

Name: _____

B.N. _____

25/9/2014

Choose the correct answer:

(1) Triac is:

(i) two devices

(ii) three devices

(iii) one device

(2) Triac is:

(i) unidirectional switch

(ii) bidirectional switch

(iii) manual switch

(3) Triac is equivalent to:

(i) two thyristors connected anti-parallel

(ii) two thyristors connected parallel

(iii) two diodes connected anti-parallel

(iv) two IGBT connected parallel

(4) Duty cycle of 1-phase on/off regulator is:

(i) t_{ON}/t_{OFF} (ii) t_{OFF}/t_{ON} (iii) $t_{ON}+t_{OFF}/t_{ON}$ (iv) $t_{ON}/(t_{ON}+t_{OFF})$

(5) If supply power factor of 1-phase on/off controller is 0.81, then duty cycle is: *

(i) 0.81

(ii) 1.1

(iii) 0.9

(iv) 0.19

Mid 2013-2014

- (1) 1- An 1-kW electric heater is fed from an ac supply of 220-V, 50-Hz via 1-phase on/off controller. The controller is turning off for 120 ms, and the output power is 0.6 kW. Determine:
- number of turning on cycles
 - duty cycle to obtain 1 kW output
 - Heater resistance.
- (2) A single-phase half-wave AC controller has a resistive load of 15Ω . The input voltage is 220 V, 50 Hz. The firing delay angle is 45° . Determine:
- rms output voltage,
 - average and rms currents of the thyristor and the diode,
 - average input current,
 - input power factor, and
 - maximum and minimum power factor.

1) What are the considerations must be taken, when you design a chopper circuit?

2) A boost regulator supplies 150 V to a 25Ω load from a 40 V dc source. If $\Delta V_o = 0.5 V$, $L = 200 \mu H$, and $T = 200 \mu s$. Determine;

- D
- I_{min} and I_{max}
- $I_{D(av)}$
- $I_{C(r.m.s)}$
- C

1. a) Draw the power circuit of 3-phase matrix converter.
b) Draw a simple power circuit of 1-phase, cycloconverter
c) State the merits of the matrix converter
d) Explain: "three-phase ac regulator does not contain mode (2/2) when feeding an inductive load"

2. A single-phase regulator feeds a resistive load of 10Ω via an ac supply of 220-V, 50-Hz. power consumed by the load is 2420 W. Find:
 - i) the value of the rms load voltage.
 - ii) the supply power factor.
 - iii) the triggering angle
 - iv) the conduction angle $\alpha = \beta$

3. A three-phase, 440-V, 60-Hz, ac regulator feeding a resistive load of 10Ω . The triggering angle is 75° .
 - i) draw the waveform of the output phase current.
 - ii) compute the average power consumed
 - iii) calculate the supply power factor



Answer all the following questions

1. (a) Discuss the principle operation and the applications used of dc choppers, you can declare their by used circuits diagram and waveforms. **(10 Marks)**
 (b) A step-down chopper is feeding an RL load, $V_s=220V$, $R=5\Omega$, $L=7.5mH$, $f=1KHz$, $D=0.5$
 Calculate: a) I_{min} , b) I_{max} , c) I_{dc} . d) r.m.s. V_{o1} , c) I_{o1} **(10 Marks)**
2. The Cúk regulator has the following parameter: $V_s=12V$, $D=0.25$,
 $L_2=150\mu H$, $C_2=220\mu F$, $C_1=200\mu F$, $L_1=180\mu H$, $I_a=1.25A$, and $f=25kHz$.
 Determine: a) V_o , b) Δv_{c1} , c) Δv_{c2} , d) L_{1min} , e) L_{2min} **(10 Marks)**
3. A single-phase AC voltage controller (ON-OFF control) operating on the 220, 50 Hz supply is used to control a 5Ω heating device. If the load is supplied repeatedly for 2 cycles and disconnected for 6 cycles . Determine:
 (a) the turn-on and turn-off time.
 (b) the power consumed.
 (c) the supply power factor.
 (d) the max and rms thyristor currents. **(15 Marks)**
 (e) the number of ON cycles required to improve the power factor to becomes 0.87 lag.
4. A single-phase half-wave AC voltage controller has a load resistance of 50Ω , AC supply voltage is 230V RMS at 50Hz. If the thyristor is triggered at $\alpha = 60^\circ$. Calculate:
 (a) the rms value of output voltage.
 (b) the output power.
 (c) the average value of load current.
 (d) the input power factor.
 (e) the average and rms values of thyristor current. **(15 Marks)**
5. A 380-V, 50-Hz, AC supply feeds a 3-phase heater of $10\Omega/ph$ via a 3-phase, full-wave ac regulator.
 (a) Determine the firing angles to obtain maximum load power (P_{max}) and $0.5 P_{max}$.
 (b) At the firing angle obtained for P_{max} , draw the waveforms of:
 (i) the load phase voltage.
 (ii) the thyristor voltage. **(16 Marks)**
6. (a) State the 27 switching-state combinations of the matrix converter.
 (b) The fundamental component of the output voltage of a matrix converter was:
 $(v_o = 141.4 \cos(502.7 t))$
 The matrix converter is fed from a 380-V, 50-Hz AC supply. Determine:
 (i) the modulation ratio.
 (ii) the minimum switching frequency. **(14 Marks)**

(P.T.O.)

(1/2)

The expressions of RMS load phase voltage of 3-phase ac regulator with resistive load are:

$$V_o = V_s \sqrt{\frac{1}{4\pi} \{4\pi - 6\alpha + 3 \sin 2\alpha\}} \quad \dots\dots\dots 0 \leq \alpha \leq \frac{\pi}{3}$$

$$V_o = V_s \sqrt{\frac{1}{2\pi} \left\{ \pi + \frac{3\sqrt{3}}{2} \sin\left(\frac{\pi}{6} + 2\alpha\right) \right\}} \quad \dots\dots\dots \frac{\pi}{3} \leq \alpha \leq \frac{\pi}{2}$$

$$V_o = V_s \sqrt{\frac{3}{2\pi} \left\{ \frac{5\pi}{6} - \alpha + \frac{1}{2} \sin\left(\frac{\pi}{3} + 2\alpha\right) \right\}} \quad \dots\dots\dots \frac{\pi}{2} \leq \alpha \leq 5\pi/6$$

Where V_s is the rms of the supply phase voltage

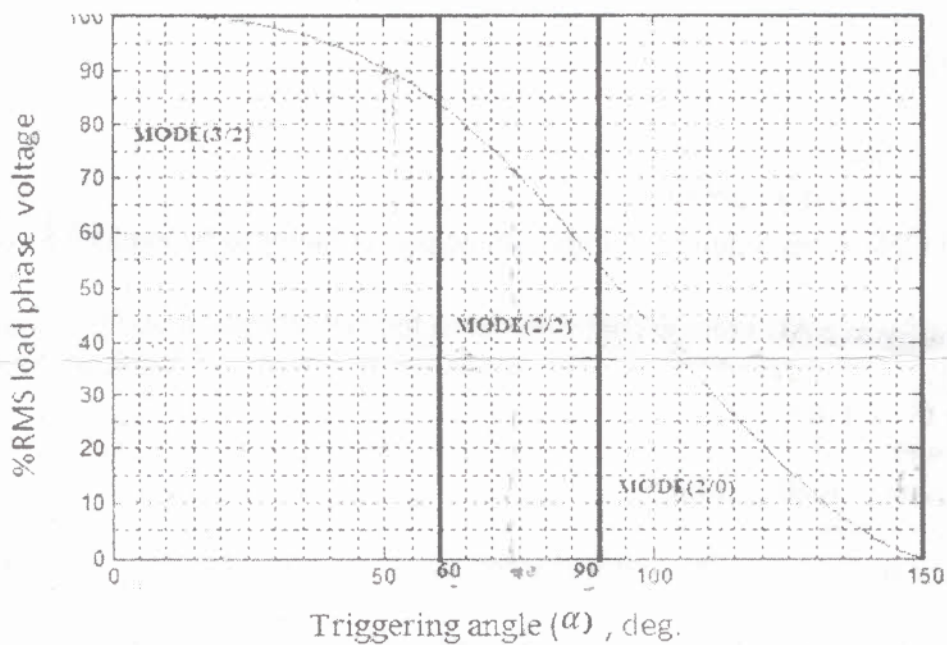


Fig.(1) %Load phase voltage- firing angle characteristics of 3-ph AC regulator

Good Luck



- Answer all the following question
 - Illustrate your answers with sketches when necessary.
 - No. of questions: 6
 - Total Mark: 90 Marks
1. The power delivered to an 25Ω electric heater is controlled by a triac which is connected to a 220V, 50 Hz AC supply. If the triac is controlled using the On-Off (integral) control technique such that the delivered On cycles are two and the Off cycles are three. Calculate:
 - (a) The rms load voltage and current.
 - (b) The load power and power factor (PF). (15 Marks)
 2. A two-step sequence control (synchronous static tap-changer) is used to control the load voltage of a pure resistive load of 10Ω through a single-phase AC voltage controller. If the primary voltage is 220V, 50Hz, the secondary voltages are: $V_{s1}=120V$ and $V_{s2}=100V$ and the triggering angle of T_1 (α_1) is 75° , determine:
 - (a) the rms load voltage.
 - (b) the triggering angle for the other thyristors.
 - (c) the rms value of the thyristor currents (T_1 and T_2). (15 Marks)
 3. A three-phase, full-wave AC voltage (bidirectional) controller is supplied from a 380V (line), 50Hz AC supply and is feeding a three-phase Y-connected resistive load with 10Ω in each phase. If the triggering angle is 90° and 3-wire connections is considered,
 - (a) draw the output phase voltage waveform.
 - (b) calculate the load power. (15 Marks)
 4. a) Discuss the principle of operation of a step-down chopper and the boundary condition for the inductor continuity current.
 b) In a step-down chopper circuit if: $V_s = 220V$, $L=7.5$ mH, $R=5\Omega$, $f=1$ kHz and $D=0.5$, determine: i) I_{max} , ii) I_{min} iii) ΔI and iv) the average value of the load current. (15 Marks)
 5. a) What are the considerations must be taken when you design a chopper circuit?
 b) A boost DC regulator supplies 150W to a 25Ω DC load from a 40V DC source. If $\Delta V_o=0.5V$, $L=200\mu H$ and $T=200\mu s$, determine: I_{min} , I_{max} , $I_{c,rms}$ and C. (15 Marks)
 6. a) Discuss the applications of DC choppers, and one of the modes of operation for the DC chopper drive.
 b) A buck-boost DC regulator has the following parameters: $V_s=12V$, $D=0.25$, $L=150\mu H$, $C=220\mu F$, $I_s=1.25A$, $R=12.5\Omega$, $f=25kHz$. Determine: V_o , ΔV_o , ΔI and $I_{sw,peak}$. (15 Marks)

BOARD OF EXAMINERS:

Prof. Dr. Hamed Galal and Assoc. Prof. Hassan Mansour

Answer the Following Questions:(25 degrees)

- 1) (a) Drive an expression of the RMS of the output phase voltage of a 1-phase, full-wave AC voltage controller feeding an inductive load. How can you modify this expression for resistive loads?
- (b) A 3-phase, full-wave AC voltage controller feeds Y-connected resistive load and is supplied from an AC source of 380V, 50 Hz. If the firing delay angle is 30° . Determine:
- the expression of the output phase voltage (v_{ao})
 - the values of the load phase voltage (v_{ao}), at $\omega t = 15^\circ, 45^\circ, 75^\circ$ and 135°
 - the maximum value of the voltage applied to thyristor (T_{st})
- (10 degrees)**
- 2) A single-phase AC regulator feeds an inductive load of $R=10\Omega$. The regulator is fed from 220-V, 50-Hz AC supply. The voltage across the switch terminals, at the instant of firing, is $(+0.8V_{max})$ and at the instant of turning off is $(-0.25V_{max})$. Find:
- the firing angle (α) and the extinction angle (β),
 - the RMS value of the load voltage,
 - the minimum value of the load inductance to make the load current continuous,
 - the supply power factor, if the load inductance is short circuited.
- (15 degrees)**