

(POWER ELECTRONICS-DIE504)-

End Term Examination-2024

Full Marks- 100: Time- 3 Hours

Answer Question No. 1 and any four from the remaining questions.

1. a) Fill up the blanks- 5 X 1 = 5
- i) The minority carriers in a p-n-p transistor are _____.
- ii) In a p-n junction, the depletion region will extend more towards the region having _____ doping concentration.
- iii) GTO is a/an _____ switch.
- iv) In a power transistor, _____ current is the controlled parameter.
- v) The value of anode current required in SCR to keep in the ON-state is called as _____.
- b) Multiple choice questions- 5 X 1 = 5
- i) Which of the following does not belong to the thyristor family?
- [A] SCR [B] SCS [C] IGBT [D] GTO
- ii) In SCR, the forward breakover voltage is maximum when the Gate current is equal to-
- [A] I_{gmin} [B] I_{gmax} [C] 0 [D] independent of Gate current
- iii) Choose the false statement.
- [A] SCR is a bidirectional device [B] SCR is a semi-controllable device
- [C] SCR is used in high power applications
- [D] SCR can be triggered with a light source
- iv) Which of the following thyristors has an inbuilt avalanche diode between gate and cathode terminals?
- [A] SCR [B] PUT [C] SUS [D] SCS
- v) Which of the following switches can be used in a chopper circuit?
- [A] BJT [B] MOSFET [C] GTO [D] All of these
- c) Answer the following questions in brief- 5 X 2 = 10
- i) What is the function of the drift region found in a power diode?
- ii) State two differences between BJT and MOSFET.
- iii) Define the term "holding current" for an SCR.
- iv) State the intrinsic stand-off ratio of a Unijunction transistor.
- v) What is the minimum anode voltage required to turn ON a PUT?
2. a) What is the cause of reverse current in a diode even after the anode current becomes zero? Draw the reverse recovery characteristics diagram of a diode. 2 + 3 = 5
- b) With the help of a diagram show how the gate current affects the the I-V characteristics of an SCR for at least four different values of gate current. (e.g. $I_{g4} > I_{g3} > I_{g2} > I_{g1}$) 5
- c) Describe the various methods of turning ON an SCR. 5
- d) What do you mean by time-constant of an R-C charging circuit? For an R-C charging circuit if- 5
- $V_s = 10 \text{ V}$, $R = 1 \text{ K}\Omega$, and $C = 2 \text{ mF}$, calculate-
- i) Time-constant ii) Capacitor voltage after 2 seconds (approximately)

3. a) What is a thyristor firing circuit? Draw the Resistance firing circuit and find the values for R_1 and R for an SCR with the following parameters- $2 + 4 + 4 = 10$
- I_{gm} (Maximum gate current allowed) = 50 mA,
 V_{gm} (Maximum gate voltage allowed) = 10 V,
 V_m (Peak Anode Voltage) = 200 V,
- Also, find out the peak gate voltage (V_{gp}) and the least firing angle (α) achievable with the firing circuit designed as above to turn-On the SCR (i.e. when $R_2 = 0$).
- b) Draw the physical structure and the equivalent circuit of a UJT and explain its working as a switch. 5
- c) Derive the expression for the anode current of SCR with the help of the two-transistor model. 5
4. a) What is the main function of a DC chopper? Deduce the output voltage expression for an elementary chopper circuit. 6
- b) With the help of voltage and current waveforms, explain the working of a single-phase half-wave rectifier circuit with 'R' load. 6
- c) What is an inverter? Draw the circuit diagram of a single phase full-bridge inverter and explain its working. 8
5. a) Name the different thyristor commutation techniques. Briefly explain any one of these techniques. $2 + 5 = 7$
- b) For a half-wave rectifier circuit with R-L Load, draw the output current and voltage waveforms with respect to the input voltage and firing angle. 5
- c) For a full-bridge inverter, draw the output current waveforms for the following types of loads- $4 \times 2 = 8$
- i) R ii) R-L iii) R-L-C over-damped and under-damped
6. a) Draw the physical structure and explain how the conduction of current takes place in any four of the following power devices- $5 \times 4 = 20$
- i) GTO ii) Triac iii) IGBT
iv) PUT v) PMOSFET vi) SCR