Code No: RT31025 **R13** SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, October/November-2017

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**

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PART –A

1 a) How the SCR is protected from high di/dt and dv/dt values? [4M]
b) How the line commutation is happens in a half wave controlled rectifier? [3M]
c) Why is power factor of semi converter better than full converter? [3M]
d) What are the functions of inductor in circulating current type dual converter? [4M]
e) Write the principle of operation of cyclo-converter. [4M]
f) What are the differences between uni-polar and bi-polar switched inverter? [4M]

PART -B

2 a) Draw the switching characteristics of SCR and explain. [8M]
b) Draw output and transfer characteristics of MOSFET and explain the terms (i) pinch off voltage (ii) threshold voltage and (iii) trans-conductance. [8M]

3 a) Explain the working principle of single phase ac voltage controller? What is the effect of load inductance on the performance of ac voltage controller? [8M]
b) A single phase half wave controlled rectifier with $R = 10\ \Omega$ is supplied from 230 V, 50 Hz supply. Assume rms voltage is 50% of maximum possible rms voltage, determine (i) firing angle (ii) average dc output voltage (iii) average and rms current of SCR. [8M]

4 a) Draw the input voltage, output voltage, load current and supply current wave forms of single phase fully controlled rectifier having RLE load, when (i) extinction angle, $\beta > \pi$ and (ii) extinction angle, $\beta < \pi$ [8M]
b) A single phase semi converter is operated from 230 V, 50 Hz AC supply. The load current with an average value, I_{dc} is continuous and ripple free, when firing angle, $\alpha = \pi/6$. Determine [8M]
i) Displacement factor
ii) Harmonic factor for input current
iii) Input power factor

5 a) Describe the operation of three phase full converter showing rectification and inversion mode of operation? [8M]
b) A three phase dual converter is supplied from 400 V, 50 Hz AC supply and it is connected to a load of R = 20 Ω, the value of limiting reactor is L = 0.08 H. if the firing angle of converter – 2, $\alpha_2 = 40^0$. determine (i) firing angle of converter – 1 (ii) average value of load voltage (iii) peak value of circulating current (iv) peak currents of both converters. [8M]
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Code No: RT31025 **R13** SET - 1

6 a) Explain the operation of buck-boost converter and derive the expression for average output voltage? [8M]

b) A buck converter has an input voltage of 15 V and the required output voltage is 6 V at R = 200 Ω and the peak to peak output ripple voltage is 20 mV. If it is operating at 20 kHz and peak to peak ripple current of inductor is 0.8 A, determine (i) duty cycle ratio (ii) filter inductance and capacitance (iii) critical values of L and C. [8M]

7 a) Explain working of 3 phase bridge inverter feeding a resistive star connected load with 180^0 mode of conduction? Draw relevant waveforms for output voltages. [8M]

b) Explain sinusoidal PWM technique used in inverter circuits. What is the significance of modulation indices to control output voltage? [8M]

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Code No: RT31025 **R13** SET - 2

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2. Answering the question in **Part-A**is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1 a) What are the factors that influence the turn-off time of a SCR? [3M]
b) How the line commutation happens in ac voltage controller? [3M]
c) In which phase controlled rectifier a freewheeling diode is not required? [4M]
d) What are the disadvantages of circulating current type dual converter? [4M]
e) What is meant by current-limit control strategy in dc-dc converter? [4M]
f) How the PWM strategy is applied to a uni-polar inverter? [4M]

PART -B

2 a) Explain various operating regions in the V-I characteristics of SCR? Describe the effect of gate current on the V-I characteristics. [8M]
b) What are various SCR triggering method? Explain the UJT triggering circuit for SCR. [8M]

3 a) Explain the working principle of single phase ac voltage controller when connected load is (i) pure resistive (ii) pure inductive load [8M]
b) A single phase half wave controlled rectifier with $R = 10\ \Omega$ is supplied from 230 V, 50 Hz supply. If the average load current is 10 A, determine (i) firing angle (ii) average dc output voltage (iii) rms voltage and current of SCR [8M]

4 a) Discuss the effect of source impedance on the performance of a single phase full converter indicating clearly the conduction of various thyristors during one cycle [8M]
b) A single phase semi converter is operated from 210 V, 50 Hz AC supply and operates on continuous current mode at firing angle, $\alpha = 45^0$. Determine [8M]
i) Displacement factor
ii) Harmonic factor for input current
iii) Input power factor

5 a) Derive the expression for the peak value of circulating current and describe disadvantage of circulating mode dual converter? [8M]

b) A three phase semi converter is connected to a load with $R = 10\ \Omega$. If the firing angle of thyristor is 75^0 and it is fed input power of 4 kW. Determine the maximum amplitude per phase input voltage by deducing the necessary expression for V_{rms}. [8M]
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Code No: RT31025 **R13** SET - 2

6 a) With neat sketch and output voltage waveforms explain the principle of operation of bridge type step-up cyclo converter RL load. [8M]

b) A buck-boost converter has an input voltage of 15 V, the duty cycle is 0.3 and it operates at 20 kHz when $L = 300\ \mu H$, $C = 250\ \mu F$ and average load current is 1.5 A. Determine (i) average output voltage (ii) peak to peak output voltage ripple and (iii) peak to peak ripple current through the inductor and (iv) critical value of L and C. [8M]

7 a) Explain the single phase inverter for uni-polar and bi-polar modes of operation. [8M]

b) What are the techniques used for control of harmonics in output voltage of three phase inverter? Explain. [8M]

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Code No: RT31025 **R13** SET - 3

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Time: 3 hours Max. Marks: 70

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1 a) Define turn-on time and turn-off time of an SCR. [4M]
b) Write the advantages of freewheeling diode in single phase half wave controlled rectifier when connected load is RL. [4M]
c) Why the inversion mode of operation is not possible in semi-converter? [3M]
d) What is meant by line commutated inverter? [3M]
e) What is meant by time ratio control strategy in dc-dc converter? [4M]
f) What are the advantages of PWM inverters? [4M]

PART -B

2 a) With the help of two transistor analogy, explain latching characteristics of SCR. [8M]
b) An SCR is operating at peak supply voltage of is 325 V and it has the following parameters [8M]

Repetitive peak current, $I_p = 100\ A$,

$\frac{dv}{dt}|_{max} = 500\ V/\mu s$,

$$\frac{di}{dt}|_{max} = 60\ A/\mu s$$

Design a snubber circuit for SCR protection, assume the factor safety is 2, and minimum value of resistance is 25 Ω

3 a) Explain the operation of single phase half-wave controlled rectifier with RLE load and derive the expression for average dc current. [8M]
b) A single phase ac voltage controller is supplied from 230 V, 60 Hz ac supply and it is connected with RL load. When $R = 6\ \Omega$, $|\omega L| = 6\ \Omega$, determine (i) the range of firing angle (ii) maximum value of rms load current (iii) maximum value of $\frac{di_o}{dt}$and (iv) maximum power and power factor [8M]

4 a) Explain the concept of overlap angle and associated voltage drop in single phase full converter. [8M]
b) A single phase bridge controlled rectifier consists of one thyristor and three diodes and it is connected with 220 V, 50 Hz ac supply. If the firing angle, $\alpha = \pi/6$,determine the average output current and power delivered to RLE load of $R = 10\ \Omega$, $L = 4\ mH$ and$E = 100\ V$ assuming current is constant [8M]
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Code No: RT31025 **R13** SET - 3

5 a) Explain three phase semi converter feeding to a RL load with freewheeling diode. Draw output voltage and current waveforms for $\alpha = 45^0$and $\alpha = 90^0$.What is the requirement of circuit for continuous conduction? [8M]

b) A three phase dual converter operates in circulating current mode when per phase rms voltage is 220 V and L = 20 mH with firing angle of converter – 1, $\alpha_1 = 40^0$ find the expression for circulating current and determine the peak value of circulating current? [8M]

6 a) With neat sketch and output voltage waveforms explain the principle of operation of bride type step-down cycloconverter RL load. [8M]

b) A buck-boost converter has an input voltage of 12 V, the duty cycle is 0.6 and it operates at 40 kHz when $L = 300\ \mu H$, $C = 220\ \mu F$ and average load current is 1.5 A, determine (i) average output voltage (ii) peak to peak output voltage ripple and (iii) peak to peak ripple current through the inductor and (iv) critical value of L and C. [8M]

7 a) Explain working of three phase bridge inverter feeding a resistive star connected load with 120^0 mode of conduction? Draw relevant waveforms for output voltages. [8M]

b) Explain the working of a single phase bridge inverter with square wave mode operation. [8M]

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Code No: RT31025 **R13** SET - 4

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2. Answering the question in **Part-A**is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1 a) What is meant by pinch off voltage and trans-conductance in MOSFET? [4M]
b) What is meant by integral cycle control? [3M]
c) What is meant by overlap angle in single phase full converter? [3M]
d) What is the limit of firing angles in circulating and non-circulating dual converter? [4M]
e) What are the limiting factors of the cyclo-converters? [4M]
f) What is condition for number of pulses generated per half cycle in sinusoidal PWM? [4M]

PART -B

2 a) What are the different methods for turning off an SCR? Explain all methods in detail? [8M]
b) Explain switching characteristic of IGBT and compare MOSFET and IGBT? [8M]

3 a) Describe possible configurations of single phase voltage controllers and compare them. [8M]
b) A single phase half wave controlled rectifier with $R = 25\ \Omega$ is supplied from 230 V, 50 Hz supply. Assume rms voltage is 75% of maximum possible rms voltage; determine (i) firing angle (ii) average dc output voltage (iii) average and rms current of thyristor? [8M]

4 a) Derive the expression for output voltage of single phase fully controlled rectifier with source inductance? [8M]
b) A 250 V, 1 kW resistive load is supplied from 230 V, 50 Hz source through single phase semi controlled rectifier, Calculate the following for 800 W output [8M]
(i) Output voltage
(ii) rms value of input current
(iii) fundamental component of input current
(iv) displacement factor

5 a) Explain single phase dual converter. Draw waveforms for output voltage at $\alpha = 60^0$and$\alpha = 150^0$. Comment on mode of operation of single phase dual converter at $60^0$and 150^0 [8M]
b) A three phase full converter is fed by 400 V, three phase 50 Hz supply the average load current is 120A and the load is highly inductive. For firing angle of 60^0find the output power, rms and peak current through the SCR's? [8M]
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Code No: RT31025 **R13** SET - 4

6 a) Draw the circuit diagram and wave forms of single phase to single phase step up cyclo-converter for output frequency four times input frequency? Briefly explain its operation? [8M]

b) A buck converter has an input voltage of 25 V and the required output voltage is 15 V at R = 400 Ω and the peak to peak output ripple voltage is 20 mV. If it is operating at 20 kHz and peak to peak ripple current of inductor is 0.8 A, determine (i) duty cycle ratio (ii) filter inductance and capacitance (iii) critical values of L and C? [8M]

7 a) Explain how uni-polar and bi-polar modes of operation are obtained in the single phase inverter. [8M]

b) Explain sinusoidal PWM technique used in inverter circuits? What is the significance of pulse number to control output voltage. [8M]

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