

End Semester Examination, 2015
B. Tech. VI Sem. (Electrical Engg.)
Subject: Power Electronics, EE-1601

Time: 3.00 Hr

Max. Marks: 60

NOTE: Attempt Five questions in all. Question no. 6 is compulsory.

Q. 1(a) Discuss the dynamic characteristic of GTO thyristor with the help of its two-transistor analogy and compare its merits and demerits over SCR. [6]

(b). For the circuit shown in Fig. 1, the output current i_o is considered constant at I_o because of the large inductor L . Sketch the waveforms of v_s , i_s , v_o , i_D , i_{FD} and i_s . Also calculate:

- (i) Average value of output voltage and output current.
- (ii) Average and rms value of the freewheeling diode current.
- (iii) Supply power factor. [6]

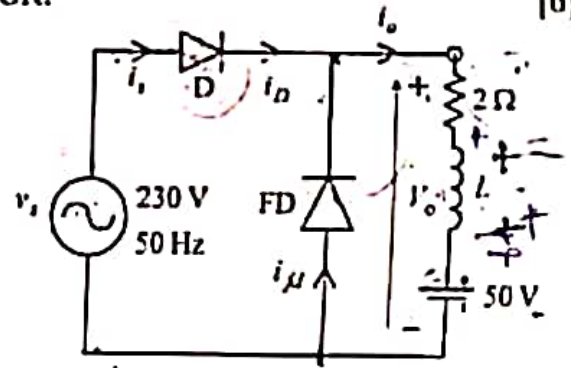


Fig.1

Q. 2(a) Describe the UJT relaxation oscillator used for the firing circuit of SCR. Derive the expression for the triggering frequency and its maximum and minimum possible variations. [6]

(b) A relaxation oscillator using an UJT as shown in Fig. 2(b) is to be designed for triggering an SCR. The UJT has the data: $\eta = 0.72$, $I_p = 0.6$ mA, $V_p = 18.0$ V, $V_v = 1.0$ V, $I_v = 2.5$ mA and $R_{BB} = 5$ k Ω . Normal leakage current with emitter open is 4.2 mA, firing frequency is 2 kHz and $C = 0.04$ μ F. Compute the values of R , R_1 and R_2 . Also obtain the maximum and minimum values of R and corresponding frequencies. [6]

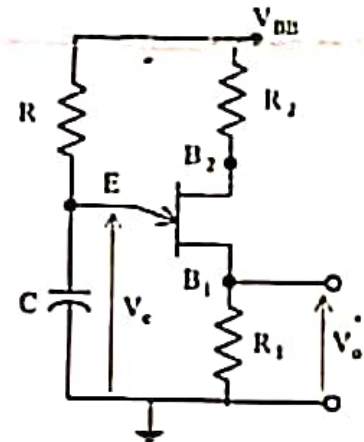


Fig.2(b)

Q. 3(a) A single phase full converter delivers power to a resistive load R . For ac source voltage (rms) of V_s , (i) derive the expression for the average output voltage; (ii) sketch the time variations of the source voltage, output voltage, output current and the voltage across one pair of SCRs. Also find the circuit turn-off time. (iii) Derive the expression for the rms value of output current. [6]

(b). A single-phase full converter bridge is connected to an RLE load. The source voltage is 230 V, 50 Hz. The average load current of 10 A is continuous over the working range. For $R = 0.4$ Ω and $L = 2.0$ mH, compute firing angle delay for (i) $E = 120$ V, (ii) $E = -120$ V, (iii) Indicate which source is delivering power to load in parts (i) and (ii), (iv) Sketch the time variations of output voltage and load current for parts (i) and (ii), (v) In case the output current is assumed constant, find the input power factor for both the parts in (i) and (ii). [6]

Q.4(a) For the chopper circuit shown in Fig. (4), show that

$$\text{Maximum load current } I_{\max} = \frac{V_s}{R} + \frac{V_s}{2fL} \left[1 - \frac{V_o}{V_s} \right]$$

$$\text{Minimum load current } I_{\min} = \frac{V_s}{R} - \frac{V_s}{2fL} \left[1 - \frac{V_o}{V_s} \right]$$

where f = Operating frequency of the chopper switch,

Assume the value of the L to be large enough to ensure continuous current through it, with linear growth and decay. [6]

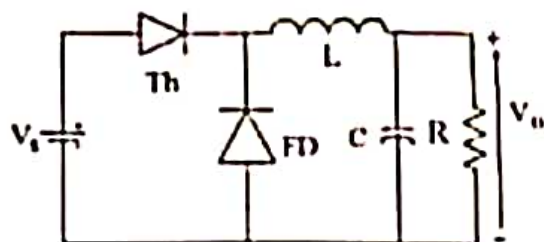


Fig. 4

b) For the following values of the circuit parameters for the circuit shown in Fig. (4),

$f = 2 \text{ kHz}$, $V_s = 100 \text{ V}$, $R = 10 \Omega$ and load time constant (τ) = 6 mSec

Find: (i) Average load current and magnitude of the load current ripple for the average load voltage of 50 V.

(ii) Maximum and minimum value of the load current. [6]

Q.5(a) Draw the power circuit of 3-phase (VSI) and explain its operation for 120° mode of conduction. Sketch the waveforms of output phase and line voltages, showing the conduction of devices during the different interval for one cycle of input voltage. Also write the mathematical expressions of output line to line and phase voltages of three phases. [5]

(b). For a single-phase full bridge inverter, source voltage $V_s = 230 \text{ V dc}$, switching period $T = 1 \text{ ms}$. Load consist of RLC in series with $R = 1 \Omega$, $\omega L = 6 \Omega$ and $1/\omega C = 7 \Omega$.

(i) Sketch the waveform of load voltage v_o , fundamental component of load current i_{o1} , source current i_s , and voltage across the thyristor 1. Indicate the device under conduction during different interval of one cycle.

(ii) Calculate the rms value of the fundamental of load voltage, rms of fundamental of load current and express the fundamental of load current as uncton of time.

(iii) Find the power delivered to load due to fundamental component.

(iv) Check whether forced commutation is required or not. Take thyristor turn-off time as $100 \mu \text{ sec}$. [7]

Q.6 Put (C) for correct statement and (X) for the wrong one, and give justification in not more than 3-5 lines in support of your answer:

(i) Higher the pulse-number of a controlled rectifier, higher the ripple in the load current.

(ii) Controlled rectifier has high power factor at low output voltages.

(iii) DC-DC converter of a switch mode power supply should be operated at high switching frequency. (T)

(iv) A battery driven vehicle employing dc motor should be supplied from a two quadrant chopper capable of operating in quadrants I and II (with V_o on Y axis and I_o on X axis). (F)

(v) MOSFETS must be protected against the second breakdown. ~~Temp co-eff~~

(vi) Switching devices employed in a voltage source inverter must have reverse voltage blocking capability.

(vii) An IGBT can be turned off by connecting a small resistance between gate and emitter.

(viii) A dc motor feeding an overhauling load should never be supplied from a half controlled converters (rectifiers). (T)