Ref. No.: Ex/PE/IEE/T/226/2018

B.E. Power Engineering 2nd Year 2nd Semester-2018

Power Electronics

Time: 3 hours **Full Marks: 100**

Attempt any five questions from the following

1. (a) Describe the reverse recovery characteristics of power diode. A power diode has reverse recovery time of 2.5ms and *di/dt* is 35 A/ms, find the peak reverse current. 3+2

   (b) How an SCR differ from TRIAC? 5

   (c) Explain the switching characteristics of SCR with suitable diagram. 7

   (d) An SCR in a circuit is subjected to a 50 A surge that lasts for 12 ms. Determine whether or not this surge will destroy the device. Given that circuit fusing rating is 90 A^2s. 3

2. (a) A 1-phase diode bridge rectifier with a free-wheeling diode (as shown in Fig. 2(a)) is supplied from a 120 V, 50 Hz supply with a source inductance (L_s) of 0.33 mH. Assuming the load is continuous (I_d) at 4A. Find the commutation angle of the circuit and also deduce the necessary theory. 5

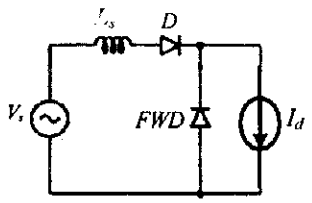

Fig. 2(a)

   (b) A half-wave rectifier circuit employing an SCR is adjusted to have a gate current (I_g) of 1mA. The forward breakdown voltage of SCR is 100 V for I_g = 1 mA. If a sinusoidal voltage of 200 V peak is applied, find : 2×3

   (i) firing angle (ii) conduction angle (iii) average current.

   Assume load resistance = 100Ω and the holding current to be zero.

(c) A dc battery (E_b) is charged through a resistor R (as shown in Fig. 2(c)). Derive an expression for the average value of charging current on the assumption that SCR is fired continuously. 3×3

(i) Find the value of average charging current for an AC source voltage of 230 V, 50 Hz and R=5 ohm, E_b= 150V.

(ii) Find the power supplied to the battery.

(iii) Calculate the supply power factor.

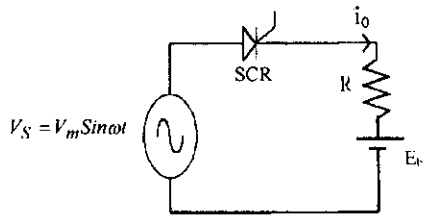

Fig. 2(c)

3. (a) What is the effect of freewheeling diode on a rectifier circuit? 3

(b) Explain the 3-phase 6-pulse uncontrolled rectifier circuit (as shown in Fig. 3(b)) with proper waveform. Calculate output voltage of the circuit at 30^0, 60^0 as well as 90^0 instant and also calculate the average value of line-phase load voltage. 4+4+2

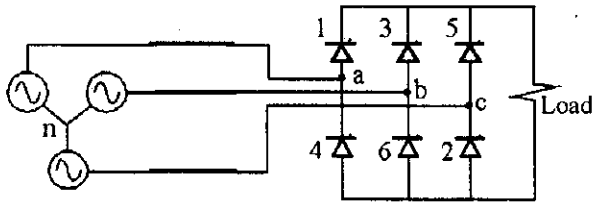

Fig. 3(b)

(c) Derive the expression of conduction angle for uncontrolled rectifier circuit with RL load. 7

4. (a) Show that the total load current and average load current for 1-phase controlled half wave rectifier circuit for RLE load are given by 5+4

$$i_0 = \frac{V_m}{Z}\left[Sin(\omega t - \phi) - Sin(\alpha - \phi)e^{-\frac{R}{L\omega}(\omega t - \alpha)}\right] - \frac{E}{R}\left[1 - e^{-\frac{R}{L\omega}(\omega t - \alpha)}\right] \text{ and}$$

$I_{avg} = \frac{1}{2\pi R}\left[2V_m Sin\left(\alpha + \frac{\gamma}{2}\right) Sin\frac{\gamma}{2} - E\gamma\right]$ respectively; where the symbols have their usual meaning.

(b) Explain the circuit diagram of 1-phase controlled bridge rectifier circuit for RL load in presence of source inductance (as shown in Fig. 4(b)) with proper waveform. 6

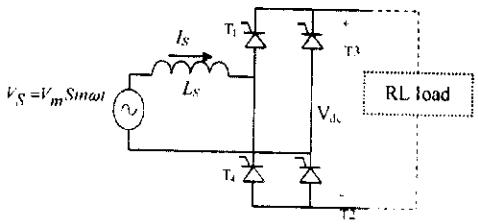

Fig. 4(b)

(c) Show that the critical inductance of a step down chopper circuit (as shown in Fig. 4(c)) is given by $L = \frac{V_0^2(V_S - V_0)}{2fV_S P_0}$; where V_0, V_S, P_0 and f are the load voltage, source voltage, load power and chopping frequency respectively. 5

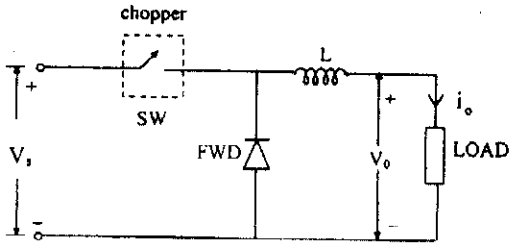

Fig. 4(c)

5. (a) Show that the peak-to-peak output ripple voltage of the capacitor in Buck regulator is given by $\Delta V_c = \frac{D(1-D)V_S}{8f^2LC}$; where the symbols have their usual meaning. 8

(b) An ideal type-A chopper (as shown in Fig. 5(b)) has supply voltage V_s=220 V, chopping frequency= 500 Hz, duty ratio (D) =0.3, R=1 Ω, L=3 mH and E=23 V.

(i) Deduce the necessary formula for maximum and minimum values of steady state output current and also find out the numerical values. 8+4

(ii) Check whether the load current is continuous or not.

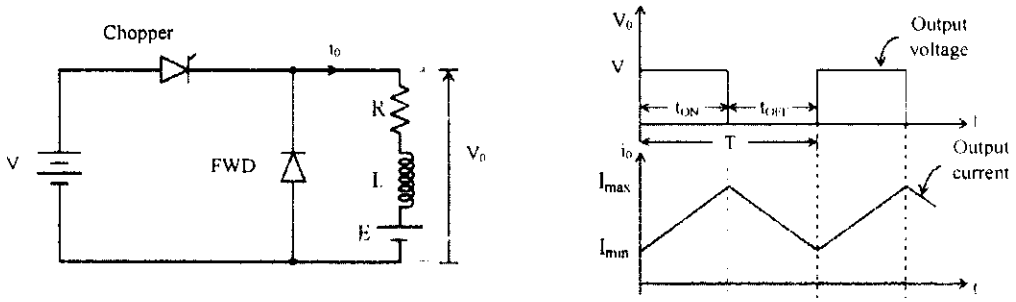

Fig. 5(b)

6. (a) What is current source inverter? Mention its merits and demerits compared to voltage source inverter. 2+3

   (b) Draw and explain the equivalent circuits for a 120^0 mode 3-phase balanced star-connected load voltage source inverter with proper waveform. What are the advantages of 120^0 mode conduction over 180^0 mode conduction of voltage source inverter? 8+2

   (c) Explain the block diagram of a control scheme for cyclo-converter. 5

7. Write short notes on any ***four*** the following: 4 × 5

   (a) Turn-off mechanisms of SCR

   (b) Snubber circuit

   (c) Pulse width modulation

   (d) Blocked group operation

   (e) Step-up chopper circuit

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