

B. TECH.**SIXTH SEMESTER EXAMINATION, 2003-2004
FUNDAMENTALS OF POWER ELECTRONICS***Time : 3 Hours**Total Marks : 100*

Note : Attempt all FIVE questions. All questions carry equal marks.

1. Attempt any FOUR parts of the following :— (5×4=20)

(a) Draw circuit symbol and static $v-i$ characteristic of the following power semiconductor devices :—

- (i) Power diode,
- (ii) Thyristor, and
- (iii) MOSFET.

(b) With the help of symbol, static emitter characteristic and equivalent circuit, explain working of an Unijunction Transistor (UJT) as relaxation oscillator.

(c) Draw and explain thyristor voltage and current characteristics during turn-off and hence define turn-off time of thyristor.

(d) The latching current of a thyristor in series with a pure inductive load of 0.1 H and a d.c. source voltage of 100 V is 4 mA. Determine the minimum width of the firing pulse required to properly turn-on the thyristor.

(e) Distinguish and compare a Bipolar junction transistor and a MOSFET.

(f) Why are the multiple connections of power semiconductor devices required ?

Calculate the number of thyristors, each with a rating of 500 V and 75 A, required in each branch of a series-parallel combination for a circuit with total voltage and current rating of 7.5 kV and 1 kA respectively. Assume a derating factor of 14%.

2. Attempt any *FOUR* parts of the following :— (5×4=20)

(a) Distinguish and compare a Cycloconverter and an Inverter. Also mention areas of application for each.

(b) Discuss basic concept of half-wave diode rectifier with the following load combination :—

(i) Resistive load, and

(ii) Resistive and inductive load.

Draw the voltage and current waveforms in each case.

(c) A 220 V, 50 Hz single-phase a.c. voltage source supplies a resistive load of 20 ohms through a half-wave controlled rectifier circuit. If the thyristor delay angle is fixed at $\pi/2$, determine :

(i) the ratio of rectification,

(ii) the voltage ripple factor, and

(iii) the peak inverse voltage of thyristor.

(d) Define, compare and distinguish between an Integral cycle power controller and a phase controlled a.c. voltage controller.

(e) State and explain normal specification of power supplies. Name three types of a.c. and d.c. power supplies in each case. Also briefly describe any one type of power supply.

A three-phase full-wave controlled bridge rectifier contains six ideal thyristors and is fed from an ideal 3-phase source of 230 V, 50 Hz. The load resistor of 20Ω is connected in series with a large smoothing inductor. Calculate the average load voltage and the power dissipation at firing delay angle of $\pi/6$.

3. Attempt any *TWO* parts of the following :— (10×2=20)

- (a) Explain principle of inverter operation with square output voltage waveform. Also obtain expression for rms value of output voltage.
- (b) Give the design aspects of parallel inverter employing feedback diode.
- (c) Discuss basic properties of three-phase sinusoidal PWM inverters.

4. Attempt any *TWO* parts of following :— (10×2=20)

- (a) Explain functions of Choppers.

An ideal chopper operating in first quadrant is supplied with power from an ideal battery source of terminal voltage of 220 V. The load voltage waveform consists of rectangular pulses of 1 msec duration in overall chopper time period of 3 msec. The load current is constant and ripple free. Calculate : average and rms values of load voltage and voltage ripple factor.

- (b) Explain working of step up choppers. Obtain expression for average value of load voltage. Also mention their applications.
- (c) Distinguish between Voltage and Current commutated choppers. Briefly explain working of a current commutated chopper with the help of its circuit.

- (a) Explain speed control of ceiling fans, using a triac and a diac.
- (b) A d.c. separately excited motor is powered by an ideal single quadrant d.c. choppers from a 600 V d.c. mains. The armature resistance is 0.05Ω . The back emf constant of motor is 1.527 V/rad/sec . The average armature current is 250 A, continuous and ripple free. The field current is 2.5 A. If the duty cycle of chopper is 60%, determine :
- (i) the input power from the source,
 - (ii) the motor speed, and
 - (iii) the developed torque.
- (c) A three-phase, 4-pole, 50 Hz squirrel-cage induction motor is developing torque of 1500 synchronous watts at 1440 rpm. If the motor frequency is now increased to 75 Hz and motor is operating in constant power mode, determine the new value of torque developed by the motor at the constant slip.