

III B. Tech I Semester Supplementary Examinations, October/November - 2020**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. Answer **ALL** the question in **Part-A**3. Answer any **FOUR** Questions from **Part-B****PART -A****(14 Marks)**

1. a) Define Latching Current. [2M]
- b) Why power factor of semi converter is better than full converter? [2M]
- c) Draw the circuit diagram of three phase M-3 controlled converter. [2M]
- d) List the applications of step up choppers. [3M]
- e) What is shoot through fault? Explain. [3M]
- f) A 1-phase voltage controller has input voltage of 230 V, 50 Hz for 6 cycles on and 4 cycles off. Determine RMS output voltage. [2M]

PART -B**(56 Marks)**

2. a) Explain the operation of snubber circuit and also design the parameters of snubber circuit. [7M]
- b) Draw the two-transistor analogy of a SCR? Explain SCR operation with this analogy. [7M]
3. a) Explain the operation of single phase two pulse midpoint converter with relevant voltage and current waveforms and also derive the expression for average output voltage. [7M]
- b) A single phase semi converter is delivering power to RLE load with $R = 5\Omega$, $L = 10\text{ mH}$ and $E = 80\text{ V}$. The ac source voltage is 230 V, 50 Hz. For continuous conduction, find the average value of output current for a firing angle of 50° . If one of the SCR is damaged and open circuited find the new value of average output current on the assumption to continuous conduction. Also sketch the output voltage and current waveforms? [7M]
4. a) Explain the working of three-phase half wave uncontrolled rectifier with relevant wave forms for 'R' load. [7M]
- b) A Three phase fully controlled bridge converter is connected to a supply voltage of 230 V per phase and frequency of 50 Hz. The source inductance is 3 mH. The load current on dc side is constant at 15 A. If load consists of a dc source voltage of 400 V having an internal resistance of 1Ω . Find the firing angle and overlap angle. [7M]
5. a) Explain the principle of operation and working of buck converter with relevant waveforms in CCM mode. [10M]
- b) A boost regulator has an input voltage of $V_s = 5\text{ V}$. The average output voltage $V_a = 15\text{ V}$ and the average load current $I_a = 0.5\text{ A}$. The switching frequency is 25 kHz. If $L = 150\text{ }\mu\text{H}$ and $C = 220\text{ }\mu\text{F}$, determine (i) the duty cycle, (ii) the ripple current of inductor ΔI , (iii) the critical values of L and C. [4M]

6.
 - a) With necessary waveforms explain the working of single phase half bridge inverter with RL load and also derive the expression for RMS value of output voltage. [7M]
 - b) Single phase full bridge inverter has a resistive load of $R = 2.4$ ohms and DC input voltage of 48 volts. Calculate: i) RMS output voltage at fundamental frequency, ii) output power, iii) Average and peak current of each thyristors. [7M]
7.
 - a) Explain the operation of a single phase AC voltage controller with a neat circuit diagram and output wave forms with respect to source voltage waveforms at $\alpha = 60$ degrees for R-load. [7M]
 - b) Explain the principle of integral cycle control with relevant waveforms and also derive the expression for rms value of output voltage, power delivered to load and input power factor. [7M]

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1. a) What are the necessary conditions for turning ON a SCR? [2M]
- b) What is reactive power input of single phase full converter at $\alpha = 30^\circ$? [2M]
- c) Give the list of applications of three phase controlled converters. [2M]
- d) What is the principle of operation of fly-back converter in CCM? [3M]
- e) What are the difference between VSI and CSI? [3M]
- f) Draw the waveforms of single phase ac voltage controller with R load with $\alpha = 60^\circ$. [2M]

PART -B**(56 Marks)**

2. a) What are the types of switching characteristics of SCR? How do you know turn ON and turn OFF times from the switching characteristics? Explain. [7M]
- b) What are the requirements of good gate driver circuits of IGBT and MOSFET? Explain. [7M]
3. a) Explain the operation of single phase full-wave controlled rectifier using center tapped transformer with R-L load under continuous mode of operation. Draw the waveforms of output voltage, voltage across SCR and average load current for $\alpha = 45^\circ$. [7M]
- b) A single phase fully controlled bridge converter is connected to R-L load with $R = 10 \Omega$ and $L = 6 \text{ mH}$. The converter is supplied from 230 V, 50 Hz ac supply. (i) Determine average and rms load current; (ii) if one SCR of the bridge configuration is open circuited due to fault, what will be the average and rms load current at this condition? [7M]
4. a) Draw the output voltage waveforms and derive the average and rms voltage expressions of three phase semi converter on discontinuous conduction mode. [7M]
- b) A three phase full converter is connected to a resistive load of 10Ω . If the firing angle of SCR is $\alpha = 45^\circ$ and it feeds 4 kW power to a resistive load determine the amplitude of maximum line input voltage. [7M]
5. a) Explain the operation of boost converter in the CCM mode and obtain the expression for amplitude of ripple current. [7M]
- b) A buck-boost converter has the input voltage of 12 V and it operates at 20 kHz, when the average output voltage is 24 V, the average load current is 1.2 A, it is having $L = 300 \mu\text{H}$, $C = 150 \mu\text{F}$. Find duty cycle, ripple current through the inductor, ripple voltage and critical values of L and C. [7M]

6. a) Discuss various PWM techniques used in inverters. How sinusoidal PWM is useful in the harmonic elimination? [7M]
- b) A 50 Hz single – phase full bridge produces a square wave voltage across load when operating from a 300 V DC supply, the AC load consists of a resistance of $30\ \Omega$ in series with inductance 15 mH. Determine the frequencies and r.m.s values of the lowest order harmonics in the AC load current. [7M]
7. Explain the operation of a three – phase bidirectional AC voltage controlled feeding star connected with resistive load. Draw the output voltage waveform with $\alpha = 60^\circ$ and $\alpha = 120^\circ$. [14M]

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1. a) Define holding current. [2M]
- b) What are the drawbacks of source inductance on the performance of phase controlled rectifiers? [2M]
- c) Compare continuous and discontinuous modes of operation of converters. [2M]
- d) List any two applications of choppers. [3M]
- e) List differences between CSI and VSI. [3M]
- f) Explain the principle of Integral Cycle control. [2M]

PART -B**(56 Marks)**

2. a) Explain the various turn-on methods of SCRs. [7M]
- b) Following are the specifications of a thyristor operating from a peak supply voltage of 500 V. [7M]

Repetitive peak current, $I_p = 250 \text{ A}$;

$$\left(\frac{di}{dt}\right)_{\max} = 60 \text{ A} / \mu\text{s}, \left(\frac{dv_a}{dt}\right)_{\max} = 200 \text{ V} / \mu\text{s}$$

Take a factor of safety as 2 for the specifications mentioned above. Design a suitable snubber circuit, if the minimum load resistance is 20Ω . Take $\xi=0.65$.

3. a) Explain the effect of source inductance on the performance of a single-phase full converter with the help of voltage waveforms. Derive an expression for its output voltage in terms of supply voltage, source inductance and load current. [7M]
- b) A single phase semi converter is supplied from 230 V, 50 Hz source. The load consists of $R = 10 \Omega$ and $E = 100 \text{ V}$ and a large inductor so as to maintain the load current constant. For a firing angle of 45° , find i) average output voltage ii) average output current iii) average and rms values of thyristor currents iv) input power factor. [7M]
4. a) Explain the working of three phase semi converter with relevant wave forms with highly inductive load for firing angle of 30° . [7M]
- b) A three-phase, half-wave converter is supplying a load with a continuous constant current of 40A over a firing angle range from 0 to 75° . What will be the power dissipated by the load at these limiting values of firing angle? The supply voltage is 415 V (line). [7M]

5. a) Explain the working of boost converter with relevant waveforms in CCM mode and also derive the expressions for critical values of L and C. [10M]
- b) The buck regulator has an input voltage of $V_s = 15$ V. The required average output voltage is $V_a = 5$ V at $R = 400 \Omega$ and the peak-to-peak output ripple voltage is 10 mV. The switching frequency is 20 kHz. If the peak-to-peak ripple current of inductor is limited to 0.6 A, determine: i) the duty cycle ii) the filter inductance L, iii) the filter capacitor C. [4M]
6. a) With necessary waveforms explain the working of single phase full bridge inverter with RL load and also derive the expression for RMS value of output voltage. [7M]
- b) Single phase half bridge inverter has a resistive load of $R = 3 \Omega$ and DC input voltage of 50 V. Calculate: i) RMS output voltage at fundamental frequency, ii) output power, iii) Average and peak current of each thyristors. [7M]
7. a) Describe the principle of phase control in single phase half wave ac voltage regulator. Derive the expressions for average and rms value of output voltage for this control. [7M]
- b) A single phase full wave ac voltage controller has a load of $R = 5 \Omega$ and input voltage is 230 V, 50 Hz. If the load power is 5 kW, find firing angle delay of SCR and input power factor. [7M]

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2. Answer **ALL** the question in **Part-A**

3. Answer any **FOUR** Questions from **Part-B**

PART –A

(14 Marks)

1.
 - a) Why protection is required during the operation of SCR? [2M]
 - b) Calculate power delivered to a 1 kW heater which is connected to a single phase half wave controlled rectifier when $\alpha = 30^\circ$, Supply voltage = 220V. [2M]
 - c) Give the conduction periods of lower group thyristors in 6 pulse converters for 60 Hz frequency with $\alpha = 60^\circ$. [2M]
 - d) Write the advantages of buck-boost converter. [3M]
 - e) Mention the advantages of pulse width modulation control strategy. [3M]
 - f) Draw the waveforms of single phase unidirectional ac voltage controller with RL load with $\alpha = 30^\circ$. [2M]

PART –B

(56 Marks)

2. a) Describe the switching characteristics of power MOSFET and what are the requirements of gate drive to get less turn OFF and turn ON times? [7M]
b) Explain the design of snubber circuit used for a SCR, how it provides different voltage protections? [7M]
3. a) Explain the operation of single phase full-wave controlled rectifier using center tapped transformer having R-L load and freewheeling diode under discontinuous and continuous conduction modes with the help of wave forms. [7M]
b) A single phase fully controlled bridge converter is supplied from 230 V, 50 Hz ac supply and it is fed to load consisting of $R = 10 \Omega$ and large inductance such that load current is constant. When the firing angle is 45° , i) calculate average and rms current ii) if the source inductance of 1.5 mH is connected find the average voltage and overlap angle at the same firing angle. [7M]
4. a) Derive the average and rms voltage expressions of three phase half-wave controlled rectifier having R load operated on discontinuous conduction mode. [7M]
b) A three phase full converter is fed by 230 V, 50 Hz, three phase supply, the average load current is 25A and the load is highly inductive. For firing angle of 60° find average, rms and peak current through the SCR's. [7M]
5. a) Explain the operation of buck converter in the DCM mode and obtain the expression for amplitude of ripple current. [7M]
b) A buck-boost converter has the input voltage of 24 V and it operates at 30 kHz, when the duty cycle is 0.25, $L = 300 \mu\text{H}$, $C = 150 \mu\text{F}$ and the average load current is 1.5 A. Determine average output voltage, peak to peak ripple current through the inductor, peak to peak ripple voltage and critical values of L and C. [7M]

6. a) Draw a neat circuit diagram for single phase full bridge inverter feeding inductive load. [7M]
What is the function of feedback diodes?
- b) Explain the working of a current source inverter with a neat circuit diagram and waveforms. [7M]
7. a) A single phase voltage controller has input voltage of 230 V, 50 Hz; the load consists of a resistance $30\ \Omega$ in series with inductance 15 mH, for 6 cycles off and 4 cycles on. Determine the output voltage and input power factor. [7M]
- b) Explain the synchronous connection charge control of a Single-phase transformer connection charger. [7M]

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1. a) What is meant by reverse recovery time of a SCR? [2M]
- b) Calculate power delivered to a 1 kW heater which is connected to a single phase full wave controlled bridge rectifier, when $\alpha = 90^\circ$, Supply voltage = 220V? [2M]
- c) Give the conduction periods of upper group thyristors in 6 pulse converters for 60 Hz frequency with $\alpha = 30^\circ$. [2M]
- d) What is meant by fly back mode of operation of buck-boost converter? [3M]
- e) Mention the advantages of sinusoidal pulse width modulation control. [3M]
- f) Draw the static V – I characteristics of a TRIAC. [2M]

PART -B**(56 Marks)**

2. a) Describe the switching characteristics of power IGBT and what are the requirements of gate drive to get less turn OFF and turn ON times? [7M]
- b) Discuss about the different turn ON methods of a SCR. [7M]
3. a) Explain the operation of single phase half-wave controlled rectifier having R-L load and freewheeling diode under discontinuous and continuous conduction modes with the help of wave forms. [7M]
- b) A single phase full converter is used to deliver a constant load current, it is operated such that overlap angle is 15° for a firing angle, $\alpha = 0^\circ$. Determine the overlap angles for firing angles $\alpha = 30^\circ$, $\alpha = 45^\circ$ and $\alpha = 60^\circ$. [7M]
4. a) Describe the operation of three phase full converter feeding an R load and draw the wave forms for any firing angle which is more than the 90° . [7M]
- b) A three-phase three pulse controlled rectifier with freewheeling diode D_F is fed from three phase, 400 V, 50 Hz ac supply and it is connected with a constant current load of 90 A at firing angle of $\alpha = 45^\circ$. Calculate dc output voltage, rms output voltage, average and rms current of free-wheeling diode. [7M]
5. a) Explain the working of buck converter in continuous conduction mode. Derive the expression for output voltage. [7M]
- b) A boost converter has the input voltage of 24 V and it operates at 20 kHz, when the average output voltage is 12 V, the average load current is 1.2 A, it is having $L = 300 \mu\text{H}$, $C = 150 \mu\text{F}$. Find duty cycle, ripple current through the inductor, ripple voltage and critical values of L and C ? [7M]

6. a) Explain the working of a three phase inverter with 120° mode of conduction with three phase delta connected resistive load. [7M]
- b) A 50 Hz PWM inverter employs sinusoidal pulse width modulation based on sine-triangle comparison. If the triangular carrier frequency is 15 kHz, what will be the number of pulses per half period in the output waveform and with 80% modulation index what will be the width of the longest pulse? [7M]
7. a) Describe the operation of single phase full wave ac regulator feeding resistive load. Derive the expression for output voltage. [7M]
- b) A single phase ac voltage controller is employed for controlling the power flow from 230 V, 50 Hz source in to a load circuit consisting of $R = 4 \Omega$ and $\omega L = 3 \Omega$. Calculate: i) the control range of Firing angle; ii) the maximum power delivered to load and power factor; iii) the maximum values of average and rms SCR currents. [7M]

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, μ .
- 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 10Ω . 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° (ii) 180° (iii) 70° . [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]

Code No: 136DJ

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

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

POWER ELECTRONICS

(Electrical and Electronics Engineering)

Time: 3 hours

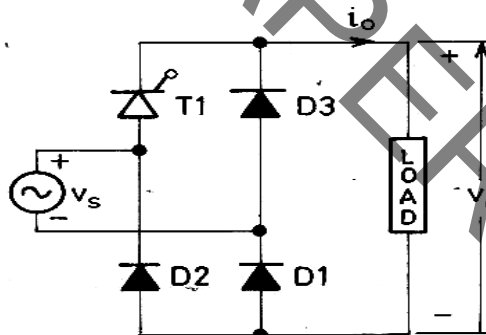
Max. Marks: 75

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 $R = 0.4 \text{ Ohms}$ and $L = 2 \text{ mH}$, compute the firing angle delay for $E = 120 \text{ V}$.
- 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 $R = 20 \text{ ohms}$ 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 $R = 20 \text{ ohms}$ 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, $T = 1 \text{ ms}$. The load consists of $R = 1 \text{ Ohm}$, 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]

Code No: 125AF**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD****B.Tech III Year I Semester Examinations, May/June - 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) What is the use of snubber circuit? [2]
- b) What do you understand by "dynamic latch up" of an IGBT? How can it be prevented? [3]
- c) Is it possible to operate a single phase fully controlled half wave converter in the inverting mode? Explain. [2]
- d) Which connection is required for signal transformer used to generate the carrier waves for firing pulse generation of a three phase fully controlled rectifier? [3]
- e) Define duty ratio of dc-dc converter. [2]
- f) Sketch the load voltage waveform of step up chopper. [3]
- g) How to vary the rms value of output voltage of single phase ac voltage controller? [2]
- h) Is there any need for free wheeling diode in AC voltage controllers? Why? [3]
- i) List out the methods of reducing harmonic distortion in the output voltage of inverters. [2]
- j) A single-phase full bridge inverter with square wave output voltage is connected to a dc input voltage of 600 volts. What maximum rms load voltage that can be obtained from bridge? [3]

PART - B**(50 Marks)**

- 2.a) Draw static V-I characteristics of Silicon Controlled Rectifier. How the device can be controlled as a switch? What are the conditions required for turn on?
- b) A resonant commutation circuit supply voltage is 200 V. Load current is 10 A and the device turn off time is 20μ s. The ratio of peak resonant current to load current is 1.5. Determine the value of L and C of the commutation circuit. [5+5]

OR

- 3.a) Draw the circuit required to turn on thyristor using UJT. What are significant points to be noted in designing UJT firing circuit? Explain.
- b) A thyristor is connected in series with a source of 100 V (dc) and a load of 20 ohms resistance and 0.5 H inductance. The thyristor is fired with a gate pulse of 50 micro sec. Will the SCR turned on reliably? If not why? The latching current of SCR is 50mA. [5+5]

4.a) Derive an expression for average output voltage of single phase half controlled rectifier with common cathode.

b) A three phase fully controlled rectifier is supplied at 150 V/phase, 50 Hz, the source inductance being 1.2 mH per phase. Assuming a thyristor voltage drop of 1.5 V and continuous load current of 30 A. determine average load voltage at firing angles
(i) 30 deg (ii) 60 deg [5+5]

OR

5.a) Derive an expression for source current of single phase fully controlled rectifier feeding power to R-L load. Assume load current to be continuous.

b) A 3 phase fully controlled bridge rectifier is operating from a 400 V, 50 Hz supply. There is a FWD across the load. Find the average output voltage for a firing angle of
(i) 45 deg (ii) 60 deg (iii) 90 deg [5+5]

6. Draw the circuit of load commutated dc-dc converter. Explain its working. Sketch the output voltage waveform and voltage across thyristor for a typical duty ratio. [10]

OR

7.a) Two loads having 10 ohm resistance each are to be serviced from a dc supply. The supply voltage is 24 V. Design commutation circuit component when turn off time specification of thyristor(s) is 20 micro sec. The chopper operating frequency is 1 kHz. Choose the duty ratio as per requirement.

b) Draw the circuit of Jone's chopper. Explain its operation highlighting method of commutation of thyristor. [5+5]

8.a) Explain the operation of single phase mid-point cyclo-converter. Derive an expression for rms value of output voltage.

b) A resistance heating load is controlled from a single phase supply using a TRIAC in the phase angle control mode. Determine firing angle when the output power is at (i) 80 % of its maximum (ii) 30% of its maximum. [5+5]

OR

9.a) Explain how the output frequency can be controlled in single phase cyclo converters. What are measures adopted to reduce THD in output voltage?

b) A single phase load of 9 ohms and 0.03 H inductance, is controlled by inverse parallel-connected thyristors using phase angle delay. The ac supply voltage is 230 V, 50 Hz. Determine the load current waveform and load power at delay angle of 30°. [5+5]

10.a) Explain the operation of 3-phase bridge inverter in 120 degrees conduction mode.

b) A 400 Hz, single phase, center-tapped inverter is required to generate an output close to sine wave shape from 72 V dc source into 10 ohms load via 1/1 transformer. Determine the required values of capacitance and inductance. Neglect losses. [5+5]

OR

11.a) Describe how sine-pulse width modulation is implemented in inverters. How THD reduction can be accomplished with PWM? Explain

b) A three-phase sine-PWM inverter operates from a dc link voltage of 600 volts. For modulation index = 1.0. Compute the rms value of line voltage of fundamental frequency. [5+5]

Code No: 115AF**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, μ .
- 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 10Ω . 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° (ii) 180° (iii) 70° . [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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III B. Tech I Semester Supplementary Examinations, May - 2019**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. Answer **ALL** the question in **Part-A**3. Answer any **FOUR** Questions from **Part-B**

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**PART -A**

1. a) Why turn ON time is less than turn OFF time in SCR? [2M]
- b) What is active power input of single phase full converter at  $\alpha = 60^\circ$ ? [2M]
- c) Give the conduction periods of diodes in in three phase semi converter for 60 Hz frequency with  $\alpha = 30^\circ$ ? [2M]
- d) What is the principle operation of forward converter in CCM? [3M]
- e) What is the mechanism provided to prevent shoot through fault in VSI? [3M]
- f) Draw the waveforms of single phase half wave ac voltage controller with RL load with  $\alpha = 30^\circ$ ? [2M]

**PART -B**

2. a) Describe the switching characteristics of power MOSFET and IGBT and compare them? [7M]
- b) Draw the gate characteristics of a SCR and explain its importance in the design of gate drive circuit? [7M]
3. a) Explain the operation of single phase full-wave controlled rectifier using center tapped transformer with R-L load under discontinuous mode of operation? Draw the waveforms of output voltage, voltage across SCR and average load current for  $\alpha = 60^\circ$ ? [7M]
- b) A single phase half wave controlled rectifier without a freewheeling diode is connected to R load of  $10\ \Omega$ . The converter is supplied from 230 V, 50 Hz ac supply (i) determine average and rms load voltage (ii) if inductive load is added to the resistive load such that  $R = 10\ \Omega$  and  $L = 6\text{ mH}$ , calculate new values of average and rms load voltages? Assume  $\alpha = 30^\circ$ . [7M]
4. a) Describe the operation of three phase full converter with RL load? Draw the waveforms by choosing firing angle such that output voltage has negative part. [7M]
- b) A three phase semi converter is connected to a RL load with  $R=10\ \Omega$ . If the firing angle of SCR is  $\alpha = 60^\circ$  and it feeds 4 kW power to a resistive load determine the amplitude of maximum per phase input voltage. [7M]
5. a) Explain the operation of buck-boost converter in the CCM mode and obtain the expression for amplitude of ripple current. [7M]
- b) A buck converter has the input voltage of 220 V and it operates at 1 kHz, when the average load current is 50 A, the load resistance is  $3\ \Omega$ . Determine the value of inductance to limit the maximum peak to peak ripple current through inductor to 10% and find the value of inductance for maximum ripple current? [7M]

6. a) How do you use PWM to inverters? Explain operation of single full bridge inverter with quasi-square wave pulse width modulation. [7M]  
b) Explain the working of auto sequential commutated current source inverter? [7M]
7. a) Explain four modes of operation of TRIAC and also state in which quadrant for which polarities of terminals it is more sensitive. [7M]  
b) A single phase ac voltage controller is connected with a load of  $R = 10 \Omega$  with input voltage of 230 V, 50 Hz supply. If the firing angle of SCR is  $90^\circ$  calculate, rms value of output voltage, power delivered to load, average value of thyristor current and input power factor? [7M]

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**Code No: 115AF****JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD****B. Tech III Year I Semester Examinations, November/December - 2017****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) 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]

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**III B. Tech I Semester Regular Examinations, October/November - 2018****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. Answer **ALL** the question in **Part-A**3. Answer any **FOUR** Questions from **Part-B**

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PART -A

1. a) Draw the turn – OFF characteristics of SCR. [2M]
- b) Explain the effect of source inductance in fully controlled bridge rectifier with continuous conduction. [2M]
- c) Draw the circuit diagram of a 3-phase full wave uncontrolled rectifier. [2M]
- d) Explain duty cycle in step up chopper operation [3M]
- e) What is the principle of operation of Inverter? [3M]
- f) Compare turn off mechanism of TRIAC and Thyristor [2M]

PART -B

2. a) What is power MOSFET? What are the types of power MOSFET? Write the difference between general purpose MOSFET and power MOSFET? [7M]
- b) Describe the basic behavior of thyristor using a two- transistor model. [7M]
3. What is phase angle controlled technique? Explain the operation of single – phase angle controlled rectifier. Derive the expression for average dc output voltage. Draw the relevant waveforms. [14M]
4. A three –phase full converter is connected to a load resistance of $5\ \Omega$ and it is supplied from a 220 V, 50 Hz ac supply, If the firing angle of thyristor is $\alpha = 30^\circ$, Draw the relevant waveforms and determine i) average output voltage, ii) average output current, iii) rms output voltage and iv) rms output current. [14M]
5. a) Explain the operating principle of dc chopper with a suitable diagram. Draw the voltage and current waveforms of chopper. Derive expressions for average output voltage and rms output voltage. [10M]
- b) Discuss the principle of operation of Buck-Boost converter. [4M]
6. a) Describe the V-I characteristics of TRIAC and modes of operation. [7M]
- b) A single –phase half –wave ac voltage controller is connected with a load of $R = 5\ \Omega$ with an input voltage of 230 V, 50 Hz. If the firing angle of thyristor is 45° , determine i) RMS output voltage, ii) Power delivered to load [7M]
7. a) What are pulse width modulated inverters? What are the different PWM techniques used in inverter? [7M]
- b) With the help of a neat circuit diagram and waveforms, explain the operation of 3-phase bridge inverter with R load. [7M]

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III B. Tech I Semester Regular Examinations, October/November - 2018

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. Answer **ALL** the question in **Part-A**3. Answer any **FOUR** Questions from **Part-B**

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**PART -A**

1. a) Explain the turn – ON and turn – OFF time of SCR. [2M]
- b) Draw the 1-phase fully controlled rectifier circuit with freewheeling diode. [2M]
- c) In the case of a 3-phase , half controlled rectifier feeding a purely resistive load, if two values of the firing angle  $\alpha$  are measured from the point of natural commutation are 20 and 40 degrees , then obtain the extinction angles measured from the origin. [2M]
- d) Draw the static V-I characteristics of TRIAC. [3M]
- e) List the advantages and disadvantages of Boost converter. [3M]
- f) Compare VSI and CSI. [2M]

**PART -B**

2. a) Draw the V-I characteristics of a power MOSFET and explain different operating regions. [7M]
- b) Draw the V-I characteristics of SCR and explain it briefly? [7M]
3. a) A single phase 220 V, 1 kW heater is connected to a half- wave controlled rectifier and fed from a 220 V, 50 Hz ac supply, Determine the power absorbed by the heater when the firing angle is i)  $\alpha = 30^\circ$  and ii)  $\alpha = 90^\circ$ . [10M]
- b) Write the advantage of freewheeling diode in single-phase half –wave controlled rectifier with  $RL$  load. [4M]
4. Draw the circuit diagram of three – phase, half –wave controlled rectifier with  $R$  load and explain its operating principle with voltage and current waveforms. Determine the following parameters for  $R$  load with firing angle  $\alpha = 60^\circ$  : [14M]
  - i) dc output voltage ii) Average dc load current iii) rms output voltage iv) rms load current.
5. a) Explain the different control strategies in DC-DC circuits? [7M]
- b) Discuss the Principle of operation of forward and fly back converters in CCM. [7M]
6. a) Describe working of 3-Phase AC-AC regulators with  $R$  load only and draw the relevant waveforms. [7M]
- b) A single phase full –wave ac voltage controller is connected with a load of  $R = 10 \Omega$ , with an input voltage of 230 V, 50 Hz. When the firing angle of thyristors is  $45^\circ$ , determine i) power output at load, ii) average value of thyristor current and iii) rms value of thyristor current. [7M]
7. a) What is pulse width modulation? List the various PWM techniques. How do these differ from each other? [7M]
- b) A single-phase PWM inverter is fed from a 220 V dc supply and it is connected to a  $RL$  load with  $R=10$  ohms and  $L=10$  mH. Determine the total harmonic distortion in the load current .Assume width of each pulse is  $\pi/2$  and the output frequency is 50 Hz. [7M]

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## III B. Tech I Semester Regular Examinations, October/November - 2018

**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. Answer **ALL** the question in **Part-A**3. Answer any **FOUR** Questions from **Part-B****PART -A**

1. a) Compare Power MOSFET and IGBT. [2M]
- b) What would be the input power factor in a 1-phase rectifier if extinction angle control is used for improving power factor with angle  $\beta$  is  $50^\circ$  [2M]
- c) A 3-phase controlled rectifier feeds a purely resistive load. The data are  $V_s = 220V$  (rms) and  $R_{ld} = 15$  ohms. If the firing angle  $\alpha$  is  $45^\circ$  then what would be the duration of conduction of thyristor. [2M]
- d) Discuss the time ratio control in a dc chopper [3M]
- e) Draw the waveforms for 1-phase fully controlled ac regulator with inductive load. [3M]
- f) Why a PWM inverter is superior to a square wave Inverter? [2M]

**PART -B**

2. a) Draw the switching characteristics of power MOSFETs. Define turn- ON delay time, rise time, turn – ON time, turn- OFF delay time, fall time and turn- OFF time. [7M]
- b) What are the different turning – ON methods of a thyristor? Explain each method. [7M]
3. a) Draw the circuit diagram of a single – phase full wave controlled rectifier using centre tap transformer with R load and find dc output voltage. [7M]
- b) A single phase fully controlled bridge converter with RL load is supplied from 220 V, 50 Hz ac supply. If the firing angle is  $45^\circ$ , determine i) average output voltage, ii) output current iii) input power factor. [7M]
4. a) Draw the circuit diagram of a three phase bridge converter with RL load. Discuss its working principle. Draw the voltage and current waveforms. Determine the following parameters: [14M]
  - i) dc output voltage
  - ii) average dc load current
  - iii) rms output voltage
  - iv) rms load current .
5. With the help of a neat circuit diagram and associated waveforms, discuss the operation of Buck-Boost converter. [14M]
6. a) Draw the single – phase bidirectional ac voltage controller with R load and explain its working principle with waveforms. [7M]
- b) Draw the waveforms for 3-phase a.c voltage regulator for R load for firing angle  $60^\circ$  [7M]
7. Explain the working of TRIAC as voltage controller with R load and draw the relevant waveforms. [14M]

**III B. Tech I Semester Regular Examinations, October/November - 2018****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. Answer **ALL** the question in **Part-A**3. Answer any **FOUR** Questions from **Part-B****PART -A**

1. a) What is Sunbber circuit? [2M]
- b) In a 1-phase bridge type of controlled rectifier supplying RL load, under what conditions discontinuous conduction occurs. [2M]
- c) Draw a 3-phase half wave controlled converter circuit diagram and output voltage wave form for R load. [2M]
- d) List the advantages and disadvantages of Buck-Boost converter [3M]
- e) How shoot through fault will be prevented in VSI. [3M]
- f) What is meant by integrated cycle control [2M]

**PART -B**

2. a) What is IGBT? What are the advantages of IGBT over power BJT and power MOSFET? [7M]
- b) Draw the V-I characteristics of a thyristor and explain different operating regions. What is the effect of Gate current on the V-I characteristics of a thyristor? [7M]
3. a) What is the effect of source inductance in single –phase full – wave controlled bridge rectifier with *RL* load? (b) Draw the voltage and current waveforms [10 M]
- b) Explain how a free – wheeling diode improves power factor in a converter. [4M]
4. Draw the circuit diagram of 3 – phase half –wave controlled rectifier with *RL* load and explain its operating principle with voltage and current waveforms. Determine the following parameters for *RL* load with firing angle  $\alpha = 30^\circ$  : [14M]
  - i) dc output voltage ii) Average dc load current iii) rms output voltage
  - iv) rms load current v) Ripple factor
5. With help of neat circuit diagram and associated waveforms discuss the operation of a Buck converter in continuous conduction mode and discontinuous conduction mode. [14M]
6. Derive the expression for rms output voltage of bidirectional 1-phase ac voltage controller with *RL* load. And draw the relevant waveforms. [14M]
7. Explain the working of a 1-phase full bridge Inverter with *RL* load. Draw the relevant output waveforms. [14M]

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