Sheet (5)

(1) If the instantaneous expression of the first phase (v_A); in three phase supply system, is: v_A = 311 sin(314t) V. Draw in the same figure; v_A, v_{AB}, v_{AC}.

(2) If the instantaneous expression of the first phase (v_A); in three phase supply system, is: v_A = 311 sin(314t) V. Draw in the same figure; v_A, $0.5v_{AB}$, $0.5v_{AC}$.

(3) A 3-phase, full-wave AC voltage controller feeds Y-connected resistive load of 5 Ω per phase and is supplied from an AC source of 380V, 50 Hz. For each firing delay angles: 0^o, 45°, 75^o, 120^o and 150^o:

(a) Draw the waveform of the output phase voltage and current, v_{ao} and i_{ao}
(b) Write the expression of the output phase voltage and current, v_{ao} and i_{ao}
(c) Calculate the instantaneous phase voltage value (v_{ao}) at $wt = 0^o, 30^o, 45^o, 75^o, 90^o, 120^o, 150^o, 180^o, 210^o, 270^o, 330^o$ and 360^o.
(d) Calculate the rms value of output phase voltage,
(e) Calculate the load power,
(f) Calculate the source power factor,
(g) Calculate the maximum applied voltage to the thyristor in the first phase.

(4) A 3-phase, half-wave AC voltage controller feeds Y-connected resistive load of 10 Ω per phase and is supplied from an AC source of 400V, 50 Hz. For each firing delay angles: 0^o, 45°, 75^o, 120^o and 150^o.

(a) Draw the waveform of the output phase voltage and current, v_{ao} and i_{ao}
(b) Write the expression of the output phase voltage and current, v_{ao} and i_{ao}
(c) Calculate the instantaneous phase voltage value (v_{ao}) at $wt = 0^o, 30^o, 45^o, 75^o, 90^o, 120^o, 150^o, 180^o, 210^o, 270^o, 330^o$ and 360^o.
(d) Calculate the rms value of output phase voltage,
(e) Calculate the load power,
(f) Calculate the source power factor, and
(g) Calculate the maximum applied voltage to the thyristor in the first phase.

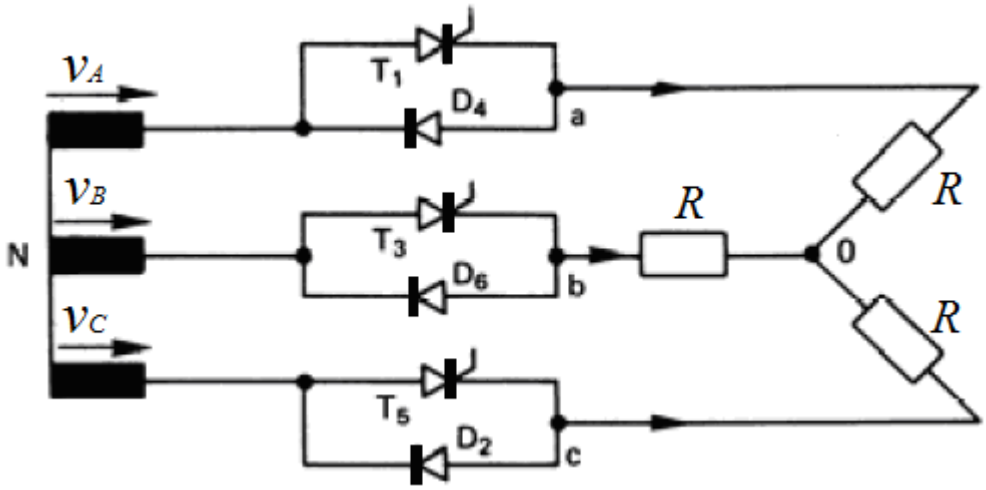
(5) A Y-connected resistive load of 20 Ω per phase is connected to 460V, 60-Hz, 3-phase supply. The load power varied from 9kW to 3kW by using a 3-phase full-wave AC voltage controller. Determine:

(a) The peak value of thyristor current,
(b) The range of required firing delay angle, and
(c) The range of supply power factor.

(6) Repeat prob. (5) for 3-phase half-wave AC voltage controller.

(7) Write a short note about soft starting of 3-phase induction motor using 3-phase ac voltage regulators.

Three Phase Half Wave AC Voltage Controller with Y connected Resistive Load



The expressions for RMS load phase voltage with resistive load are:

$$V_o = V_s\sqrt{\left\{1-\frac{3\alpha}{4\pi}+\frac{3}{8\pi}\sin 2\alpha\right\}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 0^o \le \alpha \le 90^o$$

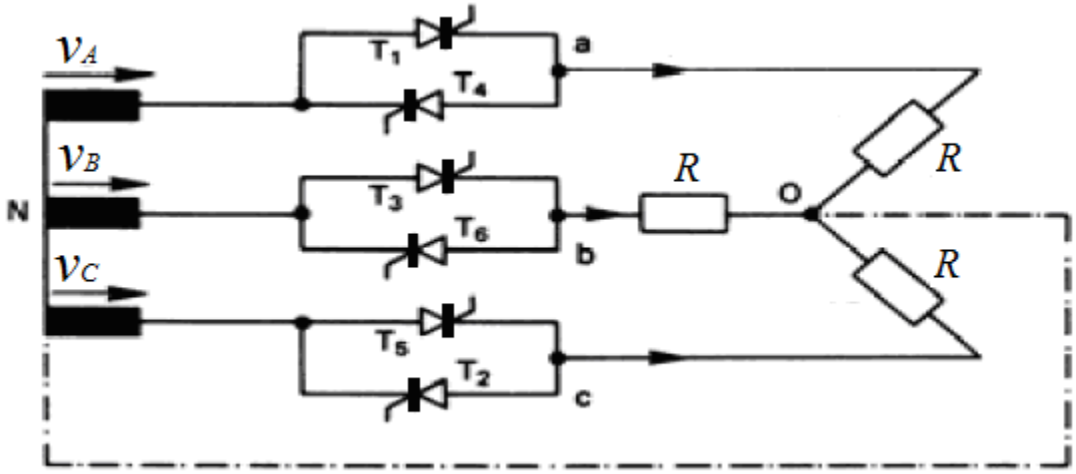
$$V_o = V_s\sqrt{\left\{\frac{11}{8}-\frac{3\alpha}{2\pi}\right\}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 90^o \le \alpha \le 120^o$$

$$V_o = V_s\sqrt{\left\{\frac{7}{8}-\frac{3\alpha}{4\pi}+\frac{3}{16\pi}\sin 2\alpha-\frac{3\sqrt{3}}{16\pi}\cos 2\alpha\right\}} \quad \ldots\ldots\ldots\ldots\ldots\ 120^o \le \alpha \le 210^o$$

$$V_o = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ \alpha \ge 210^o$$

Where V_s is the rms of the supply phase voltage

Three Phase Full Wave AC Voltage Controller with Y connected Resistive Load



The expressions for RMS load phase voltage with resistive load are:

$$V_o = V_s\sqrt{\left\{1-\frac{3\alpha}{2\pi}+\frac{3}{4\pi}\sin 2\alpha\right\}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 0^o \le \alpha \le 60^o$$

$$V_o = V_s\sqrt{\left\{\frac{1}{2}+\frac{9}{8\pi}\sin 2\alpha+\frac{3\sqrt{3}}{8\pi}\cos 2\alpha\right\}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ 60^o \le \alpha \le 90^o$$

$$V_o = V_s\sqrt{\left\{\frac{5}{4}-\frac{3\alpha}{2\pi}+\frac{3}{8\pi}\sin 2\alpha+\frac{3\sqrt{3}}{8\pi}\cos 2\alpha\right\}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ 90^o \le \alpha \le 150^o$$

$$V_o = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ \alpha \ge 150^o$$

Where V_s is the rms of the supply phase voltage

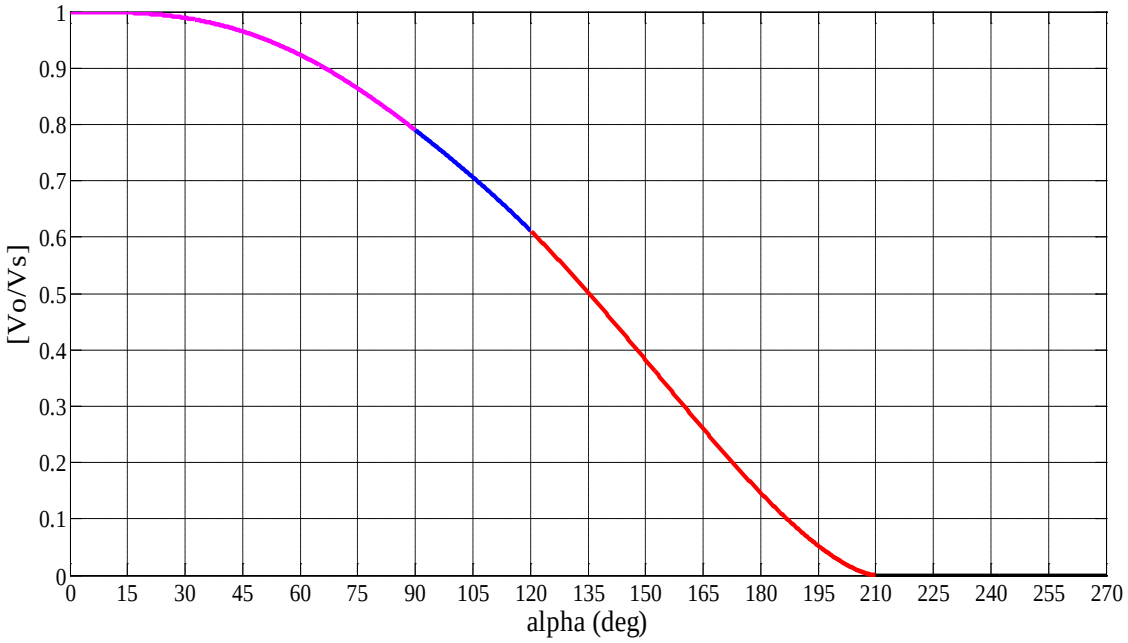


Fig. (1): [Vo/Vs] versus [firing angle] for a Y- connected resistive load in 3-ph Half Wave AC Voltage Controller

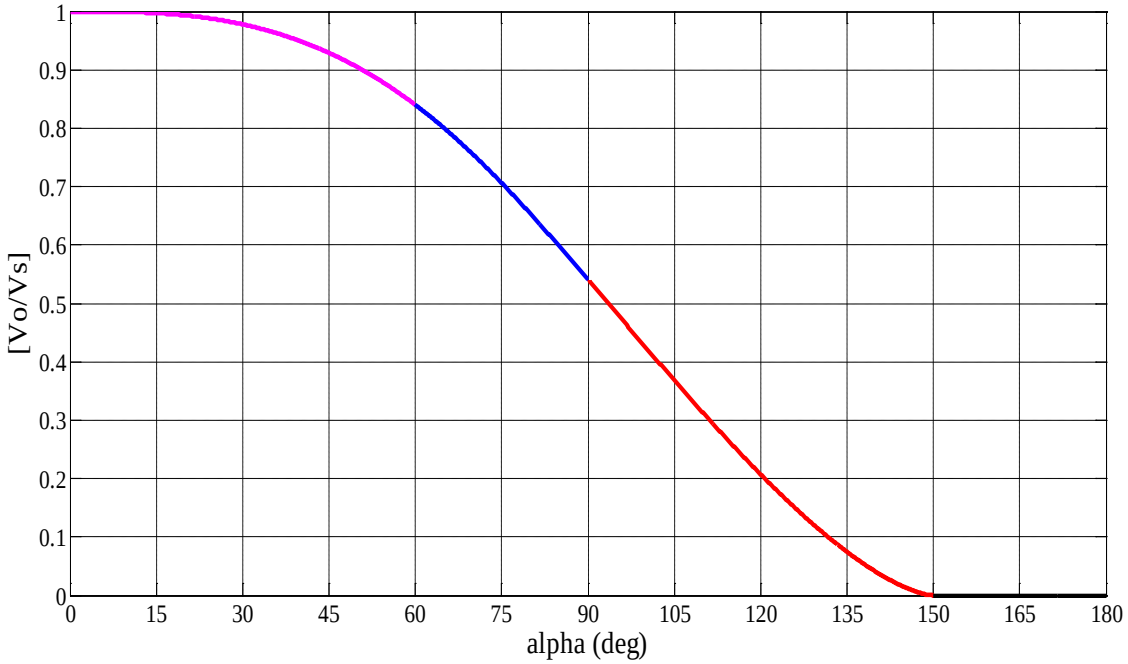
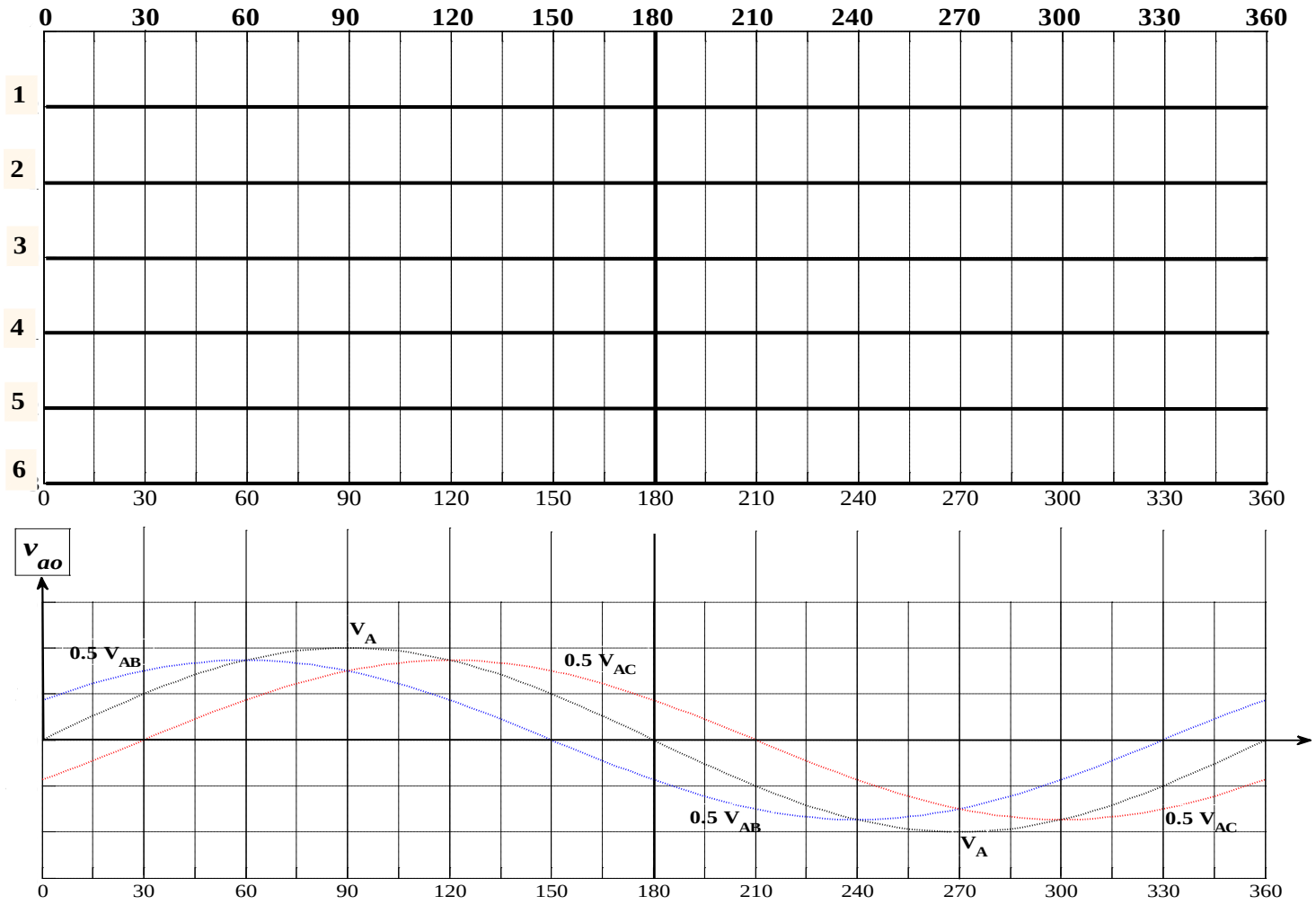


Fig. (2): [Vo/Vs] versus [firing angle] for a Y- connected resistive load in 3-ph Full Wave AC Voltage Controller


0 30 60 90 120 150 180 210 240 270 300 330 360
1
2
3
4
5
6
0 30 60 90 120 150 180 210 240 270 300 330 360
v_{ao}
V_A
0.5 V_{AB}
0.5 V_{AC}
0.5 V_{AB}
V_A
0.5 V_{AC}
0 30 60 90 120 150 180 210 240 270 300 330 360