===

Sheet (4)

(1) An inductive load of R=10 Ω and L=31.83 mH is fed from 220-V 50-Hz ac supply via 1-phase controller uses phase angle control. For triggering angles of π/4, π/2, find:

(a) The extinction angle (β),
(b) The conduction angle,
(c) The max. and min. values of the voltage applied to the switch and
(d) Draw typical waveforms for each part of the circuit.

(2) A 1-phase ac phase angle controller feeds an inductive load of R=10 Ω and L=31.83 mH. The input supply voltage is 220-V, 50-Hz and the triggering angle is π/3. Find:

(a) The RMS value of the load voltage,
(b) The RMS value of the fundamental component of the load voltage, and
(c) The percentage of the fundamental component.

(3) A 1-phase ac phase angle controller is fed from 220-V, 50-Hz ac supply and feeding an inductive load of R=10 Ω and L=55.13 mH. At triggering angle of π/2, find:

(a) The RMS values of the load voltage and current,
(b) The power consumed by the load, and
(c) The supply power factor.

(4) At the instant of firing of a 1-phase ac phase angle controller, the forward voltage applied to the switch is 220V. The controller is fed from 220-V, 50-Hz ac supply and feeding an inductive load of R=10 Ω, if the output voltage is 0.96 V_s. Find:

(a) The extinction angle (β),
(b) The RMS load voltage, and
(c) The load inductance (mH).

(5) A single phase Transformer Tap Changer; its primary voltage is 208V, 60Hz and its secondary voltages are V_{s1}= 120V and V_{s2}= 88V. If the load resistance is 5Ω and the RMS load voltage is 180V, determine:

(a) The delay angles of thyristors T_1 and T_2,
(b) The RMS current of all thyristors,
(c) The input power factor, and
(d) The maximum power that can be delivered to the load.

(6) A TRIAC Light Dimming Circuit is to be designed for a 100W filament lamp working from a 220V, 50Hz source. The capacitor of 0.05μF, an adjustable resistance R and a DIAC with breakover voltage of 40V are used. Determine the lowest RMS voltage down to which adjustment is possible if R=3KΩ.

(1) Expressions of AC voltage controller

(I) On/off control

duty cycle, $k = \frac{t_{on}}{t_{on}+t_{off}} = \frac{n}{n+m}$

RMS value of the load voltage,

$$V_o = V_s\sqrt{k}$$

Active power,

$$P = \frac{V_s^2\sqrt{k}}{R}$$

Supply power factor,

$$Pf=\sqrt{k}$$

(II) phase angle control

(i) RMS of load voltage

$$V_o = V_s\sqrt{\frac{1}{\pi}\left\{(\beta-\alpha)+\frac{[\sin 2\alpha - \sin 2\beta]}{2}\right\}}$$

(ii) The fundamental component of load voltage

$$a_1 = \frac{V_m}{2\pi}[\cos 2\alpha - \cos 2\beta]$$

$$b_1 = \frac{V_m}{2\pi}[2(\beta-\alpha)+\sin 2\alpha - \sin 2\beta]$$

$$\theta_1 = \tan^{-1}\frac{a_1}{b_1}$$

(iii) The n^{th} component of load voltage

$$a_n = \frac{V_m}{\pi}\left\{\frac{\cos(1+n)\alpha - \cos(1+n)\beta}{(1+n)} + \frac{\cos(1-n)\alpha - \cos(1-n)\beta}{(1-n)}\right\}$$

$$b_n = \frac{V_m}{\pi}\left\{\frac{\sin(1-n)\beta - \sin(1-n)\alpha}{(1-n)} - \frac{\sin(1+n)\beta - \sin(1+n)\alpha}{(1+n)}\right\}$$

$$\theta_n = \tan^{-1}\frac{a_n}{b_n}$$

n=3, 5, 7, ……….,

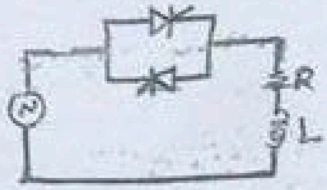
(iv) The RMS of load voltage from Fourier series

$$V_{On} = \frac{\sqrt{a_n^2+b_n^2}}{\sqrt{2}}$$

where n=1, 3, 5, …..

$$V_0 = \sqrt{V_1^2+V_3^2+\cdots+V_n^2}$$

(v) The RMS of the load current obtained from Fourier series



Single-Phase Full Wave AC Voltage Controller with RL-Load

(1) Expressions of phase angle control

(i) RMS of load voltage

$$V_o = V_s\sqrt{\frac{1}{\pi}\left\{(\beta-\alpha)+\frac{\sin 2\alpha-\sin 2\beta}{2}\right\}}$$

(ii) The fundamental component of load voltage

$$a_1 = \frac{V_m}{2\pi}[\cos 2\alpha - \cos 2\beta]$$

$$b_1 = \frac{V_m}{2\pi}[2(\beta-\alpha)+\sin 2\alpha - \sin 2\beta]$$

$$\vartheta_1 = \tan^{-1}\frac{a_1}{b_1}$$

قوانين هارمونية للـ Fourier Series مع الـ RL-load 1-φ AC regulator

وإذا استخدم R-load only تكون نفس القوانين ولكن $\beta = \pi$

(iii) The nth component of load voltage

$$a_n = \frac{V_m}{\pi}\left\{\frac{\cos(1+n)\alpha-\cos(1+n)\beta}{(1+n)}+\frac{\cos(1-n)\alpha-\cos(1-n)\beta}{(1-n)}\right\}$$

$$b_n = \frac{V_m}{\pi}\left\{\frac{\sin(1-n)\beta-\sin(1-n)\alpha}{(1-n)}-\frac{\sin(1+n)\beta-\sin(1+n)\alpha}{(1+n)}\right\}$$

$$\vartheta_n = \tan^{-1}\frac{a_n}{b_n}$$

n=3, 5, 7, ...,

(iv) The RMS of load voltage from Fourier series

$$V_{0n} = \frac{\sqrt{a_n^2+b_n^2}}{\sqrt{2}}$$

where n=1, 3, 5, ...,

$$V_o = \sqrt{V_1^2+V_3^2+\cdots+V_n^2}$$

(v) The RMS of the load current obtained from Fourier series

$$I_o = \sqrt{I_1^2+I_3^2+\cdots.+I_n^2}$$

Where $I_1 = \frac{V_1}{Z_1}, I_3 = \frac{V_3}{Z_3}$ and $I_n = \frac{V_n}{Z_n}$,

$Z_1 = \sqrt{R^2+(\omega L)^2}, Z_3 = \sqrt{R^2+(3\omega L)^2}$, and $Z_n = \sqrt{R^2+(n\omega L)^2}$,

$\varphi_1 = \tan^{-1}\frac{\omega L}{R}$, $\varphi_3 = \tan^{-1}\frac{3\omega L}{R}$ and $\varphi_n = \tan^{-1}\frac{n\omega L}{R}$

(vi) Active power

$$P = V_1 I_1\cos(\vartheta_1-\varphi_1)+V_3 I_3\cos(\vartheta_3-\varphi_3)+\cdots.+V_n I_n\cos(\vartheta_n-\varphi_n)$$

$$P = I_0^2 R$$

$$P = (I_1^2+I_3^2+\cdots.+I_n^2)R$$

(vii) Reactive power

$$Q_1 = V_1 I_1 \sin(\vartheta_1-\varphi_1)$$

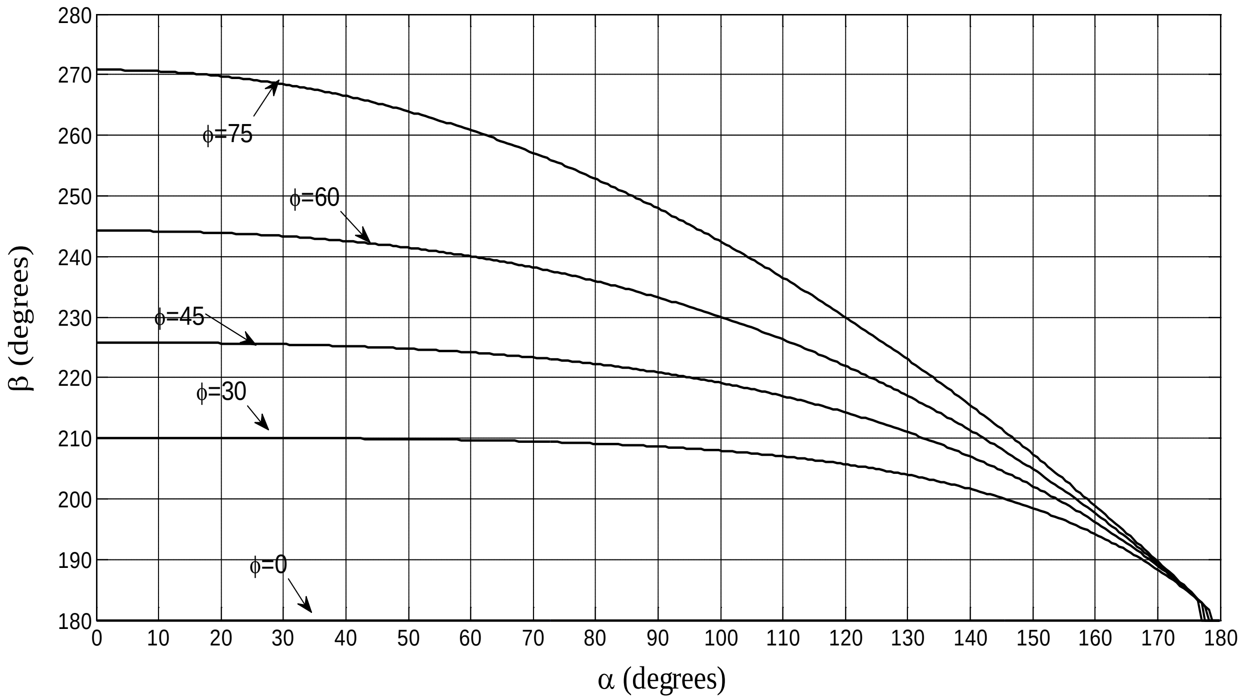


Fig. (1): Relation between *thyristor trigger delay angle (α)* *versus thyristor extinction angle angle (β)* *(at using RL load)*