

(8)

B.Tech. 6th Semester Exam., 2014

POWER ELECTRONICS

Time : 3 hours

Full Marks : 70

Instructions :

- (i) The questions are of equal value.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. 1 is compulsory.

1. Choose the correct answer (any seven) :

- (a) Power electronic device with poor turn-off gain is
 - (i) symmetrical thyristor
 - (ii) conventional thyristor
 - (iii) power bipolar junction transistor
 - (iv) gate turn-off thyristor
- (b) It is preferable to use a train of pulse of high frequency for gate triggering of SCR in order to reduce
 - (i) $\frac{dv}{dt}$ problem
 - (ii) $\frac{di}{dt}$ problem
 - (iii) the size of the pulse transformer
 - (iv) the complexity of the firing circuit

- (iii) the r.m.s. and peak current of each thyristor;
- (iv) the conduction time of thyristors and diodes if only fundamental component is considered.

9. (a) Sketch static $I-V$ characteristics of a thyristor. Label the various voltages, currents and the operating modes on this sketch.

- (b) SCR 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 no. of series and parallel units required in case derating factors are (i) 0.1 and (ii) 0.2.

* * *

(c) In a fully-controlled converter, the load voltage is controlled by which of the following quantity?

- (i) Extension angle
- (ii) Firing angle
- (iii) Conduction angle
- (iv) None of the above

(d) In a single-phase full-wave controlled bridge rectifier, minimum output voltage and maximum output voltage are obtained at which conduction angle?

- (i) 0° , 180° respectively
- (ii) 180° , 0° respectively
- (iii) 0° , 0° respectively
- (iv) 180° , 180° respectively

(e) In the continuous conduction mode, the output voltage waveform does not depend on

- (i) firing angle
- (ii) conduction angle
- (iii) supply
- (iv) load

(f) A step-down chopper is operated in the continuous conduction mode in steady state with a constant duty ration D . If V_o is the magnitude of the d.c. output voltage and V_s is the magnitude of the d.c. input voltage, the ratio V_o / V_s is given by

- (i) D
- (ii) $1 - D$
- (iii) $\frac{1}{1 - D}$
- (iv) $\frac{D}{1 - D}$

(g) In a single-pulse modulation PWM inverter, third harmonics can be eliminated if the pulse-width is made equal to

- (i) 30°
- (ii) 150°
- (iii) 60°
- (iv) 120°

(h) In case of voltage-source inverter, free-wheeling can be needed for the load of

- (i) inductive nature
- (ii) capacitive nature
- (iii) resistive nature
- (iv) back e.m.f. nature

(i) PWM switching is preferred in voltage-source inverters for the purpose of

- (i) controlling output voltage
- (ii) output harmonics
- (iii) reducing filter size
- (iv) controlling output voltage, output harmonic and reducing filter size

- (j) Compared to a single-phase half-bridge inverter, the output power of a single-phase full-bridge inverter is higher by a factor of
- (i) 12
 - (ii) 8
 - (iii) 4
 - (iv) 2

2. (a) Circuit of given Fig. 1, employing resonant-pulse commutation (or class-B commutation) has $C = 20\mu\text{F}$ and $L = 5\mu\text{H}$. Initial voltage across capacitor is $V_s = 230\text{ V}$, for a constant load current of 300 A , calculate—

- (i) conduction time for the auxiliary thyristor;
- (ii) voltage across the main thyristor when it gets commutated;
- (iii) the circuit turn-off time for the main thyristor.

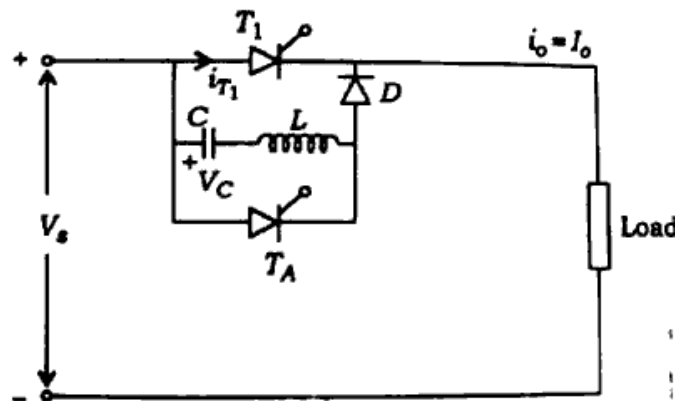


Fig. 1

(b) What is complementary impulse commutation?

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3. A d.c. battery is charged through a resistor R as shown in Fig. 2. Derive an expression for the average value of charging current in terms of V_m, E, R , etc.

On the assumption that SCR is fired continuously—

- (a) for an a.c. source voltage of 230 V , 50 Hz , find the value of average charging current for $R = 8\ \Omega$ and $E = 150\text{ V}$;
- (b) find the power supplied to battery and that dissipated in the resistor;
- (c) calculate the supply p.f.

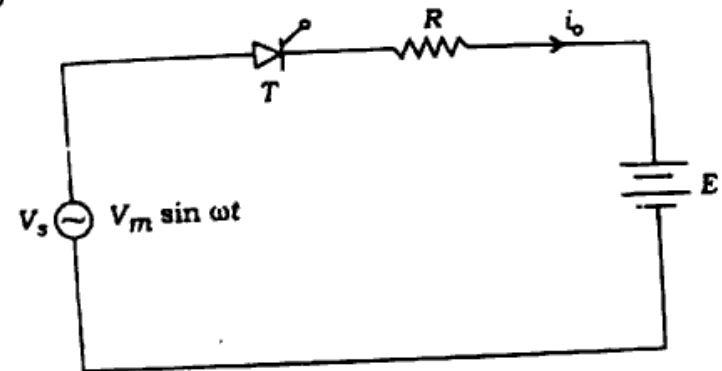


Fig. 2

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4. A single-phase full-converter bridge is connected to RLE load. The source voltage is 230 V , 50 Hz . The average load current of 10 A is constant over the working range for $R = 0.4\ \Omega$ and $L = 2\text{ mH}$.

(a) Compute the firing angle delay for $E = 120\text{ V}$.

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(b) Compute the firing angle delay for $E = -120$ V.

Indicate which source is delivering power to load in parts (a) and (b). Sketch the time variations of output voltage and load current for both the parts.

(c) In case output current is assumed constant, find the input p.f. for both the parts (a) and (b).

5. (a) For type-A chopper of Fig. 3, DC source voltage = 230 V, load resistance = 10 Ω . Take a voltage drop of 2 V across chopper when it is on, for a duty cycle of 0.4, calculate—

- (i) the average and r.m.s. values of output voltage;
- (ii) the chopper efficiency.

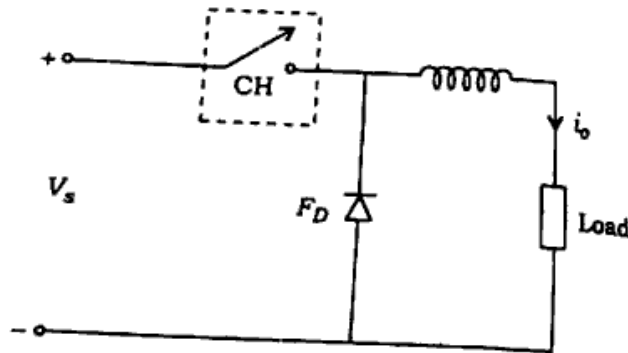


Fig. 3

(b) What is meant by step-up chopper? Explain its operation.

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6. A step-down chopper, fed from 220 V d.c. is connected to RL load with $R = 10 \Omega$ and $L = 150$ mH, chopper frequency is 1250 Hz and duty cycle is 0.5. Calculate—

- (a) the minimum and maximum value of load current;
- (b) the maximum value of ripple current;
- (c) the average and r.m.s. values of load current;
- (d) the r.m.s. value of chopper current.

7. With the help of equivalent circuit, obtain the nature of waveform of phase voltage of a star-connected resistive load fed from a three-phase DC to AC bridge-inverter operating in 180° conduction mode.

8. (a) Describe the working of single-phase full-bridge inverter.

(b) A single-phase full-bridge inverter has R-L-C load of $R = 4 \Omega$, $L = 35$ mH and $C = 155 \mu\text{F}$. The DC input voltage is 230 V and the output frequency is 50 Hz. Find an expression for load current up to fifth harmonic.

Also calculate—

- (i) the r.m.s. value of fundamental load current;
- (ii) the power absorbed by load and the fundamental power;

6. (a) Describe the principle of d.c. chopper operation.
 (b) Derive an expression for its average d.c. output voltage. $6+8=14$
7. (a) Describe integral cycle control type a.c. voltage controller.
 (b) Enumerate the merits and demerits of a.c. voltage controller. $8+6=14$
8. (a) Draw the basic integrated structure and the V-I characteristics of a TRIAC and briefly explain its principle of working.
 (b) Briefly explain the working of an oscillator employing a UJT. Derive the expressions for the frequency of triggering firing angle delay in terms of η , and the charging resistance values. $6+8=14$
9. Write short notes on any two of the following : $7 \times 2 = 14$
- (a) Uninterrupted power supply
 (b) Regenerative braking control
 (c) Speed control of three-phase induction motor
 (d) HVDC transmission

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B.Tech 6th Semester Exam., 2015

POWER ELECTRONICS

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Instructions :

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 (iii) Attempt **FIVE** questions in all.
 (iv) Question No. 1 is compulsory.

1. Choose the correct option (any seven) : $2 \times 7 = 14$

(a) When an SCR is reverse biased

- (i) two junctions are reverse biased and one junction is forward biased
 (ii) all the three junctions are reverse biased
 (iii) one junction is reverse biased and two junctions are forward biased
 (iv) Any of the above depending on the magnitude of reverse bias

- (b) An R-C snubber circuit is used to protect a thyristor against
- (i) false triggering
 - (ii) failure to turn on
 - (iii) switching transients
 - (iv) failure to commutate
- (c) A single-phase semiconverter is feeding a highly inductive load and has free-wheeling diode across the load. The waveshapes of output voltage and output current
- (i) are similar
 - (ii) are not similar
 - (iii) may be similar or dissimilar
 - (iv) are similar only if firing angle is zero
- (d) A single-phase half-wave rectifier is feeding a resistive load. Input voltage $v = V_m \sin \omega t$. The output d.c. voltage is $V_{d.c}$ and output r.m.s. voltage is $V_{r.m.s.}$. If firing angle is 180° , $V_{d.c}$ and $V_{r.m.s.}$ respectively are
- (i) 0 and 0
 - (ii) $\frac{V_m}{\pi}$ and $\frac{V_m}{\sqrt{2}}$
 - (iii) 0 and $-V_m$
 - (iv) $-\frac{V_m}{\pi}$ and $-\frac{V_m}{2}$

- (e) In a step-down chopper using pulse-width modulation $T_{on} = 3 \times 10^{-3}$ s and $T_{off} = 1 \times 10^{-3}$ s. The chopping frequency is
- (i) 333.33
 - (ii) 250
 - (iii) 500
 - (iv) 1000
- (f) In a three-phase full-wave regulator feeding a star-connected resistance load the input voltage is 400 V line to line. The firing angle is 160° . The line to line output voltage would be
- (i) 400 V
 - (ii) about 100 V
 - (iii) about 20 V
 - (iv) zero
- (g) Assertion (A) :
An inverter does not require forced commutation.
- Reason (R) :
A series inverter is a forced commutation inverter.
- (i) Both A and R are correct and R is correct explanation of A
 - (ii) Both A and R are correct but R is not correct explanation of A
 - (iii) A is correct but R is wrong
 - (iv) A is wrong but R is correct

(h) A three-phase bridge inverter is fed by 400 V battery. The load is star-connected and has a resistance of 10Ω per phase. The peak value of load current is

- (i) 8 A
- (ii) 20 A
- (iii) 10 A
- (iv) 5 A

(i) The waveshape of output voltage of half-bridge inverter is

- (i) sinusoidal
- (ii) square
- (iii) triangular
- (iv) Either (i) or (ii)

(j) In dielectric heating, the thyristor circuits consist of

- (i) rectifier-chopper combination
- (ii) controlled rectifier
- (iii) a.c. regulator
- (iv) rectifier-inverter combination

2. (a) Discuss some of the advantages and disadvantages of power electronic converters.

(b) Define latching and holding currents as applicable to an SCR. Show these on the V-I characteristics. 6+8=14

3. (a) Why are dv/dt and di/dt protections in case of thyristor important?

(b) An SCR operating from a peak supply voltage of 400 V has the following specifications :

Repetitive peak current

$$I_p = 200 \text{ A}$$

$$(di/dt)_{\max} = 50 \text{ A/us}$$

$$(dv/dt)_{\max} = 200 \text{ V/us}$$

Choosing a factor of safety of 2 for I_p , $(di/dt)_{\max}$ and $(dv/dt)_{\max}$, design a suitable snubber circuit. The minimum value of load resistance is 10 ohms.

$$8+6=14$$

4. (a) Explain the principle of phase control with suitable diagram and waveform.

(b) Discuss in detail three-phase full converter with R-L-E load with suitable diagram and waveform. 7+7=14

5. (a) What is inverter? List a few industrial applications of inverter.

(b) Discuss in detail three-phase 120 degree mode voltage source inverter. 7+7=14

B.Tech 6th Semester Exam., 2016

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Instructions :

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 (ii) There are **NINE** questions in this paper.
 (iii) Attempt **FIVE** questions in all.
 (iv) Question No. 1 is compulsory.

1. Choose the correct option (any seven) : $2 \times 7 = 14$

(a) A single-phase one pulse diode rectifier is feeding an RL load with freewheeling diode across the load. For conduction angle β , the main diode and freewheeling diode would, respectively, conduct for

(i) $\pi, \pi - \beta$ ~~(ii) $\pi, \beta - \pi$~~ (iii) β, π (iv) $\beta - \pi, \pi$

(b) When a thyristor is forward biased, the number of blocked $p-n$ junctions is

~~(i) 1~~

(ii) 2

(iii) 3

(iv) 4

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(c) During forward blocking state, a thyristor is associated with

~~(i) large current, low voltage~~~~(ii) low current, large voltage~~

(iii) medium current, large voltage

(iv) low current, medium voltage

(d) When a UJT is used for triggering an SCR, the wave shape of the voltage obtained from UJT circuit is a

(i) sine wave

~~(ii) sawtooth wave~~

(iii) trapezoidal wave

(iv) square wave

(e) In a commutation circuit employed to turn off an SCR, satisfactory turn-off is obtained when

(i) circuit turn-off time < device turn-off time

~~(ii) circuit turn-off time > device turn-off time~~

(iii) circuit time constant > device turn-off time

(iv) circuit time constant < device turn-off time

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(f) A step-up chopper has V_s as the source voltage and α as the duty cycle. The output voltage for this chopper is given by

(i) $V_s(1+\alpha)$

~~(ii) $V_s/(1-\alpha)$~~

(iii) $V_s(1-\alpha)$

(iv) $V_s/(1+\alpha)$

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(g) In an inverter with fundamental output frequency of 50 Hz, if third harmonic is eliminated, then the frequencies of other components in the output voltage wave, in Hz, would be

(i) 250, 350, 450, high frequencies

(ii) 50, 250, 350, 450

~~(iii) 50, 250, 350, 550~~

(iv) 50, 100, 200, 250

(h) A cycloconverter is a frequency converter from

1. higher to lower frequency with one-stage conversion

2. higher to lower frequency with two-stage conversion

3. lower to higher frequency with one-stage conversion

4. AC at one frequency to DC and then DC to AC at different frequencies

From these, the correct statement(s) is/are

(i) 2, 4

(ii) 1 only

(iii) 2, 3

(iv) 1, 3

(i) If, for a single-phase half-bridge inverter, the amplitude of output voltage is V_s and the output power is P , then their corresponding values for a single-phase full-bridge inverter are

(i) V_s, P

(ii) $2V_s, P$

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(iii) $2V_s, 2P$

~~(iv) $2V_s, 4P$~~

(j) In DC choppers, the waveforms for input and output voltages are respectively

(i) discontinuous, continuous

~~(ii) both continuous~~

(iii) both discontinuous

(iv) continuous, discontinuous

2. (a) Briefly discuss the $V-I$ characteristic of SCR. 6

(b) Explain the turn-on and turn-off characteristics of SCR with neat waveforms. 8

3. (a) Explain the operation of three-phase half-wave controlled converter for a firing angle less than 30° and feeding R load. Also derive the expression for its average output voltage. 8

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- (b) The specification sheet for an SCR gives maximum rms on-state current as 35 A. If this SCR is used in a resistive circuit, compute average on-state current rating for half sine wave current for conduction angle of 180° . 6
4. (a) Explain the effect of source inductance in the operation of single-phase fully controlled converter. 8
- (b) With neat circuit diagram and waveform, explain the working principle of single-phase AC voltage controller with R - L load. 6

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5. (a) Explain the principle of operation of three-phase inverter with 180° conduction mode with necessary waveforms and circuit. 8

- (b) A step-up chopper has input voltage of 220 V and output voltage of 660 V. If the conducting time of thyristor-chopper is $100\ \mu\text{s}$, compute the pulse width of output voltage. In case output-voltage pulse width is halved for constant frequency operation, find the average value of new output voltage. 6

6. (a) Explain the two-transistor analogy of a thyristor. 7

- (b) Discuss the various mechanisms that can be used to trigger thyristors. 7

7. (a) Discuss the operation of step-up chopper and prove that its output voltage is greater than input voltage. 8

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- (b) Snubber circuit for an SCR should primarily consist of capacitor only. But, in actual practice, a resistor is used in series with capacitor. Discuss. 6
8. (a) With neat circuit diagram and waveform, explain the operating principle of $1\text{-}\phi$ to $1\text{-}\phi$ step down mid-point type cycloconverter, with continuous load current. Assume the loads to be R and L in series. 8

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(b) A single-phase half-wave AC voltage controller feeds a load of $R = 20 \Omega$ with an input voltage of 230 V, 50 Hz. Firing angle of thyristor is 45° . Determine—

(i) rms value of output voltage;

(ii) average input current. 6

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9. Briefly discuss the different types of PWM schemes available for voltage control in an inverter. 14

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