

Code No: 125AF

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD****B. Tech III Year I Semester Examinations, May - 2018****POWER ELECTRONICS****(Electrical and Electronics Engineering)****Time: 3 hours****Max. Marks: 75****Note:** This question paper contains two parts A and B.

Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

**PART - A****(25 Marks)**

- 1.a) What is the two transistor model of SCRs? [2]
- b) What is a forced commutation? What are the advantages of forced commutation for ac-dc converters? [3]
- c) What is symmetric-angle control of converters? [2]
- d) Does the input power factor of converters depend on the load power factor? [3]
- e) What are the advantages and disadvantages of a boost converter? [2]
- f) What is the discontinuous mode of operation of a regulator? [3]
- g) What are the steps involved in determining the output voltage waveforms of three phase bidirectional controllers? [2]
- h) What are the advantages and disadvantages of cycloconverters? [3]
- i) What are the advantages of parallel resonant inverters? [2]
- j) What are the effects of eliminating lower order harmonics? [3]

**PART - B****(50 Marks)**

- 2.a) What are the problems associated with firing of parallel connected SCRs? Draw and explain circuit for firing of parallel connected SCRs.
- b) Draw and explain the necessity of static and dynamic equalizing circuit for series connected SCRs? Derive relations used for determining the values of shunt resistor R and capacitor C in this circuit. [5+5]

**OR**

- 3.a) What will happen if one of the SCR has large delay time in parallel SCRs? Explain the convenient method of triggering parallel connected SCRs.
  - b) Draw and explain the simultaneous triggering circuit of series connected SCRs. [5+5]
- 4.a) A three phase fully controlled bridge converter is connected to three phase ac supply of 400V, 50Hz and operates with a firing angle  $\alpha = \pi/4$ . The load current is maintained constant at 10a and the load voltage is 360V, compute: (i) Source inductance  $L_s$   
(ii) Load resistance R, (iii) Overlap angle,  $\mu$ .
  - b) Explain the operation of three phase, half wave controlled converter with resistive load and inductive load. Sketch the associated waveforms also. [5+5]

**OR**

- 5.a) Describe the working of six pulse midpoint converter with interphase reactor. Sketch the waveforms for  $\alpha=30^\circ$  and  $\alpha=120^\circ$ .
- b) Explain the effect of battery load on the performance of single phase fully controlled bridge converter. [5+5]

- 6.a) With the circuit diagram and output voltage waveforms, explain the working of Jones chopper.
- b) A dc on-off chopper operating at 1 kHz and duty cycle of 10% is supplied from a 200V source. If the load inductance is 10mH and resistance 10 $\Omega$ . Compute the maximum and minimum current in the load. [5+5]

**OR**

- 7.a) Draw a schematic diagram of a single phase ac chopper and discuss in brief with output voltage and current waveforms.
- b) Explain in brief how average voltage across the load is made more than dc supply voltage using chopper. Derive the expression for the average voltage. [5+5]
- 8.a) Draw and explain the control circuit block diagram for a cycloconverter with non-circulating current mode.
- b) A three phase resistive load is to be controlled by three Triacs from a 415V supply. If the load is 15 kW, determine the required ratings of Triacs. If thyristors were used instead of Triacs, determine their rating. [5+5]

**OR**

- 9.a) Describe the control scheme for a cycloconverter using voltage sensing principle of converter group selection. Also, draw and discuss the various voltage waveforms of a control scheme.
- b) A single phase half wave AC voltage controller, using one SCR in antiparallel with a diode. Feeds 1kW, 230V heater. Find the load power for a firing angle of (i)  $0^\circ$  (ii)  $180^\circ$  (iii)  $70^\circ$ . [5+5]
- 10.a) Explain the single phase PWM, transformer connection, multiple commutation and filter methods used for reduction of harmonics in inverter output.
- b) Draw and explain the operation of the time sharing inverter circuit. Also draw the related voltage and current waveforms. [5+5]

**OR**

- 11.a) A single phase half bridge inverter may be connected to a load consisting of (i) R (ii) RL and RLC overdamped (iii) RLC underdamped. For all these loads, draw the load voltage and load current waveforms under steady state operating conditions. Also, indicate the conduction of the various elements of the inverter circuit.
- b) Give the detailed design aspects of series inverter. [6+4]

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, May - 2019

POWER ELECTRONICS

(Electrical and Electronics Engineering)

Time: 3 hours

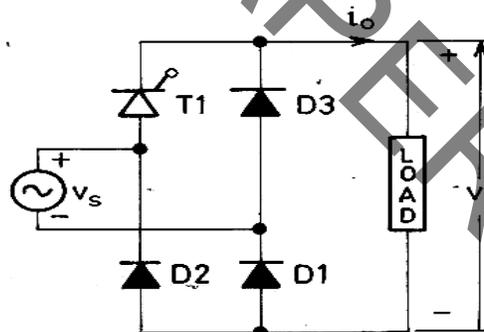
Max. Marks: 75

**Note:** This question paper contains two parts A and B.

Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

**PART - A****(25 Marks)**

- 1.a) Name any four power semiconductor devices. [2]
- b) Draw the firing circuit for SCR using UJT and write the necessary design equations. [3]
- c) Which converter will act as three pulse as well as six pulse converter? [2]
- d) Draw the firing pulse, output voltage and load current for the circuit shown in Figure. Assume the load is highly inductive. [3]



- e) Mention the applications of AC voltage controllers. [2]
- f) In an AC voltage controller, six cycles of input voltage are made on and four cycles are made off simultaneously across the load. Find the circuit power factor. [3]
- g) Compare time ratio control and current limit control. [2]
- h) Find the effective resistance and average thyristor current in a basic DC-DC chopper in terms of duty cycle. [3]
- i) What are the advantages of modified series inverter? [2]
- j) Define harmonic factor, THD and Distortion factor. [3]

**PART - B****(50 Marks)**

- 2.a) Explain the working of SCR.
- b) SCRs with a rating of 1000 V and 200 A are available to be used in a string to handle 6 kV and 1 kA. Calculate the number of series and parallel units required. Assume the derating factor is 0.1. [5+5]

**OR**

- 3.a) Explain the working of MOSFET.  
b) Explain resonant pulse commutation with necessary circuit and waveforms. [5+5]
- 4.a) A single phase transformer, with secondary voltage of 230 V, 50 Hz delivers power to load 10 ohms through a half wave controlled rectifier circuit. For a firing angle delay of 60 degrees, determine rectification efficiency.  
b) SCRs with peak forward voltage rating of 1000 V and average on-state current rating of 40 A are used in single phase mid-point converter and single phase bridge converter. Find the power that these two converters can handle. Use a factor of safety of 2.5. [5+5]

**OR**

- 5.a) A single phase full converter bridge is connected to RLE load. The supply voltage is 230 V, 50 Hz. The average load current of 10 A is constant over the working range. For  $R = 0.4$  Ohms and  $L = 2$  mH, compute the firing angle delay for  $E = 120$  V.  
b) Explain the working of three phase full converter for a firing delay angle of 45 degree. [5+5]
6. A single phase half wave ac voltage controller feeds a load of  $R = 20$  ohms with an input voltage of 230 V, 50 Hz. Firing angle of thyristor is 45 degrees. Determine  
a) rms voltage and power delivered to the load.  
b) Average input current and input power factor. [5+5]

**OR**

7. A single phase full wave ac voltage controller feeds a load of  $R = 20$  ohms with an input voltage of 230 V, 50 Hz. Firing angle for both the thyristors is 45 degrees. Calculate  
a) rms value of output voltage and load power  
b) Input power factor, average and rms current of thyristors. [5+5]
8. The speed of a separately excited dc motor is controlled using type A chopper. The supply voltage is 220 V DC. The armature resistance is 0.5 ohms and armature inductance is 10 mH. The motor constant is 0.1 V/ rpm. The motor drives a constant torque load requiring an average armature current of 30 A. On the assumption of continuous armature current, calculate,  
a) The range of speed control  
b) The range of duty cycle. [5+5]

**OR**

- 9.a) Explain the working of Morgans chopper.  
b) Explain the working of Jones chopper. [5+5]
10. For a single phase full bridge inverter, input voltage = 230 V DC,  $T = 1$  ms. The load consists of  $R = 1$  Ohm, Inductive reactance = 6 Ohms and capacitive reactance of 7 Ohms.  
a) Sketch the waveforms for load voltage, fundamental component of load current, source current and voltage across thyristor 1. Indicate the devices under conduction during different intervals of one cycle.  
b) Check whether forced commutation is required or not. Take thyristor turn off time as 100 micro seconds. [7+3]

**OR**

11. Explain the following:  
a) Internal voltage control of inverter  
b) External voltage control of inverter. [5+5]

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**PART - A****(25 Marks)**

- 1.a) Sketch static V-I characteristics of IGBT and mark the region in which the device is operated as a switch. [2]
- b) Define the ratings of SCR (i) Average ON state current (ii) Forward breakover voltage. [3]
- c) What is the effect of connecting free wheeling diode across R-L load in controlled rectifiers? [2]
- d) Write down general expression for average voltage of p- pulse fully controlled rectifier. [3]
- e) Draw the output voltage waveform of single phase AC chopper. [2]
- f) A Class B turn-off circuit commutates an SCR. The load current is constant at 10Amps. Dimension the commutating components L and C. The supply voltage is 100V dc. Turn off time spec of SCR is 20 micro sec. [3]
- g) Draw the equivalent circuit of a cyclo-conveter. [2]
- h) What are advantages and disadvantages of cyclo-converter as compared to ac voltage controllers. [3]
- i) What type of commutation is used in basic series inverter? How frequency of output can be controlled in series inverter? [2]
- j) How can a PWM control signal be obtained using a carrier wave and reference wave with the help of diagram. [3]

**PART - B****(50 Marks)**

- 2.a) Draw dynamic characteristics of SCR during turn off. Explain how turn off process can be carried out?
- b) Explain the two-transistor analogy of SCR. [5+5]

**OR**

- 3.a) What are problems encountered when SCRs are operated in (i) series (ii) parallel. Derive an expression to find the value of resistance to be connected across each thyristor for voltage balancing.
- b) Design RC firing circuit with following specifications: [5+5]  
AC input voltage: 115 V  
Thyristor ratings:  $V_g(\min) : 2.5 \text{ V}$  ,  $V_g(\max) : 5 \text{ V}$   
 $I_g(\min) : 1 \text{ mA}$  ,  $I_g(\max) : 5 \text{ mA}$   
Load: 15 ohms resistance

- 4.a) Explain the operation of single phase half controlled bridge rectifier with R-L-E load. Derive the expression for (i) Average output voltage (ii) RMS value of output voltage
- b) A fully controlled rectifier is used to charge a 115 V battery. The battery is already charged to 60 V. The source voltage of bridge is 230 V at 50 Hz. Find the range of firing angle possible. [5+5]

**OR**

- 5.a) Draw the output voltage waveform of 3-phase fully controlled rectifier for a firing angle of 60 degrees. Indicate firing sequence. Also derive expression for output voltage.
- b) A 3 phase fully controlled bridge rectifier is operating from a 400V, 50 Hz supply. The load is highly inductive and current constant and continuous. Find the load voltage at firing angle of 45 deg. [5+5]

- 6.a) Draw the circuit of class-B commutation circuit. Explain how thyristor is commutated in class-B chopper. What are disadvantages of this commutation circuit?
- b) A class-A chopper circuit has a load resistance of 100 ohms, capacitance of 10 micro farads and inductance of 10 mH. Find the time for which thyristor will remain in ON state. What will be the turn ON time if the load resistance is decreased to 25 ohms. [5+5]

**OR**

- 7.a) Derive expressions for minimum and maximum values of load current in a step down chopper with R-L-E load.
- b) A step-up chopper has a source of 250 V (dc) in series with inductance of 0.1 H. If the semiconductor switch is operated with different values of duty ratio, plot output voltage vs duty ratio. [6+4]

- 8.a) Distinguish between an ac voltage controller and a cyclo-converter with respect to operation and control aspects.
- b) Derive an expression for rms value of output voltage of single phase bridge type ac voltage controller. [5+5]

**OR**

9. Draw the circuit of single phase voltage controller with antiparallel connection of two thyristors and an R-L load. Explain its working. Sketch load voltage and load current waveforms. Derive an expression for output voltage. [10]

- 10.a) Explain the operation of single phase bridge inverter with the help of load voltage and load current waveforms for R-L Load.
- b) A 3-phase bridge inverter is fed from a dc source of 200 V. If the load is star connected of 10 ohms / phase, determine rms value of load current and required current rating of thyristors. [6+4]

**OR**

11. Discuss various voltage control techniques employed in inverter circuits. [10]

**R15**

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**PART - A****(25 Marks)**

- 1.a) Differentiate latching current with holding current of an SCR. [2]
- b) Define different components of turn on time and turn off times of a thyristor. [3]
- c) What is the effect of source resistance on the average output voltage of a single phase semi-converter? [2]
- d) How four quadrant of operation is possible with single phase fully controlled converters? [3]
- e) What are the advantages and disadvantages of chopper? [2]
- f) What is the Current limit control of dc-dc converter? Explain briefly. [3]
- g) List out two difference between TRIAC and thyristor? [2]
- h) What are the three main limitations of a cycloconverter compared ac voltage controller. [3]
- i) What is the difference between series inverter and parallel inverter? [2]
- j) Draw the circuit diagram for parallel inverter. [3]

**PART - B****(50 Marks)**

- 2.a) Discuss the switching characteristics of SCR by mentioning its salient features.
- b) What are "dv/dt" and "di/dt" ratings of SCRs? What happens if these ratings are exceeded? [5+5]

**OR**

- 3.a) Draw and explain the transfer and output characteristics of *n*-channel enhancement type MOSFET's.
- b) Mention the importance of snubber circuit which is connected across SCRs. [5+5]
- 4.a) Trace the input and output load voltage waveform of 1- Phase half controlled bridge converter having highly inductive load with firing delay angle of  $60^{\circ}$ . Justify your comments about the power flow.
- b) Derive an expression for i) average load voltage ii) average load current iii) RMS load voltage of 1-phase half-controlled converter with inductive load. [5+5]

**OR**

- 5.a) Explain the operation of 3-phase fully controlled Converter with R load for inverter operation
- b) The dc voltage from a 1- phase fully controlled bridge converter with RL load is 110 V. The ac source voltage is 220 V rms. The load resistance,  $R = 0.5 \Omega$ , and load inductance,  $L$  is large enough to cause the load current to be essentially constant.
- i) Determine the delay angle  $\alpha$  ii) Estimate the power delivered to the load. [5+5]

- 6.a) Explain the operation of step-up chopper with a neat circuit diagram and necessary output waveforms and also derive expression for output voltage.
- b) The step-down dc chopper has a resistive load,  $R = 20 \Omega$  and input voltage,  $V_s = 220$  v. When the chopper remains on, its voltage drop,  $V_{ch} = 1.5$  V and chopping frequency,  $f = 10$  kHz. If the duty cycle is 80 %, Estimate the: (i) average output voltage (ii) rms output voltage, and (iii) Chopper efficiency. [5+5]

**OR**

- 7.a) Explain the operation of ac chopper with neat circuit diagram and waveforms.
- b) A chopper circuit is operating on TRC principle at a frequency of 2KHz on 220v dc supply. If the load voltage is 170v, compute the conduction and blocking periods of thyristor chopper in each cycle. [5+5]

- 8.a) Discuss the methods of voltage control employed in ac voltage controllers with necessary waveforms
- b) A single phase bidirectional controller supplies a resistance load of  $R = 10 \Omega$ . Determine the output voltage and power consumed by the load for following cases:  
(i)  $\alpha = 30^\circ$  (ii)  $\alpha = 75^\circ$  (iii)  $\alpha = 120^\circ$ . [5+5]

**OR**

- 9.a) Illustrate the principle of working of a 1-phase to 1-phase bridge type step down cyclo-converter feeding an R load.
- b) A 1 – phase a.c.regulator feed power to a resistive load of  $4 \Omega$  from 230 V, 50 Hz a.c.source. Determine i) the peak value of average and rms thyristor currents for any firing angle  $\alpha$ . ii) the minimum circuit turn-off time for any firing angle  $\alpha$ . [5+5]

- 10.a) A 3-phase bridge inverter is operated in  $180^\circ$  conduction mode. Derive output line voltage and phase voltage expression.
- b) A six-step three-phase inverter has an adjustable dc input. The load is a balanced Y connection with a series  $RL$  combination in each phase, with  $R = 5 \Omega$  and  $L = 50$  mH. The output frequency is to be varied between 30 and 60 Hz. Determine the range of the dc input voltage required to maintain the fundamental-frequency component of current at 10 A (rms). [5+5]

**OR**

- 11.a) Describe sinusoidal PWM control of single phase VSI with the help of suitable waveform.
- b) A square-wave inverter has a dc source of 125 V, an output frequency of 60 Hz, and an RL series load with  $R = 20 \Omega$ , and  $L = 25$  mH. Determine (i) an expression for load current, (ii) rms load current, and (iii) average source current. [5+5]