C

03000EE305092001

Pages: 4

JYOTHI ENGG. COLLEGE LIBRARY THRISSUR EDUCATIONAL TRUST CHERUTHURUTHY

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (S, FE) / S3 (PT) (S, FE) Examination December 2023 (2015 Scheme)

Course Code: EE305

Course Name: POWER ELECTRONICS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries5 marks. Marks

1	Draw a neat, labeled diagram showing the V-I characteristics of an SCR. Clearly indicate all relevant data-points.	(5)
2	List down the advantages of UJT triggering over R-triggering and RC-triggering circuits.	(5)
3	List down the main advantages of three-phase fully-controlled rectifiers over single-phase fully-controlled rectifiers.	(5)
4	Compare and contrast 120^0 mode of operation and 180^0 mode of operation, with reference to three-phase inverters.	(5)
5	List the advantages of using Sinusidal PWM over single-PWM and multiple-PWM.	(5)
6	A single-phase AC voltage controller is operated at a firing angle of 60^0, and feeds a purely resistive load of 100 Ω. The input supply to the controller is rated at 230 V, 50 Hz. Find the system power factor.	(5)
7	A Buck-converter operates at a duty cycle of 40% from a DC source of 50V. The inductance and capacitance of the circuit is 600 μH and 100 μF respectively. The converter is operated at a switching frequency of 20 kHz and it feeds a resistive load of 20 Ω. Calculate the output voltage, peak-to-peak inductor current ripple and peak-to-peak capacitor voltage ripple assuming CCM operation and ideal elements.	(5)
8	Draw a neat labelled circuit diagram of a 4-quadrant chopper and describe the operation of the chopper in each quadrant.	(5)

PART B

Answer any two full questions, each carries10 marks.

9	a)	Twelve SCRs are connected in a string to withstand a supply voltage of 30kV.	(5)

Maximum leakage current and recovery charge difference of thyristors are 18 mA and 250 μC respectively. Resistance and Capacitance used are of values 72 kΩ and 0.8 μF respectively. Find Steady State Derating-Factor and Transient Derating Factor of the string

b) Explain the significance of isolation in power electronic gate pulses. With the aid of a neat circuit diagram, explain the operation of pulse-transformer based isolation circuit. (5)

10 a) With the help of a neat, labelled diagram, explain the reverse recovery characteristics of a thyristor (5)

b) Design a UJT relaxation oscillator using an UJT with the following parameters: V_{BB} = 30 V, Intrinsic stand off ratio, η = 0.51, Peak Current, I_p = 10 μA, Valley voltage, V_v = 3.5 V, and Valley current, I_v = 10 mA. Assume diode drop, V_D = 0.5 V. The frequency of oscillation is 50 Hz and width of triggering pulse must be 50 μs. (5)

11 a) Using two-transistor analogy, explain the gate turn-ON process of a thyristor. (5)

b) A single phase full-wave semi-controlled rectifier operated from a 240V,50Hz ac supply is feeding a load resistance of 10 Ω. If output voltage obtained was 75% of maximum possible output voltage, determine (5)

i Firing angle (α)

ii Rms output voltage (V_{rms})

iii For the same firing angle, what will be the output voltage if the converter was a half-wave controlled rectifier.

PART C

Answer any two full questions, each carries10 marks.

12 a) Draw a neat labelled circuit diagram of a single-phase dual-converter. What are the different types of dual converter? (5)

b) A single phase full-bridge inverter has an RLC load with R = 10 Ω, L = 10 mH and C = 100 μF. The inverter frequency is 50 Hz and the DC input voltage is 220V. (Assume that 9^{th} harmonic and subsequent higher order harmonics are negligible). Calculate the THD of load current. (5)

13 a) A three-phase fully-controlled rectifier charges a battery from a three-phase supply rated at 400V, 50Hz. The battery voltage is 200V and internal resistance of the battery is 0.5 Ω. Due to the large inductance connected in series with the battery, the charging current remains constant at 25A. Calculate the firing angle of the converter. (5)

b) Define Total Harmonic Distortion (THD). What is the physical significance of THD of an inverter. Find the THD of a single-phase full-bridge inverter connected to a 48V battery as input and feeding power to a 2.4Ω resistive load. (5)

14 a) A 220 V, 1500 rpm, 50 A Separately Excited DC Motor has an armature resistance of 0.5 Ω. The motor is fed from a single-phase circulating current dual converter. The input to the dual converter is a single phase ac source rated at 220 V, 50 Hz. Determine the firing angles of the dual converter for Motoring Operation of the DC motor at rated torque and 1000 rpm. (5)

b) Compare and contrast Voltage Source Inverter (VSI) and Current Source Inverter (CSI) (3)

c) Define Total Harmonic Distortion and Distortion Factor with reference to inverters (2)

PART D

Answer any two full questions, each carries 10 marks.

15 a) A Buck-Boost Converter has the following parameters: (5)

Input voltage = 24 V. Duty Ratio = 40%. Load resistance = 5Ω. Filter inductance = 20 μH. Filter capacitance = 80 μF. Switching frequency = 100 kHz.

Determine

i Output voltage

ii Average, minimum and maximum value of inductor current

b) Suggest a PWM scheme for control of a single phase bridge inverter which will eliminate 5th harmonic from the output waveform. The inverter is fed from a 230V dc source and feeds a series R-L load comprising R = 12 Ω and L = 25mH. Determine the power delivered to the load for the suggested PWM scheme if the inverter operates at an output frequency of 50 Hz. (Consider up-to 7^{th} harmonic only) (5)

16 a) Determine the power delivered to a series R-L load comprising R = 10 Ω and L = 25 mH by a single-phase full-bridge inverter. The inverter is operated from a 200V dc source and the output frequency is 50 Hz. The inverter is controlled using single-PWM with an ON-period of 50% of a cycle. (Consider up-to 7^{th} harmonic only) (5)

b) Design a Boost-converter for continuous conduction mode of operation. Input voltage is 12 V and desired output voltage is 30 V. Output voltage ripple should not exceed 1%. Load resistance is 50 Ω. Assume ideal components. (5)

17 a) What is meant by the critical value of inductance with respect to DC-DC converters? Derive the expression for critical inductance of a Boost Converter. (5)

b) Draw a neat labelled circuit diagram of a single-phase AC voltage controller. Explain the operation of the system for a resistive load. Derive the expression of RMS output voltage. (5)

****