GATE 2018

POWER ELECTRONICS

ELECTRICAL ENGINEERING

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CHAPTER - 1
DEVICES

1.1. INTRODUCTION

Power electronics is an established technology that bridges the power industry with its need for fast controllers, and the semiconductor industry with its attempt to produce devices with greater power handling capabilities. In essence, what power electronics does is to condition the power from a supply to suit the needs of the load. The main element of power electronics is the semiconductor switch.

1.2 DC SUPPLIES TO A LOAD

Table 1.1 indicates that there are at least three possibilities (types 1, 2 and 3) to obtain an adjustable dc voltage by power electronics. In practice there are many complex circuits. The reader needs only view the different dc power supplies on the market to confirm this. However, the principles are not so different from those generic forms that follow.

TABLE 1.1 Power conditioning

	Type	Description
1.	ac) to) dc	Integral-cycle control
2.	ac) to) dc	Point-on-wave switching
3.	dc) to) dc	Chopper control
4.	ac) to) ac	Integral-cycle control
5.	ac) to) ac	Point-on-wave switching
6.	ac) to) ac	Cycloconverter
7.	dc) to) ac	Inverter

1.3 AVERAGE VALUES

Determination of the average value of the voltage across a dc load is important. If the instantaneous value of the voltage v(t) is periodic with a period T, then the average voltage is given by

$$V_{av} = \frac{1}{T}\int_0^T v(t)dt$$

It can be convenient to transform time t to radian θ measure, so that

$$V_{av} = \frac{1}{2\pi}\int_0^{2\pi} v(\theta)\,d\theta$$

where $\theta = \omega t$, $\omega = 2\pi f$ and $f = 1/T$.

1.4 RMS VALUES

The rms (root mean square) value of a current that varies periodically with time is the effective value that is equivalent to a constant dc current in terms of heating. That is, the periodic current and direct current produce the same average power in an element. If the instantaneous value of the current i (t) is periodic with a period T, then the rms current is given by

$$I_{rms} = \left[\frac{1}{T}\int_0^T i^2(t)dt\right]^{1/2}$$

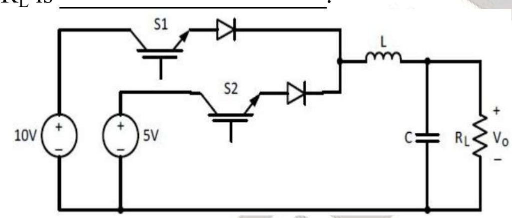
GATE QUESTIONS

1. For the power semiconductor devices IGBT, MOSFET. Diode and Thyristor, which one of the following statements is TRUE?

[GATE - 2017]

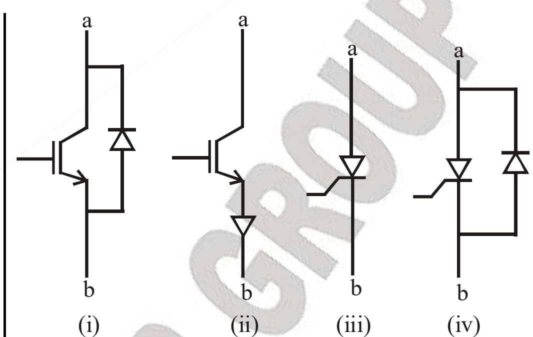
(a)All the four are majority carrier devices
(b)All the four are minority carrier devices
(c)IGBT and MOSFET are majority carrier devices, whereas Diode and Thyristor are minority carrier devices.
(d)MSOFET is majority carrier device, whereas IGBT, Diode, Thyristor are minority carrier devices.

2. The circuit shown in meant to supply a resistive load R_L from two separate DC voltage sources. The switch S1 and S2 are controlled so that only one of them is ON at any instant. S1 is turned on for 0.2 ms and S2 is turned on for 0.3ms in a 0.5ms switching cycle time period. Assume continuous conduction of the inductor current and negligible ripple on the capacitor voltage, the output voltage V_0 (in Volt) across R_L is ____________________.



[GATE - 2015]

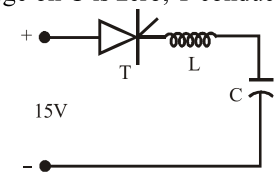
3. Figure shows four electronic switches (i), (ii), (iii) and (iv). Which of the switches can block voltages of either polarity (applied between terminals 'a' and 'b') when the active device is in OFF state?



[GATE - 2014]

(a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)
(c) (ii) and (iii) (d) (i) and (iv)

4. Thyristor T in the figure below is initially off and is triggered with a single pulse of width 10μs. It is given that $L = \left(\frac{100}{\pi}\right)\mu H$ and $C = \left(\frac{100}{\pi}\right)\mu F$. Assuming latching and holding currents of the thyristor are both zero and the initial charge on C is zero, T conducts for



[GATE - 2013]

(a) 10μs (b) 50μs
(c) 100μs (d) 200μs

5. The typical ratio of latching current to holding current in a 20A thyristor is

[GATE - 2012]

(a) 5.0 (b) 2.0
(c) 1.0 (d) 0.5

6. Circuit turn-off time of an SCR is defined as the time

[GATE - 2011]

(a)Taken by the SCR turn to be off

CHAPTER - 2
DIODE CIRCUITS AND RECTIFIERS

2.1 DIODE CIRCUITS WITH DC SOURCE

In this section, the effect of switching a dc source to a circuit consisting of diode and different circuit parameter is examined. The conclusions arrived at can then be applied to similar situations encountered later in power-electronic circuits.

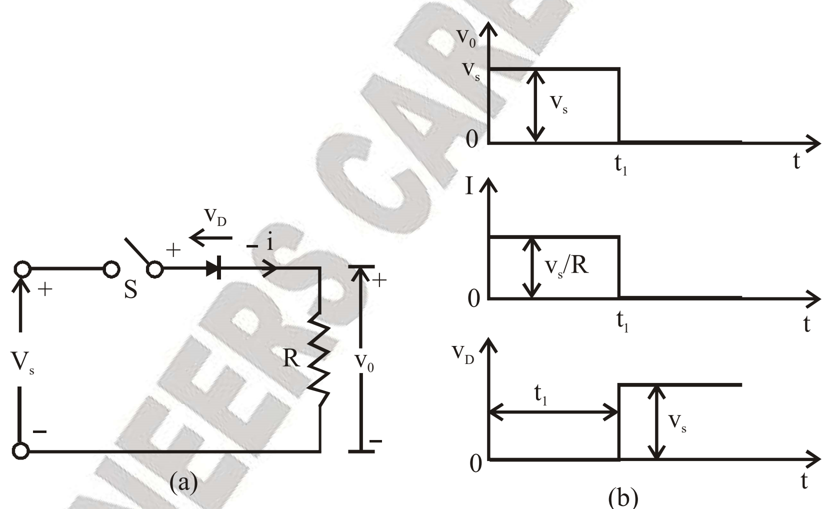
1. Resistive Load

In the circuit of figure, when switch S is closed, the current rises instantaneously to V_s/R as show in figure. Here V_s is the dc source voltage and R is the load resistance. When switch S is opened at t_1, the current at once falls to zero, figure voltage v_D across diode is zero during the time diode conducts and is equal to $+V_s$ after diode stops conducting.

2. RC Load

A circuit with dc source, diode and RC load is shown in figure. When switch S is closed at t = 0, KVL gives

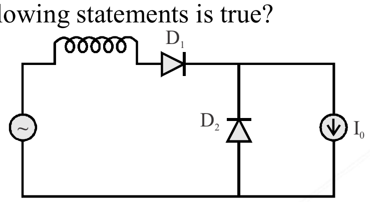
$$Ri + \frac{1}{C}\int i\,dt = V_s$$



Diode Circuit with R Load (a) Circuit Diagram and (b) Waveforms

GATE QUESTIONS

1. In the circuit shown, the diodes are ideal, the inductance is small, and $I_0 \neq 0$. Which one of the following statements is true?

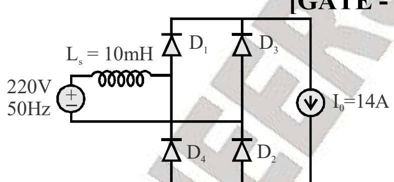


[GATE - 2017]

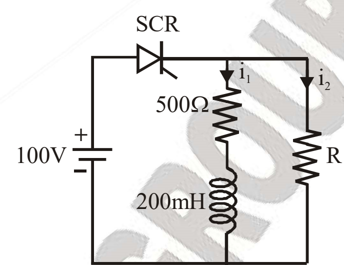
(a) D_1 conducts for greater than 180° and D_2 conducts for greater than 180°
(b) D_2 conducts for more than 180° and D_1 conducts for 180°
(c) D_1 conducts for 180° and D_2 conducts for 180°
(d) D_1 conducts for more than 180° and D_2 conducts for 180°

2. The figure below shows an uncontrolled diode bridge rectifier supplied from a 220V, 50Hz, 1-phase ac source. The load draws a constant I_0 = 14A. The conduction angle of the diode D_1 in degrees (rounded off to two decimal places) is ____.

[GATE - 2017]

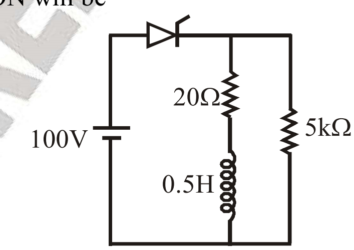


3. The SCR in the circuit shown has a latching current of 40mA. A gate pulse of 50μs is applied to the SCR. The maximum value of R in Ω to ensure successful firing of the SCR is__________.



[GATE - 2014]

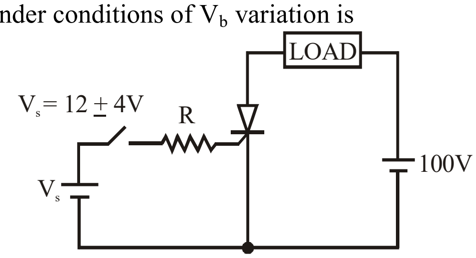
4. An SCR having a turn ON time of 5μsec, latching current of 50A and holding current of 40mA is triggered by a short duration pulse and is used in the circuit shown in figure. The minimum pulse width required to turn the SCR ON will be



[GATE - 2006]

(a) 251 μsec (b) 150 μsec
(c) 100 μsec (d) 5 μ sec

5. The triggering circuit of a thyristor is shown in figure. The thyrisotr requires a gate current of 10mA, for guaranteed turn-on. The value of R required for the thyristor to turn on reliably under conditions of V_b variation is



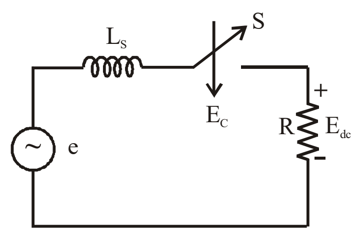
[GATE- 2004]

(a) 1000 Ω (b) 1600Ω
(c) 1200 Ω (d) 800Ω

CHAPTER - 3
PHASE CONTROLLED CONVERTERS

3.1 INTRODUCTION
Rectification is a process of converting an alternating current of voltage into a direction current or voltage. This conversion can be achieved by a variety of circuits based on an and using switching devices. The widely used switching devices are diodes, thyristors, power-transistors, power MOS, etc. The rectifier circuits can be classified broadly into three classes: uncontrolled, fully-controlled and half-controlled. An uncontrolled rectifier uses only diodes and the d.c. output voltage is fixed in amplitude by the amplitude of the a.c. supply. The fully-controlled rectifier uses thyristors as the rectifying elements and the d.c. output voltage is a function of the amplitude of the a.c. supply voltage and the point-on-wave at which the thyristors are triggered (called firing-angle α). The half-controlled rectifier contains a mixture of diodes and thyristors, allowing a more limited control over the d.c. output voltage-level than the fully-controlled rectifier. The half-controlled rectifier is cheaper than a fully-controlled rectifier of the same rating but has operational limitations.
Uncontrolled and half-controlled rectifiers will permit power to flow only from the a.c. system to the d.c. load and are, therefore, referred to as unidirectional converters. However, with a fully-controlled rectifier it is possible, by control of the point-on-wave at which switching takes place, to allow power to be transferred from the d.c. side of the rectifier back into the a.c. system. When this occurs, operation is said to be in the inverting mode. The fully controlled converter may therefore be referred to as a bidirectional converter.

3.2 PASTE ANGLE-CONTROLLED [FIRING ANGLE CONTROL]
In a.c. circuits, the SCR can be turned "on" by the gate at any angle, with respect to the applied voltage. This firing angle is measured with respect to a given reference, at which the firing pulses are applied to the thyristors gates. The reference point is the point at which the application of the gate pulses results in the maximum mean positive d.c.-terminal voltage of which the converter is capable. In other words, a firing-angle of 0° corresponds to the conditions when each thyristor in the circuit is fired at the instant its anode voltage-first becomes positive in each cycle, under this condition, therefore, the converter operates in exactly the same manner as if it was an an uncontrolled rectifier circuit. The 'α' is the symbol for the firing-angle. Hence, the most efficient method to control the turning "on" of a thyristor is achieved by varying the firing-angle of thyristor. Such a method of control is called as phase-angle control. The phase-angle control is a highly efficient means of controlling the verage-power to loads such as lamps, heaters, motors, d.c. suppliers, etc.



Half-wave controlled converter using unidirectional switch

CHAPTER - 4
THREE PHASE CONTROLLED CONVERTERS

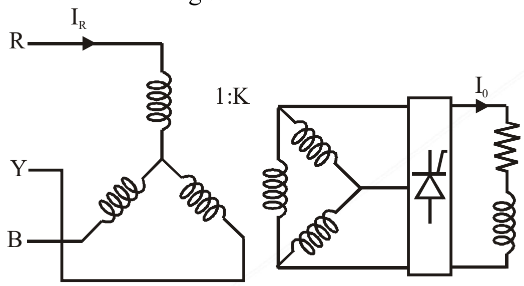
4.1 INTRODUCTION
The converter operating from a single-phase supply produces a relatively high proportion of a.c. rippile-voltage at its d.c. terminals. This ripple is generally undersirable because of its heat producing effect. Therefore, a large outlay of smoothing reactor is necessary to smoothen the output voltage as well as to reduce the possibility of discontinuous operation. The need for smoothing can be minimised by increasing the number of pulses. A three phase a.c. supply with a suitable transformer connection permits an increase in the pulse number. When the number of pulses of the converter is increased, the number of segments that fabricate the output voltage also increases and consequently the ripple content decreases. Higher the pulse number, smoother is the output voltage.
Three-phase rectifier circuits are used for large power applications. Generation of the three-phase a.c. power is now universal and in some countries, only generation frequencies may be different. Now-a days, 11kV, 33kV, 66kV three-phase a.c. supply is available to the industries. The voltage are suitably stepped down using transformers. These transformers are generally delta-connected on primary side and star-connected on the primary side and star-connected on the secondary side.
Three-phase controlled converter circuits can be studied under following categories
1. Three-pulse converters
2. Six-pulse converters
3. Twelve-pulse converters

4.1.1 Three-pulse Converters (M_3 Connection)
Three pulse converters are also known as the three-phase half wave controlled rectifier. The simplest type of phase- controlled converter operating from a three-phase supply is the three-pulse midpoint converter.

4.1.1.1 Three-Phase Half-Wave Controlled Rectifier with Resistive Load
Figure shows are power – diagram of a three-phase half-wave controlled rectifier with resistive load. This configuration is called as the mid-point configuration because all the phase emfs can have a common terminal which may be considered as the neutral point or the midpoint. As shown in figure, the primary is connected in a delta fashion and secondary in star. The load is connected to the neutral point. For the analysis of the circuit, the leakage inductance and on state SCR drops are assumed to be zero. The vector diagram of the three-phase voltage is shown in figure.

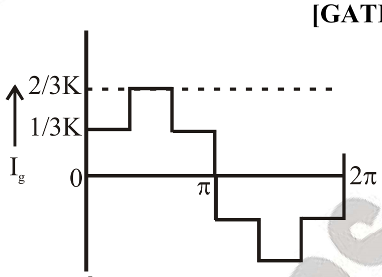
GATE QUESTIONS

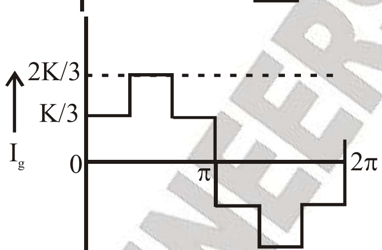
1. A three-phase fully controlled bridge converter is fed through star-delta transformer as shown in the figure.

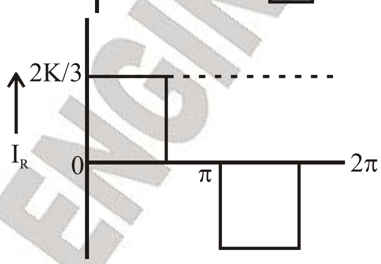


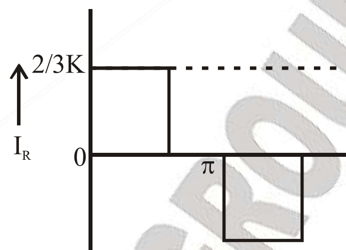
The converter is operated at firing angle of 30°. Assuming the load current (I_0) to be virtually constant at 1p.u. and transformer to be an ideal one, the input phase current waveform is

[GATE - 2014]

(a)


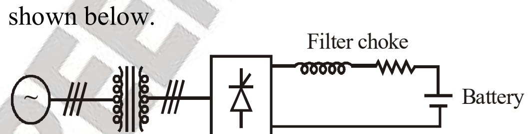
(b)


(c)


(d)


Statement linked for Q. 2 & Q.3

A solar energy installation utilize a three-phase bridge converter to feed energy into power system through a transformer of 400V/400V, as shown below.



The energy is collected in a bank of 400V battery and is connected to converter through a large filter choke of resistance 10Ω.

2. The maximum current through the battery will be

[GATE - 2011]

(a) 14A (b) 40A
(c) 80A (d) 94A

3. The kVA rating of the input transformer is

[GATE - 2011]

(a) 53.2kVA (b) 46.0kVA
(c) 22.6kVA (d) 7.5kVA

4. A three phase fully controlled bridge converter is feeding a load drawing a constant and ripple free load current of 10A at a firing angle of 30°. The approximate Total harmonic Distortion (% THD) and the rms value of fundamental component of input current will respectively be

[GATE - 2008]

(a) 31% and 6.8 A (b) 31% and 7.8 A
(c) 66% and 6.8A (d) 66% and 7.8A

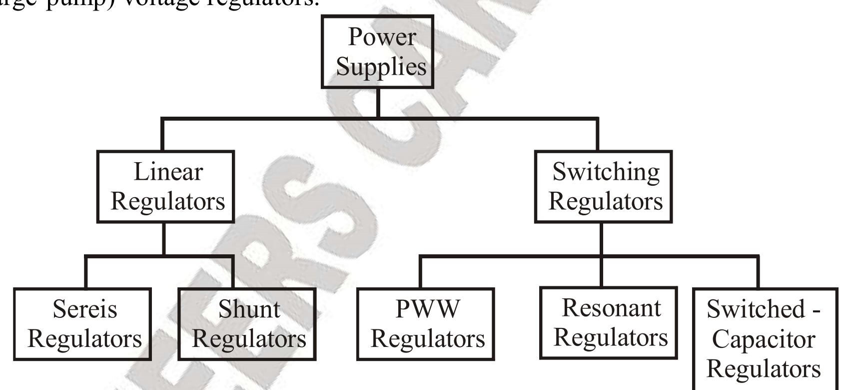
CHAPTER - 5
CHOPPER

5.1 INTRODUCTION

Many electronic system require several dc supply voltages. Power supplies are widely used in computers, telecommunications, instrumentation equipment aerospace, medical, and defense electronics. A dc supply voltage is usually derived from a battery or an ac utility line using a transformer, rectifier, and filter the resultant raw dc voltage not constant enough and contains a high ac ripple that is not appropriate for most applications. Voltage regulators are used to make the dc voltage more constant and to attenuate the ac ripple.

A power supply is constant voltage source with a maximum current capability. There are two general classes of power supplies: regulated and unregulated. The output voltage of a regulated power supply is automatically maintained within a narrow range, 1-2% of the desired nominal value, in spite of line voltage, load current, and temperature variations. Regulated dc power supplies are called dc voltage regulators. There are also dc current regulators, such as battery charges.

Shown a figure classification of regulated power supply technologies. Two of the most popular categories of voltage regulators are linear regulators and switching-mode power supplies. There are two basic linear regulator topologies: the series voltage regulator and the shunt voltage regulator. The switching-mode voltage regulators are divided into three categories: pulse-width modulated (PWM) dc-dc converters, resonant dc-dc converters, and switched-capacitor (also called charge-pump) voltage regulators.



Classification of power supply technologies

5.1.1 Basic Function of Voltage Regulator

The basic functions of a dc-dc converter are as follows:

1.To provide conversion of a dc input voltage V_1 to the desired dc output voltage within a tolerance range (e.g., $V_0 = 1.2V \pm 1\%$);

2.To regulate the output voltage V_0 against variations in the input voltage V_1, the load current I_0 (or the load resistance R_L), and the temperature;

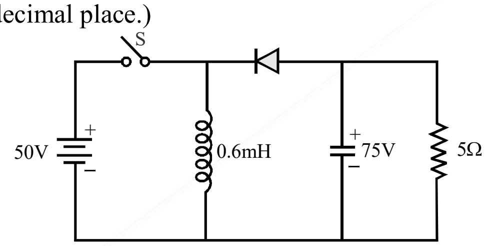
3.To reduce the output ripple voltage below the specified level;

4.To ensure fast response to rapid changes in the input voltage and load current (or load resistance);

5.To provide dc isolation;

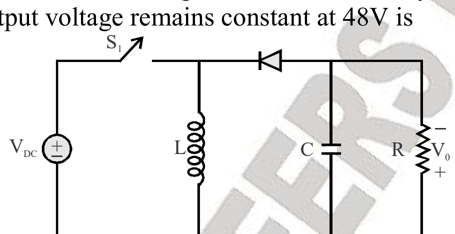
GATE QUESTIONS

1. In the circuit shown all elements are ideal and the switch S is operated at 10 kHz and 60% duty ratio. The capacitor is large enough so that the ripple across it is negligtgible and at steady state acquires a voltage as shown. The peak current in amperes drawn from the 50V DC source is _____. (Given the answer up to one decimal place.)



[GATE - 2017]

2. The input voltage V_{DC} of the buck-boost converter shown below varies from 32V to 72V. Assume that all components are ideal, inductor current is continuous, and output voltae is ripple free. The range of duty ratio D of the converter for which the magnitude of the steady-state output voltage remains constant at 48V is

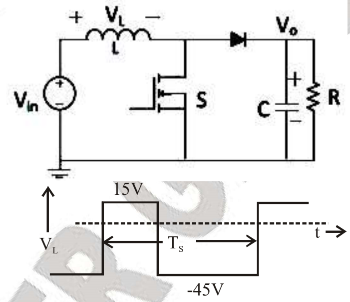


[GATE - 2017]

(a) $\frac{2}{5} \le D \le \frac{3}{5}$ (b) $\frac{2}{5} \le D \le \frac{3}{4}$

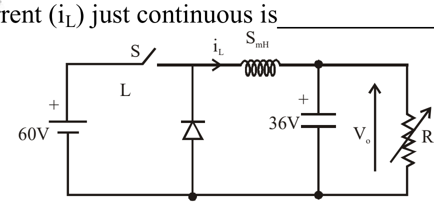
(c) $0 \le D \le 1$ (d) $\frac{1}{3} \le D \le \frac{2}{3}$

3. For the switching converter shown in the following figure, assume steady-state operation. Also assume that the components are ideal, the inductor current is always positive and continuous at switching period is T_s. If the voltage V_L is as shown, the duty cycle of the switch S is _______.



[GATE - 2015]

4. A buck converter feeding a variable resistive load is shown in the figure. The switching frequency of the switch S is 100 kHz and the duty ratio is 0.6. The output voltage V_0 is 36 V. Assume that all the components are ideal, and that the output voltage is ripple-free. The value of R (in Ohm) that will make the inductor current (i_L) just continuous is_______________.



[GATE - 2015]

5. In the following chopper, the duty ratio of switch S is 0.4. If the inductor and capacitor are sufficiently large to ensure continuous inductor current and ripple free capacitor voltage, the charging current (in Ampere) of the 5V battery, under steady-state, is_______.

[GATE - 2015]

6. A self commutating switch SW, operated at duty cycle δ is used to control the load voltage as shown in the figure

CHAPTER - 6
INVERTOR

6.1 INTRODUCTION

The D.C. to A.C. power converters are known as inverters. In other words, an inverter is a circuit which converter a D.C. power into an a.c. power at desired output voltage and frequency. The A.C. output voltage could be fixed at a fixed or variable frequency. This conversion can be achieved either by controlled turn-on and turn-off devices (e.g. BJTs, MOSFETs, IGBTs, MCTs, SITs, GTOs, and SITHs) or by forced commutated thyristors, depending on applications.

The D.C. power input to the inverter may be battery, fuel cell, solar cells or other D.C. source. But in most industrial applications, it is fed by a rectifier. This configuration of A.C. to D.C. to A.C. inverter is called a D.C. link converter because it is a two-stage static frequency converter in which A.C. power at network frequency is rectified and then filtered in the D.C. link before being inverted to A.C. at an adjustable frequency. Rectification is achieved by standard diode or thyristor converter circuits, and inversion is achieved by the circuit techniques described in this chapter.

1. Variable speed A.C. motor drives
2. Induction heating
3. Aircraft power supplies
4. Uninterruptible power supplies (UPS)
5. High voltage D.C. transmission lines
6. Battery-vehicle drives
7. Regulated voltage and frequency power supplies, etc.

6.1.1 Classification of Inverters

Inverters can be classified on the basis of a number of factors:

6.1.1.1 Classification According to the Nature of Input Source

Based on the nature of input power source, inverters are classified as

1. Voltage source inverters (VSI)
2. Current source inverters (CSI)

In case of VSI, the input to the inverter is provided by a ripple free dc voltage source and then used to supply the power to the inverter.

6.1.1.2 Classification According to the Waveshape of the Output Voltage

The inverters can be classified according to the natural of output voltage waveform as:

1. Square-wave inverter
2. Quasi-square wave inverter
3. Pulse-width modulated (PWM) inverters

A square-wave inverter produces a square-wave ac voltage of a constant magnitude. The output voltage of this type of inverter can only be varied by controlling the input dc voltage. Square-wave ac-output voltage of an inverter is adequate for low and medium power applications. However, the sine-wave output voltage is the ideal waveform for many high-power applications. Two methods can be used to make the output closer to a sinusoid.

The second method, pulse-width modulation (PWM) uses a switching scheme within the inveter to modify the shape of the output voltage waveform.

ESE OBJ QUESTIONS

1. Current source inverters are suitable for supplying power to
(a) R-L loads (b) Inductive loads
(c) All loads (d) Capacitive loads

2. The main application of multilevel inverter is in
(a) Reactive power compensation
(b) D.C. motor drive
(c) Synchronous buck-converter
(d) Voltage regulator

3. In a 3-phase inverter with 180° conduction mode the number of witches that is on at any instant of time is
(a) 1 (b) 2
(c) 3 (d) 4

4. In the sinusoidal pulse-width modulation scheme, if the zero of the triangular wave coincides with the zero of the refence sinusoidal, then the number of pulses per half cycle is
(a) $\frac{f_c}{2f}$ (b) $\frac{f_c}{2f}+1$
(c) $\frac{2f_c}{f}$ (d) $\frac{f_c}{2f}-1$

5. Modified McMurray full-bridge inverter works on
[ESE - 2015]
(a) Voltage commutation
(b) Current commutation
(c) Load commutation
(d) Complementary commutation

6. What is the region of operation of a 3-phase inverter employing sinusoidal PWM when the peak-to-peak values of both the carrier and the modulating waves are made equal?
[ESE - 2015]
(a)Linear modulation
(b)Over modulation
(c)Boundary of linear modulation and over modulation
(d)Six-step operation

7. In a single-phase full bridge inverter what is the advantage of a unipolar switching over the bipolar switching?
[ESE - 2015]
(a)Increase of the fundamental component by a factor of 115 for the same DC-input voltage
(b)Elimination of 5th and 7th harmonics
(c)Apparent doubling of the switching frequency
(d)None of the above

8. In a McMurray inverter, diodes are connected in inverse parallel to thyristors to
1. Protect the thyristor
2. Make the turn off of the thyristor successful
3. Make the turn on of the thyristor successful
4. Provide path to the reactive component of the load current
Which of the above statements are correct?
[ESE - 2015]
(a) 1 and 3 (b) 1 and 4
(c) 2 and 4 (d) 2 and 3

9. A voltage source inverter is used when source and load inductances are respectively
[ESE - 2015]
(a) Small and large (b) Large and small
(c) Large and large (d) Small and small

10. For a 1-phase full-bridge inverter fed from 48 V dc and connected to load resistance of 2.4 Ω,, the rms value of fundamental component of output voltage is
[ESE - 2015]
(a) 20V (b) 21.6V
(c) 34.4V (d) 43.2V

CHAPTER - 7
DRIVES

7.1 INTRODUCTION
An electric motor together with its control equipment and energy transmitting device forms an electric drive. And an electric drive together with its working machine constitutes an electric drive system.

1. Electric Drive
A ceiling fan motor with its speed regulator but without blades.

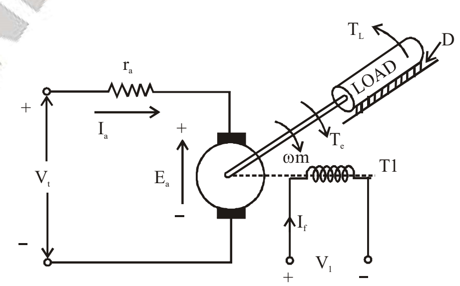
2. Electric drive system
A ceiling fan motor with regulator and also with of blades, a food mixture/mixer with food to be processed.

Electric Drives	
–1–ϕ DC drives –3–ϕ DC drives –Chopper drives	–1–ϕ induction motor drives –3–ϕ induction motor drives –Synchronous motor drives

7.1.1 D.C. Drives
DC motors are used extensively in adjustable speed drives and position control applications. Where, speed control below base speed ⇒ Armature voltage control
Speed control above base speed ⇒ filed flux control.
DC motor drives are preferred where wide-speed control range is required.
Depending upon the type of AC source or the method of voltage control, D.C. drives are classified as:-
1. 1–ϕ D.C. drive
2. 3–ϕ D.C. drive
3. Chopper drive

7.1.2 Basic Performance Equation of DC Motor

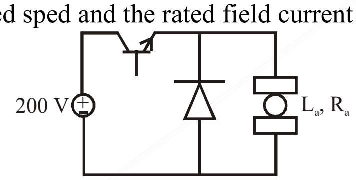
1. Separately-excited D.C. Motor
The equivalent circuit for a separately excited D.C. motor coupled with a load is shown in figure below as:



Equivalent Circuit of a Separately excited D.C. Motor

GATE QUESTIONS

1. The separately excited dc motor in the figure below has a rated armature current of 20A and a rated armature voltage of 150V. An ideal chopper switching at 5 kHz is used to control the armature voltage. If L_a = 0.1mH, R_a = 1Ω, neglecting armature reaction, the duty ratio of the chopper to obtain 50% of the rated torque at the rated sped and the rated field current is



[GATE - 2013]

(a) 0.4 (b) 0.5
(c) 0.6 (d) 0.7

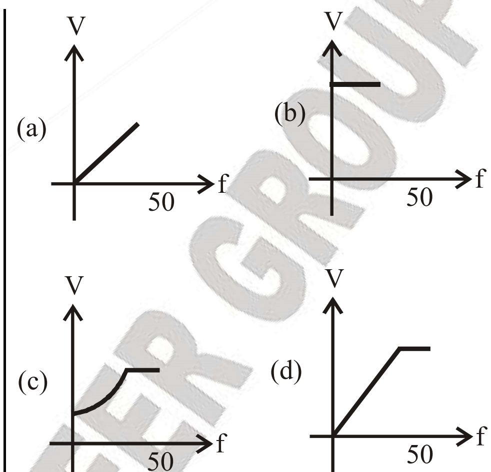
2. A three-phase, 440V, 50 Hz ac mains feed thyristor bridge is feeding a 440V dc, 15kW, 1500 rpm separately excited dc motor with a ripple free continuous current in the dc link under all operating conditions, Neglecting the losses, the power factor of the ac mains at half the rated speed is

[GATE - 2007]

(a) 0.354 (b) 0.372
(c) 0.90 (d) 0.955

3. The speed of a 3-phase, 440V and 50Hz induction motor is to be controlled over a wide range from zero speed to 1.5 times the rated speed using 3-phase voltage source inverter. It is desired to keep the flux in the machine constant in the constant torque region by controlling the terminal voltage as the frequency changes. The inverter output voltage vs frequency characteristic should be

[GATE - 2006]



4. An electric motor, developing a starting torque of 15Nm, starts with a load torque of 7Nm on its shaft. If the acceleration at start is 2 rad/sec^2, the moment of inertia of the system must be (neglecting viscous and coulomb friction)

[GATE - 2005]

(a) 0.25 kg–m^2 (b) 0.25 Nm^2
(c) 4 kg–m^2 (d) 4Nm^2

5. A single-phase half-controlled rectifier is deriving a separately excited dc motor. The dc motor has a back emf constant of 0.5V/rpm. The armature current is 5A without any ripple. The armature resistance is 2Ω. The converter is working from a 230V, single-phase ac source with a firing angle of 30°. Under this operating condition, the speed of the motor will be

[GATE - 2004]

(a) 339 rpm (b) 359 rpm
(c) 366 rpm (d) 386 rpm

6. A variable speed drive rated for 1500 rpm, 40 Nm is reversing under no load. Figure shws the reversing torque and the speed during the transient. The moment of inertia of the drive is

ESE OBJ QUESTIONS

1. It is required to control the speed and braking operation of a dc shunt motor in both the directions of rotation. The most suitable power electronic circuit will be

[ESE - 2015]

(a) A half-controlled converter
(b) A fully-controlled converter
(c) A diode-bridge converter
(d) A dual converter

2. In a single-phase to 1-phase cyclo-converter, the magnitudes of harmonic components are quite large. How can they be reduced?

[ESE - 2015]

(a) By using a chopper circuit
(b) By using a RC oscillator
(c) By using a three phase input supply
(d) By adding an alternator to the input

3. Statement (I): A switched-mode dc power supply has high efficiency and light weight.
Statement (II): A switched-mode dc power supply uses a dc to dc switching converter switched at high frequency.

[ESE - 2015]

(a)Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
(b)Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).
(c)Statement (I) is true but Statement (II) is false.
(d)Statement (I) is false but Statement (II) is true.

4. How can the 3rd harmonic current be filtered in Thyristor-controlled reactor?

[ESE - 2015]

(a) By connecting in delta
(b) By connecting in star
(c) By connecting in star-delta
(d) None of the above

5. The device used for switching in a switched Mode Power supply is

[ESE - 2014]

(a) Diode (b) Thyristor
(c) GTO (d) MOSFET

6. In a forward converter, a tertiary winding is used. What is the reason?

[ESE - 2014]

(a)To provide di/dt protection to the switching device.
(b)To provide dv/dt protection to the switching device.
(c)To provide electrical isolation between the input and output.
(d)To demagnetize the core before the application of the next switching pulse.

7. Consider the following statements:
Switched mode power supplies are preferred over the continuous types, because they are
1.Suitable for use in both ac and dc
2.More efficient
3.Suitable for low-power circuits
4.Suitable for high-power circuits Which of these statements are correct?

[ESE - 2013]

(a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 3 and 4

8. A single-phase ac regulator fed from 50 Hz supply feeds a load having 4 Ω resistance and 12.73 mH inductance. The control range of firing angle will be

[ESE - 2012]

(a) 0° to 180° (b) 45° to 180°
(c) 90° to 180° (d) 0°to 45°

9. An integral cycle a.c. voltage controller is feeding a purely resistive circuit from a single-phase a.c. voltage source. The current waveform consists alternately burst of N-complete cycle of conduction followed by M-complete of