

III B. Tech I Semester Regular/Supplementary Examinations, October- 2016
POWER ELECTRONICS

(Electrical and Electronics Engineering)

Time: 3 hours

Max. Marks: 70

- Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
 2. Answering the question in **Part-A** is compulsory
 3. Answer any **THREE** Questions from **Part-B**

PART -A

- 1 a) What are the conditions under which a transistor operates as a switch? [3M]
 b) List the applications of phase controlled rectifiers. [4M]
 c) Explain the effect of freewheeling diode on the performance of phase controlled rectifier. [3M]
 d) Define displacement factor, distortion factor, power factor and THD. [4M]
 e) Explain the use of TRC for controlling the output voltage in choppers. [4M]
 f) Explain the principle of operation of an inverter. [4M]

PART -B

- 2 a) Briefly explain the V-I characteristics of an IGBT. [8M]
 b) Explain the dynamic characteristics of SCR. [8M]
- 3 a) Discuss the principle of phase control in single-phase full-wave ac voltage controller. Derive the expression for the rms value of its output voltage. [8M]
 b) A single phase full wave ac voltage controller controls load power. The input is 230 V, 50 Hz. The load circuit consists of $R= 3 \Omega$ and $\omega_L = 4\Omega$. Determine [8M]
 (i) The control range of firing angle
 (ii) Maximum value of RMS load current
 (iii) Maximum power
 (iv) Power factor
- 4 Discuss the effect of source-inductance on the performance of a single phase fully controlled converter, indicating clearly the conduction of various thyristors during one cycle. Derive an expression for its output voltage in terms of V_m , α and μ [16M]
- 5 a) Sketch output wave form for a 3-phase semi converter for a firing angle delay of 75° . Indicate the conduction of various elements and discuss whether freewheeling diode comes in to place on the assumption of continuous load current. Hence obtain an expression for an average output voltage. [8M]
 b) A 3-Phase full convertor is connected to a RLE load. The source voltage is 3-phase, 230V, 50 Hz and the load current is 10A. For $R=0.5\Omega$ and $L=2H$, determine (a) firing angle for $E = 134V$ and (b) firing angle advance for $E = -134V$. [8M]
- 6 For a single phase mid-point Cyclo-converter, explain the operation of the circuit when fed to R-load with the help of neat circuit diagram and relevant output waveforms for $\alpha = 30^\circ$ and $\alpha = 120^\circ$ for $f_0 = 1/4 f_s$. [16M]
- 7 Discuss the principle of working of a three phase bridge inverter with an appropriate circuit diagram .Draw phase and line voltage waveforms on the assumption that, each thyristor conducts for 120° and the resistive load is star connected. [16M]



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PART -A

- 1 a) Compare power MOSFETS with BJTs? [3M]
 b) Explain briefly any thyristor turn-off method. [4M]
 c) Explain the effect of source inductance on the performance of phase controlled rectifier. [3M]
 d) List the conditions required for line commutated inverter operation of a three phase fully controlled converter. [4M]
 e) What is Cyclo-Converter? List some industrial applications of it. [4M]
 f) Define frequency and amplitude modulation? [4M]

PART -B

- 2 a) Explain the transfer and output characteristics of MOSFETs. [8M]
 b) Explain the basic operation of a SCR. [8M]
- 3 A 1- ϕ , 230V, 50HZ source connected to an anti parallel connected thyristor circuit; controlling power to the following loads, when $\alpha = 90^\circ$. Calculate output voltage, output current and load power factor for
 (a) R=10 OHMS; L=0 H R=10 OHMS; L=60mH. [16M]
- 4 a) Explain the working of single-phase fully controlled bridge converter in the following two modes (i) Rectifying mode (ii) Inversion mode [10M]
 b) A single phase 230 V, 1 kW heater is connected across a single phase, 230 V, 50Hz supply through an SCR. For the firing angle of 45° and 90° , find the power absorbed by heater element. [6M]
- 5 Describe the effect of source inductance on the performance of a 3-phase full converter with the help of phase voltage wave forms. Derive an expression for average output voltage in terms of supply voltage, source inductance load current. [16M]
- 6 a) Describe the operation of a Boost converter and derive its output voltage equation. [8M]
 b) For the ideal type A-chopper circuit, following conditions are given, $E_{dc} = 220V$, chopping frequency, = 500 Hz, duty cycle $\delta=0.3$ and $R = 1 \text{ ohm}$, $L = 3 \text{ mH}$ and $E_b = 23V$. Compute the following quantities (i) Average output current (ii) maximum and minimum values of steady state output current [8M]
- 7 Discuss the principle of working of a three phase bridge inverter with an appropriate circuit diagram. Draw voltage and current waveforms on the assumption that, each thyristor conducts for 180° and the resistive load is star connected. [16M]

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PART -A

- 1 a) Define latching and holding currents as applicable to SCR. [3M]
- b) Explain with the help of a neat circuit diagram, the use of pulse- transformer in triggering circuits. [4M]
- c) Explain the operation of a single phase half –wave converter feeding on R-load. [4M]
- d) List the differences between circulating and non- circulating current modes of operation of dual converters. [4M]
- e) List the advantages and disadvantages of boost chopper. [3M]
- f) What is pulse width modulation? List the various PWM techniques. [4M]

PART -B

- 2 a) Describe the different modes of operation of a thyristor with the help of its Static I-V characteristics. [9M]
- b) Following are the specifications of a thyristor operating from a peak supply of 500 V. [7M]
 Repetitive peak current $I_p = 250$ A
 $(di/dt)_{max} = 60A/\mu s$, $(dVa/dt)_{max} = 200V/\mu s$. Take a safety factor of 2 for the three specifications mentioned above. Design a suitable Snubber circuit if the min. load resistance is 20Ω . Take $\xi = 0.65$
- 3 a) A single phase full wave ac voltage controller feeds a load of $R = 20 \Omega$, with an input voltage of 230 V, 50 Hz. Firing angle for both the thyristors is 45° . Calculate [8M]
(i) rms value of output voltage **(ii)** load power and input pf
(iii) average and rms current of thyristors
- b) Describe the operation of single phase half-wave converter feeding on RL load with the help of voltage and current waveforms. Also, derive the expressions for the average value of output voltage. [8M]
- 4 a) A Single Phase semi converter with freewheeling diode across the load is operated [10M]
 from a 120-V,60-Hz supply. The load current with an average value of I_a is continuous with negligible ripple content. If the firing angle is $\pi/3$, Calculate (a) the harmonic factor of input current (ii) displacement factor (iii) the input power factor
- b) A single phase fully controlled bridge converter is supplied at 230V, 50Hz, with source inductance of 2mH. When the converter is operating at a firing angle of 45° with ripple free load current of 10A, determine also the load voltage. Neglect resistance voltage drop. [6M]



- 5 a) Sketch output wave form for a 3-phase full converter for a firing angle delay of 45° . [8M]
Indicate the conduction of various elements and discuss whether freewheeling diode comes in to place on the assumption of continuous load current. Hence obtain an expression for an average output voltage.
- b) A three phase dual converter operating in circulating current mode has the following [8M]
details. Source voltage is 3-phase 220 V, 60 Hz and the load resistance is $R=10\Omega$. The circulating inductance is 5mH and the delay angles are $\alpha_1 = 60^\circ$ and $\alpha_2 = 120^\circ$.
Calculate the peak circulating current and peak current of the converters.
- 6 a) What is a DC-OC converter? Describe the working of Boost converter with relevant [8M]
wave forms. Derive the expression for output voltage.
- b) A dc battery is to be charged from a constant dc source of 220 V. The dc battery is to [8M]
be charged from its internal emf of 90 V to 122 V. The battery has internal resistance of 1Ω . With a constant charging current of 10A compute the range of duty cycle.
- 7 a) What is the different pulse width modulation techniques used for inverters? [8M]
b) Explain unipolar switching scheme operation for a PWR inverter? [8M]



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PART -A

- 1 a) Describe the significance of di/dt and dv/dt in SCRs. [3M]
- b) Explain the principle of line commutation. [4M]
- c) Explain the effect of battery load on the performance of single phase fully controlled bridge converter. [3M]
- d) What are the advantages of 6-pulse converter over 2-pulse converter? [4M]
- e) What are the control strategies for the regulation of output voltage in ac voltage controller? [3M]
- f) Explain the operation of single-phase inverter. [4M]

PART -B

- 2 a) For a single phase half wave rectifier feeding a resistive load R, find the values of rectifier efficiency, form factor, voltage ripple factor, transformer utilization factor and crest factor when $\alpha = 0^\circ$. [10M]
- b) Explain briefly different turn on methods used for SCR. [6M]
- 3 a) Define the term power factor. Derive its expression for single phase voltage controller feeding a resistive load circuit. [7M]
- b) A resistive load of 10Ω is connected through a half-wave SCR circuits to 220v, 50Hz, single- phase source. Calculate the power delivered to load for a firing angle of 60° . Find also the value of input power factor. [9M]
- 4 A Single phase full converter delivers a constant load current I_o . Express its source current in Fourier series and derive expressions for the following performance parameters. (i) Displacement factor (ii) Power factor (iii) THD (iv) Current distortion factor [16M]
- 5 a) Explain the operation of a three phase dual converter in the non circulating current mode with the help of relevant waveforms. Derive the expression for the average output voltage. [10M]
- b) A three phase fully controlled bridge converter is fed from a 3-phase 400 V, 50Hz mains. For firing angle of 60° , output current is 25 A and output voltage is 250 V. Calculate the load resistance, source inductance and angle of overlap. [6M]



- 6 a) Discuss the working of a single phase bridge type cyclo converter with RL load for continuous conduction operation with relevant output waveforms and circuit diagram for $f_0 = (1/4) f_s$. [8M]
- b) Explain the principle of operation of a Back- Boost converter. [8M]
- 7 a) Explain the working of a single-phase half bridge inverter. Discuss how the output power in single-phase full bridge inverter becomes four times the power handled by a single phase half-bridge inverter. [8M]
- b) Describe briefly and compare the various methods employed for the control of output voltage of inverters. [8M]

