End Semester Examination–2018
B. Tech VI Sem. (Electrical)
Subject: Power Electronics (EE-1601)

Time: 3.0 Hrs. **MM: 60**

Dr. RKT

NOTE: Attempt *ANY FIVE* Questions.

Q1(a). Discuss what would happen to the SCR, if a forward voltage is applied to it soon after the reverse recovery current drops to zero value. [3]

(b). In an SCR anode current rises linearly from zero to $I_f = 100$ A, whereas the anode voltage across SCR falls linearly from $V_f = 600$ V to zero during its turn-on time of $t_f = 5$ μS. Derive an expression for the average power loss in the SCR for a triggering frequency f. In case $f = 100$ Hz, find the average power loss in SCR. [3]

(c) With the neat sketch of vertical section diagram explain the working of a Power MOSFET, also compare the merits and demerits of Power MOSFET with that of Power BJT. [6]

Q2(a). A single phase half controlled ac to dc bridge converter is supplied from an ac source given by $V_s = 200\sqrt{2}\sin 314t$ volts and feeds a 10 ohm resistor in series with a 100 V back emf load as shown in Fig.P2 (a). If the firing angle of the thyristor is 60°, find the average current through the resistor. What will be the new average current through the resistor, if a very large inductor is connected in series with the load? [4]

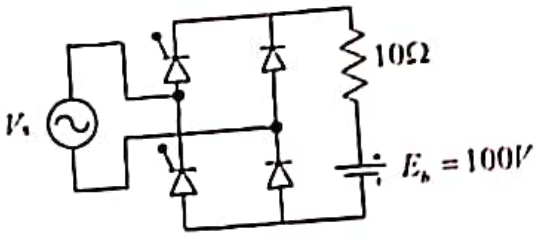

Fig. P2(a)

(b). A rectifier circuit with high source inductance as shown in Fig. P2(b). Assuming the load current to be continuous, find the expression for the overlap angle for transfer of the current from conducting thyristor to the freewheeling diode. [4]

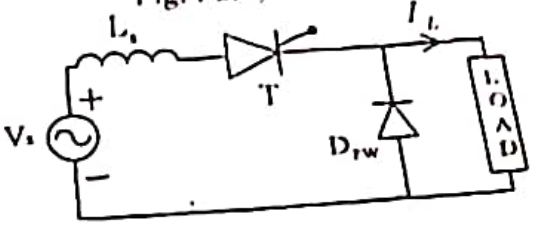

Fig. P2(b)

(c). A single-phase transformer with secondary voltage of 230 V, 50 Hz, delivers power to a load resistance $R = 10\ \Omega$ through a half wave controlled rectifier circuit. For a firing-angle delay of 60°, determine (i) rectification efficiency, (ii) form factor, (iii) voltage ripple factor, (iv) transformer utilization factor and (v) PIV of thyristor. [4]

Q3(a). What is the purpose of snubber circuit used along with the power semiconductor devices? A thyristor operating from a peak supply voltage of 400 V has following specifications:

Repetitive peak current, $I_p = 200$ A, $(di/dt)_{max} = 50$ A/μs, $(dv/dt)_{max} = 200$ V/ μs.

Choosing a factor of safety of 2 for I_p, $(di/dt)_{max}$, $(dv/dt)_{max}$, design a suitable snubber circuit The minimum value of load resistance 10 Ω. Take damping factor $\xi = 0.65$. Derive the variou expressions used. [

b). A dc battery of constant emf E is being charged through a half-wave diode circuit having series a current limiting resistor R. For source voltage of 235 V, 50 Hz and for $R = 8\ \Omega$, $E = 1$ V,

(i) find the value of average charging current,
(ii) find the power supplied to battery and that dissipated in the resistor,

(iii) calculate the supply power factor,
(iv) find the charging time in case the battery capacity is 1000 Wh and
(v) find rectifier efficiency and PIV of diode [6]

Q4(a). Draw the output voltage waveform of a three-phase full controlled converter bridge supplying a resistive load. Derive the expression for the rms output voltage.
(a). If the load resistance is 10 Ω and load takes 5 kW of power at 30° firing angle delay. Find the magnitude of per phase input supply voltage.
(b). Repeat part (a) if a large reactor in series with the load renders the load current ripple free.[6]

Q5(b). A three-phase full converter bridge is connected to a supply voltage of 230 V per phase and a frequency of 50 Hz. The source inductance is 4 mH: The load current on the dc side is constant at 20 A. If the load consists of a dc source of internal *emf* of 400 V with internal resistance of 1 Ω, then calculate: [6]
(i) Firing angle delay. (ii) Overlap angle in degrees.

Q5(a). With the neat sketch and suitable waveforms describe the various control strategies of chopper control in (i) time-ratio control mode and (ii) in current limits control. Also discuss their merits and demerits. [4]

(b). Explain the operation of Type D chopper with circuit diagram and output voltage waveform, also derive the expression for its output voltage. [3]

(c) In an ideal step down (type-A) chopper the supply voltage is 250 V, chopping frequency = 300 Hz, duty cycle = 0.5, load resistance is 5 Ω and load inductance is 5 mH. If the load has a back emf of 100 V, find the average output current of the chopper. Also find the maximum and minimum values of steady-state output current and the average value of source current. [5]

Q6(a). What are the methods to control the output voltage of a single phase VSI, explain the PWM method of voltage control in detail with necessary diagrams and waveforms. [6]

(b) A single phase full bridge inverter has *RLC* load of $R = 4\ \Omega$, $L = 35$ mH and $C = 155\ \mu F$. The dc input voltage is 230 V and the output frequency is 50 Hz. Find an expression for load current up to 5^{th} harmonic. Also calculate:
(i) rms value of fundamental load current,
(ii) the power absorbed by the load and fundamental power,
(iii) rms and peak currents of each thyristor,
(iv) Conduction time of thyristor and diodes if only fundamental components are considered. [6]

Q7(a). A single-phase controlled rectifier bridge consists of one SCR (T_1) and three diodes (D_1, D_2, and D_3). Sketch the output voltage waveform for a firing angle α for the SCR and hence obtain an expression for the average output voltage under the assumption of continuous current. Show the conduction of various components as well. For an ac source voltage of 230 V, 50 Hz and firing angle of 45°, find the average output current and power delivered to battery in case load consists of $R = 5\ \Omega$, $L = 8$ mH and $E = 100$ V. [8]

). A single-phase bridge inverter delivers power to a series connected RLC load, with $R = 2\ \Omega$, and $\omega L = 10\ \Omega$. The periodic time $T = 0.1$ msec. What value of C should the load have in order to obtain the load commutation for the SCRs. The thyristor turn-off time is 10 μS. Take the circuit turn-off time as 1.5 t_q. Assume that the load current contains only fundamental component. [4]