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06EE45

Fourth Semester B.E. Degree Examination, May/June 2010
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: *Answer any FIVE full questions, selecting at least TWO questions from each part.*

PART – A

1 a. What is a power electronic converter system? Draw the block diagram and mention any four applications of such a system. **(06 Marks)**

b. What is a switch? What is an ideal switch? What is a power semiconductor switch? What are the limitations of a practical semiconductor switch? **(06 Marks)**

c. What are the different power electronic converter systems? Specify the form of input and output, and mention two applications in each case. **(08 Marks)**

2 a. What are the different semiconductor devices that are used as switches in power converter systems? Classify these devices based on their switching control characteristics. **(06 Marks)**

b. What is an IGBT? Draw its switching characteristics. What are its advantages over BJT and MOSFET? **(06 Marks)**

c. A power BJT is used as switch in the CE mode to connect a 10 Ω load resistance to a dc supply of 200 V. If $V_{CE(sat)} = 2.5$ V; $V_{BE(sat)} = 1.75$ V and β of the transistor is varied from 10 to 60; calculate :

i) The value of base resistance R_B that results in the saturation with an overdrive factor of 4, when the base is connected to a supply of 10 V;

ii) The forced β ; and

iii) The power loss in the switch. **(08 Marks)**

3 a. Why thyristors are called as half controlled switches? What are the modes of operation; on-state and off state conditions of a thyristor? **(06 Marks)**

b. What are the voltage and current specifications of a thyristor? Define latching current and holding current of a thyristor. **(06 Marks)**

c. Define $\frac{dv}{dt}$ and $\frac{di}{dt}$ capabilities of a thyristor. How are thyristors protected against high $\frac{dv}{dt}$ and $\frac{di}{dt}$ values? The values of protection elements of a protection circuit for a thyristor, used as a switch connecting a load to a supply are, $R_s = 15\ \Omega$, $C_s = 0.1\mu F$ and $L_s = 150\ \mu H$. If the supply voltage is 300 V AC and load resistance is 10 Ω, calculate the maximum permissible $\frac{dv}{dt}$ and $\frac{di}{dt}$ values. **(08 Marks)**

4 a. Define commutation of a thyristor. What are the conditions for the successful commutation? Classify the different methods of commutation. **(06 Marks)**

b. With necessary circuit diagram and wave diagrams, explain the impulse commutation technique. **(06 Marks)**

c. A load of 40Ω is connected to a dc supply of 100V through a thyristor switch. The total inductance in the line is 0.1 H. Find the minimum width of the gate pulse required to properly turn-on the switch, if the latching current is 4mA. If the holding is 3mA with $I_G = 0$, what is the supply voltage below which the switch will turn-off? Take conduction drop of the thyristor 8 as 0.8 V. **(08 Marks)**

PART – B

5 a. Differentiate between on-off control and phase control. Define the duty cycle and delay angle in an AC voltage controller. **(06 Marks)**

b. Draw the relevant circuit diagram and wave diagrams of a 1-phase full wave AC controller feeding an R-L load. What are conduction angle and extinction angle? **(06 Marks)**

c. A single phase full wave AC voltage controller, using two thyristors in anti-parallel, supply a pure resistive load of 10 Ω. The input voltage is 200 V, 50 Hz. If the controller is operated at a delay angle of 90°, determine:
i) The rms output voltage
ii) The input power factor; and
iii) The average and rms thyristor currents. **(08 Marks)**

6 a. Explain with circuit diagrams the differences between semi-controlled and full controlled 1-phase rectifier converter systems. **(06 Marks)**

b. Draw the relevant circuit diagram and wave diagrams of a 3-phase full controlled rectifier system, supplying a pure resistive load. Explain the gating signal sequence to be used in such systems. **(06 Marks)**

c. A I-phase half wave controlled rectifier supplies a purely resistive load of 1Ω from a 230 V, 50 Hz supply. If the average output voltage is 50% of the maximum possible value of the DC output voltage, determine:
i) Delay angle of thyristors
ii) RMS and average value of output current and
iii) The input power factor. **(08 Marks)**

7 a. What is a chopper? How are choppers classified? Give the quadrants of operation and one application of each type. **(06 Marks)**

b. Explain the basic principle operation of a step-down chopper, with necessary circuit diagram and waveforms. **(06 Marks)**

c. A 15 HP, 400 V, separately excited DC motor is fed from a chopper. The input to the chopper is 440 V and the copper operates at a duty cycle of 65%. The motor parameters are: R_a = 0.20Ω, Back emf constant K_v = 1.47 V/A-rad/sec; Motor current I_a = 40A; Field current I_f = 1.2A.
Determine:
i) The power output of the chopper (which is input power to the 8 motor)
ii) The speed of the motor. **(08 Marks**

8 a. What are the parameters that indicate the quality of an inverter? Define all of them. **(06 Marks)**

b. Explain the operation of a 1-phase half bridge inverter supplying a resistive load. **(06 Marks)**

c. Explain the operation of a 1-phase full bridge inverter supplying a resistive load. Derive expressions for the output RMS voltage. **(08 Marks)**

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