CBCS SCHEME

15EC73

Seventh Semester B.E. Degree Examination, Jan./Feb. 2023
Power Electronics

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. List the classification of power converters. Explain in brief with relevant circuit diagram and waveforms. **(08 Marks)**

b. Compare power BJTs with power MOSFETs. **(08 Marks)**

OR

2 a. With the help of a neat block diagram, explain the functional elements of power electronics system. **(06 Marks)**

b. Sketch and explain switching behavior of power MOSFET. **(06 Marks)**

c. A bipolar transistor is operated as a chopper switch at a frequency of f_s = 10kHz. The DC voltage of chopper is V_s = 220V and the load current is I_L = 100A. $V_{CE(sat)}$ = 0V. The switching times are t_d = 0; t_r = 3μs and t_f = 1.2μs. Determine the values of i) L_s ii) C_s iii) R_s. Where L_s is series snubber element and C_s and R_s shunt snubber to limit di/dt and dv/dt respectively. **(04 Marks)**

Module-2

3 a. With a neat sketch describe the two transistor model of thyristor and obtain expression for anode current. **(08 Marks)**

b. Design UJT triggering circuit for SCR. Given $-V_{BB}$ = 20V, η = 0.6, I_P = 10μA, V_V = 2V, I_V = 10mA. The frequency of oscillation is 100Hz. The triggering pulse width should be 50μsec. **(08 Marks)**

OR

4 a. With a neat sketch, explain the turn-on and turn-off characteristics of SCR. **(06 Marks)**

b. Calculate the conduction time of SCR and peak SCR current that flows in the circuit employing series resonant commutation (self commutation or class A commutation). If the supply voltage is 300V, C = 1μf, L = 5mH, R_L = 100Ω. Assume the circuit initially relaxed. **(06 Marks)**

c. Differentiate between natural and forced commutation. **(04 Marks)**

Module-3

5 a. With the help of a neat circuit diagram describe the operation of a single phase fully controlled rectifier with RL load. Sketch the associated waveforms. Derive expression for average output voltage. **(08 Marks)**

b. An AC voltage controller has a resistive load of R = 10Ω and rms input voltage V_s = 120V, 50hz. The thyristor switch is on for n = 25 cycles and is off for m = 75 cycles. Determine: i) The RMS output voltage ii) The output power factor iii) The average and rms current of thyristors. Derive an expression of the rms output voltage and average and rms thyristor current. **(08 Marks)**

OR

6 a. A single phase semiconverter is operated from 120V, 50hz supply. The load resistance is 10Ω. If the average output voltage is 25% of the maximum possible average output voltage, determine: i) Firing angle ii) rms and average output current iii) rms and average thyristor current. **(08 Marks)**

b. With the help of suitable circuit diagram and relevant waveforms, explain the operation of bidirectional AC voltage controller using phase control. Also derive an expression for rms output voltage. **(08 Marks)**

Module-4

7 a. With a neat circuit diagram, explain the operation of buck-boost regulator. **(08 Marks)**

b. For the stepdown chopper having resistive load derive the expression for the following:

i) Average output voltage
ii) Rms output voltage
iii) Chopper efficiency
iv) Effective input resistance of chopper. **(08 Marks)**

OR

8 a. Input to the step up chopper is 200V. The output required is 600V. If the conducting time of thyristor is 200μsec compute

i) Chopper frequency
ii) If the pulse width is halved for constant frequency operations find new output voltage. **(06 Marks)**

b. With a neat circuit diagram and relevant waveforms explain class D chopper operation. **(06 Marks)**

c. A buck regulator has an input voltage of V_s = 12V. The required average output voltage is V_a = 5V at R = 500Ω and the peak to peak output ripple voltage is limited to 0.8A, determine: i) The duty cycle 'K' ii) The filter inductance 'L' and the filter capacitance 'C'. **(04 Marks)**

Module-5

9 a. With a neat circuit diagram and relevant waveforms explain the operation of a full bridge inverter with 'R' load. Derive an expression for rms output voltage. **(08 Marks)**

b. With a neat circuit diagram and relevant waveforms explain single-phase thyristor AC switch. What are the differences between AC and DC switches? **(08 Marks)**

OR

10 a. With a neat circuit diagram, explain the operation of a CSI (Current Source Inverter). **(06 Marks)**

b. A single phase half bridge inverter has a resistive load of 2Ω. The dc supply is 24V calculate: i) RMS output voltage at fundamental frequency ii) Output power iii) Average and peak load current. **(04 Marks)**

c. Draw the schematic of a photovoltaic relay and briefly explain its operation. Mention its advantages and over electromechanical relays. **(06 Marks)**

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