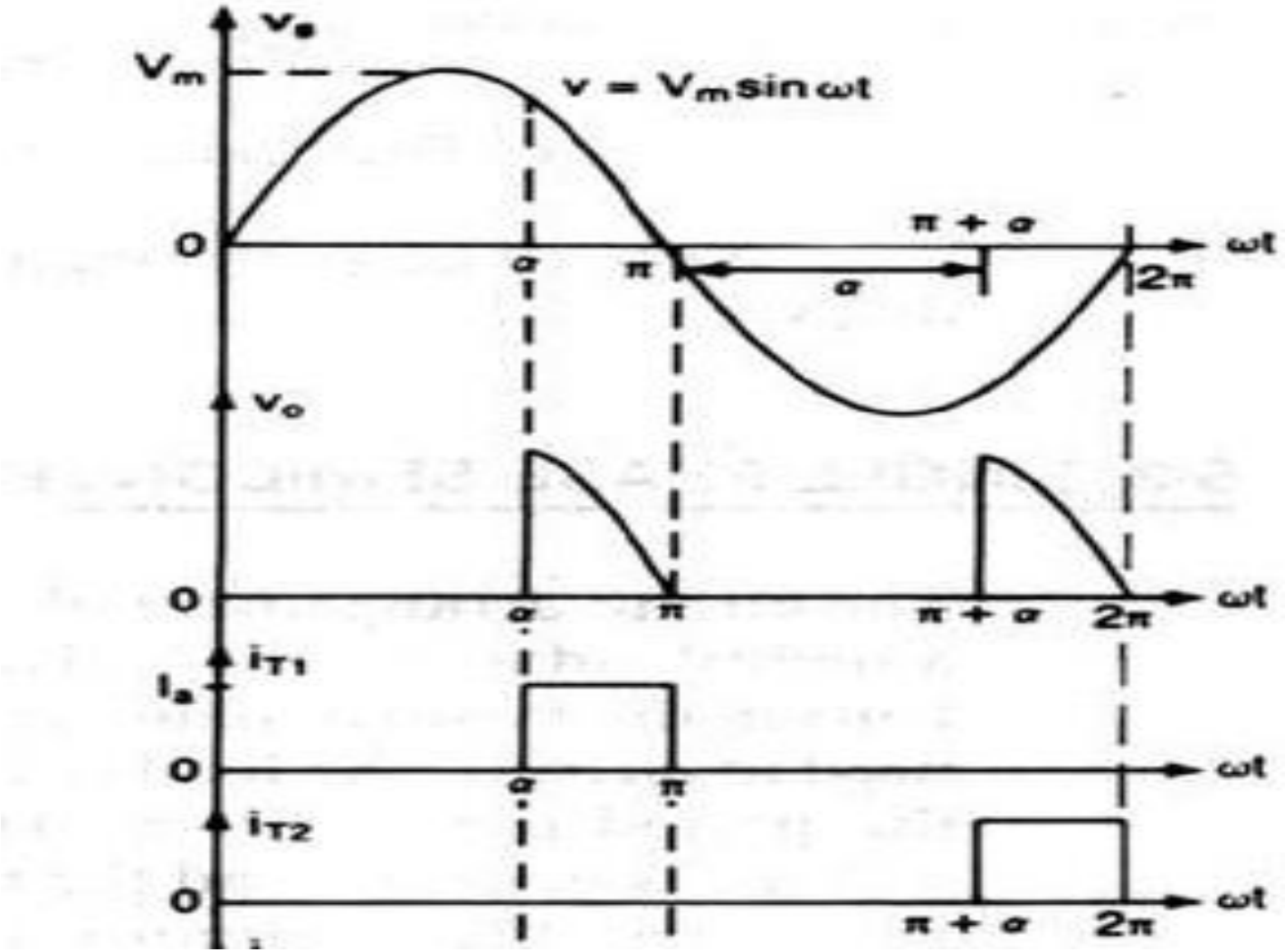
TOPIC – Single Phase Controlled Converters (2)

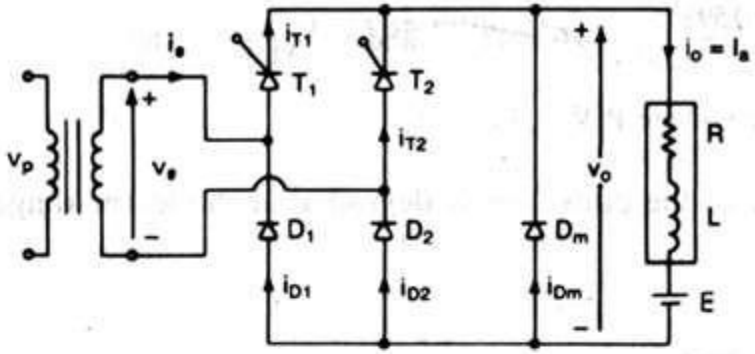
4. SINGLE PHASE SEMI CONVERTER (2 Pulse)



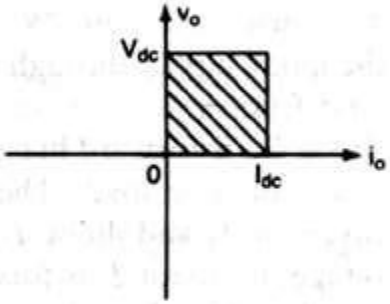
(a) Circuit

4. SINGLE PHASE SEMI CONVERTER

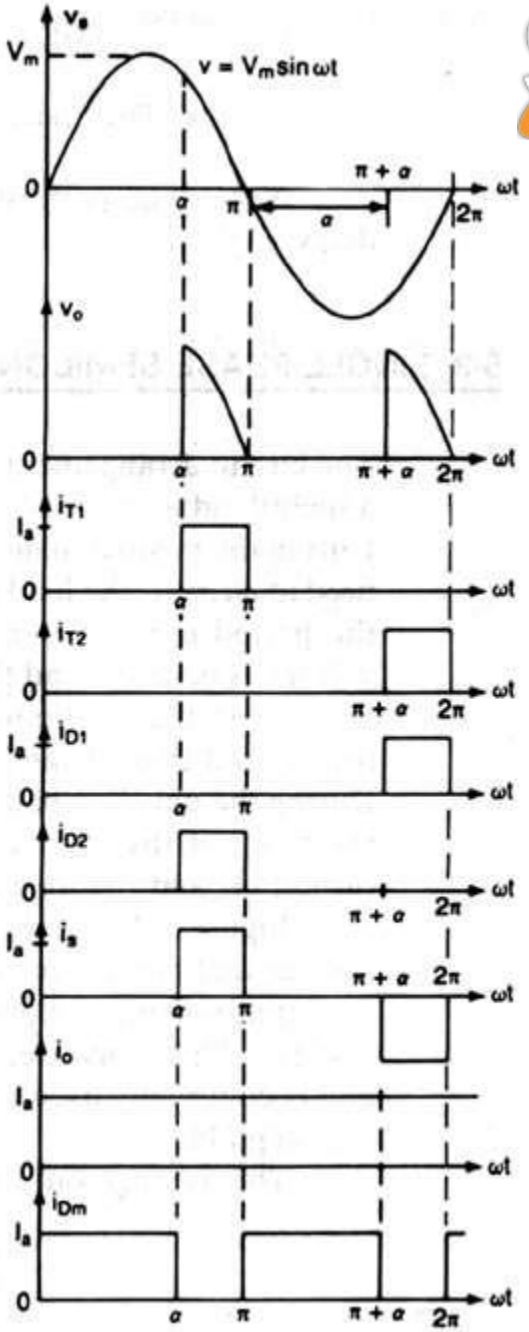




(a) Circuit



(b) Quadrant



(c) Waveforms

Single-Phase Semiconverter

$$V_{dc} = \frac{2}{2\pi}\int_{\alpha}^{\pi} V_m \sin td(\omega t = \frac{V_m}{\pi}(1+\cos\alpha)$$

$$V_{rms} = \sqrt{\frac{\omega}{2\pi}\int_{\alpha}^{\pi} V^2 \sin^2 td(\omega t)}$$

Single-Phase Semiconverter *(RL-load)*

Mode 1

$0 \le \omega t \le \alpha$

$$L\frac{di_{L1}}{dt} + Ri_{L1} + E = 0$$

$$I_{L1} = i_{L1}(\omega t = \alpha) = I_{L0}e^{-\frac{R\alpha}{L\omega}} - \frac{E}{R}\left[1 - e^{-\frac{R\alpha}{L\omega}}\right]$$

Mode 2

$\alpha \le \omega t \le \pi$

$$L\frac{di_{L2}}{dt} + Ri_{L2} + E = \sqrt{2}V_s \sin\omega t$$

$$Z = \sqrt{R^2 + (\omega L)^2}$$

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

$$I_{L2} = \frac{\sqrt{2}V_s}{Z}\sin(\omega t - \theta) - \frac{E}{R} + \left[I_{L1} + \frac{E}{R} - \frac{\sqrt{2}V_s}{Z}\sin(\alpha - \theta)\right]e^{-\frac{R}{L\omega}(\omega t - \alpha)}$$

Single-Phase Semiconverter *(RL-load)*

RMS Current for Thyristor

$$I_R = \sqrt{\frac{1}{2\pi}\int_{\alpha}^{\pi} i_L^2 \, d(\omega t)}$$

RMS Current for Thyristor

$$I_A = \frac{1}{2\pi}\int_{\alpha}^{\pi} i_L \, d(\omega t)$$

RMS Output Current

$$I_{rms} = \sqrt{\frac{1}{2\pi}\int_{0}^{\alpha} i_{L1}^2 d(\omega t) + \frac{1}{2\pi}\int_{\alpha}^{\pi} i_L^2 \, d(\omega t)}$$

AVG Output Current

$$I_{dc} = \frac{1}{2\pi}\int_{0}^{\alpha} i_1 d(\omega t) + \frac{1}{2\pi}\int_{\alpha}^{\pi} i_2 d(\omega t)$$

The single-phase semiconverter has an RL load of L = 6.5mH, R = 2.5 Ohm, and E = 10 V. The input voltage is V_S = 120 V(rms) at 60 Hz. Determine

(a) the load current I_{L0} at $\omega t = 0$, and the load current I_{L1} at $\omega t = \alpha = 60°$,

(b) the average thyristor current I_A

(c) the rms thyristor current I_R

(d)the rms output current I_{rms} and

(e) the average output current I_{dc}