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DIPLOMA EXAMINATION IN ENGINEERING /TECHNOLOGY/ MAMAGEMENT/ COMMERCIAL PRACTICE-OCTOBER,2018

POWER ELECTRONICS

MAX MARKS: 100 **TIME: 3 Hours**

PART-A

(Maximum marks: 10)

I. Answer all questions. Each question carries 2 marks.

1. Define holding current

   The holding current (hypostatic) for electrical, electromagnetic and electronic devices is the minimum current which must pass through a circuit in order for it to remain in the 'ON' state.

2. Write down two applications of UJT

   - The UJT is used in phase control circuit.
   - The UJT is used in timing circuit.

3. List any two speed control methods of 3phase induction motor

   - Control From Stator Side
   - Control From Rotor Side

4. Define inverter

Inverter, is an electronic device or circuitry that changes direct current (DC) to alternating current (AC).

5. Write any two comparison between smps and linear power supply

   The main difference between the linear power supply and SMPS is that linear power supply converts the high voltage of AC into low voltage AC first then the rectification procedure takes place. ... The linear power supply is immune to noise disturbance and thus used in audio and radio frequency application

(5x2=10)

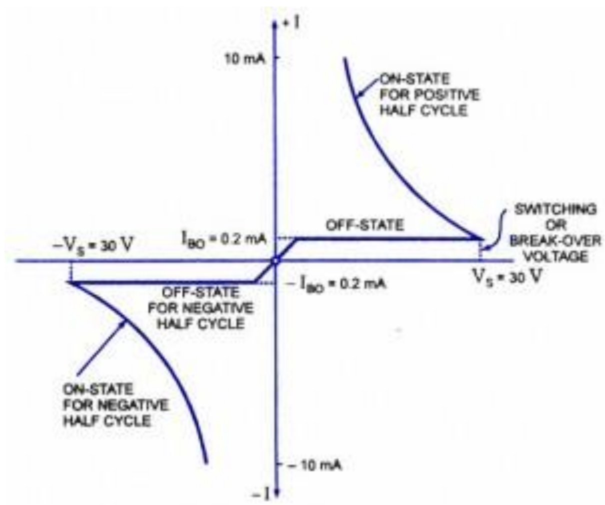
PART-B
(Maximum marks:30)

II Answer any *five* questions. Each question carries 6 marks.

1. Describe the operation of diac

Operation of a Diac.

When the terminal MT_2 is positive, the current flow path is P_1-N_2-P_2-N_3 while for positive polarity of terminal MT_1 the current flow path is P_2-N_2-P_1-N_1. The operation of the diac can be explained by imagining it as two diodes connected in series. When applied voltage in either polarity is small (less than breakover voltage) a very small amount of current, called the *leakage current*, flows through the device. Leakage current caused due to the drift of electrons and holes in the depletion region, is not sufficient to cause conduction in the device. The device remains in non-conducting mode. However, when the magnitude of the applied voltage exeeds the avalanche breakdown voltage, breakdown takes place and the diac current rises sharply, as shown in the characteristics shown in figure.



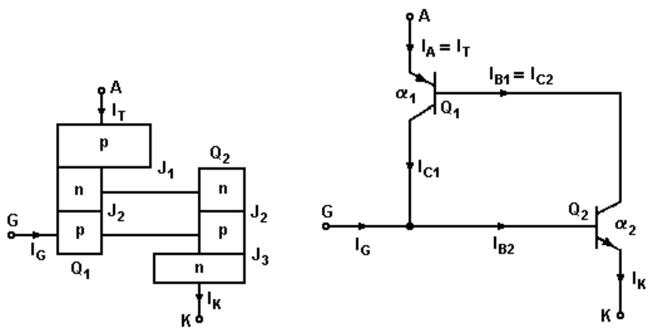
V-I Characteristic of a Diac

Characteristics of a Diac

Volt-ampere characteristic of a diac is shown in figure. It resembles the English letter Z because of the symmetrical switching characteristics for either polarity of the applied voltage.

The diac acts like an open-circuit until its switching or breakover voltage is exceeded. At that point the diac conducts until its current reduces toward zero (below the level of the holding current of the device). The diac, because of its peculiar construction, does not switch sharply into a low voltage condition at a low current level like the SCR or triac. Instead, once it goes into conduction, the diac maintains an almost continuous negative resistance characteristic, that is, voltage decreases with the increase in current. This means that, unlike the SCR and the triac, the diac cannot be expected to maintain a low (on) voltage drop until its current falls below a holding current level.

2. Discuss two transistor analogy of scr



(a) Basic structure (b) Equivalent circuit

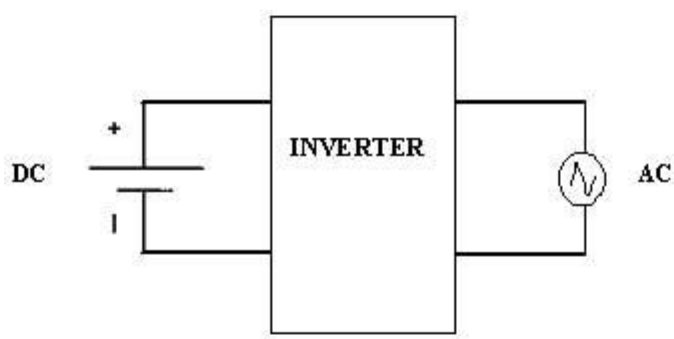
Two Transistor Model. Imagine the SCR cut along the dotted line, as shown in fig. a. Then we can have two devices, as shown in fig.b. These two devices can be recognized as two transistors. The upper left one is P-N-P transistor and the lower right N-P-N type. Further it can be recognized that the base of the P-N-P transistor is joined to the collector of the N-P-N transistor while the collector of P-N-P is joined to the base of N-P-N transistor, as illustrated in fig. c. The gate terminal is brought out from the base of the N-P-N material. This construction has been conceived merely to explain the working of SCR, otherwise in physical shape the SCR has four solid layers of P-N-P-N type only.

Now we can see that the two transistors are connected in such a manner that the collector of Q_1 is connected to the base of Q_2 *i.e.* the output collector current of Q_t becomes the base current for Q_2. In the similar way the collector of Q_2 is joined to the base of Q_1 which shows that the output collector current of Q_2 is fed to Q_1 as input base current. These are back to back connections of transistors in such a way that the output of one goes into as input of other transistor and vice-versa. This gives net gain of loop circuit as $\beta_1 \times \beta_2$ where β_1 and β_2 are current gains of two transistors respectively.

When the gate current is zero or the gate terminal is open, the only current in circulation is the leakage current, which is very small in case of silicon device specially and the total current is a little higher than sum of individual leakage currents. Under these conditions P-N-P-N device is said to be in its forward blocking or high impedance ‘off state. As soon as a small amount of gate current is given to the base of transistor Q_2 by applying forward bias to its base-emitter junction, it generates the collector current as β_2 times the base current. This collector current of Q_2 is fed as input base current to Q_1 which is further multiplied by β_1 times as I_{C1} which forms input base current of Q_2 and undergoes further amplification. In this way both transistors feedback each other and the collector current of each goes on multiplying. This process is very quick and soon both the transistors drive each other to saturation. Now the device is said to be in.on-state. The current through the on-state SCR is controlled by external impedance only.

3. Explain with circuit diagram and necessary wave forms the working of parallel inverter

   The **inverter** plays a vital role in Uninterrupted Power Supply (UPS). It is used to convert the direct current (DC) to alternating Current (AC) of required voltage.

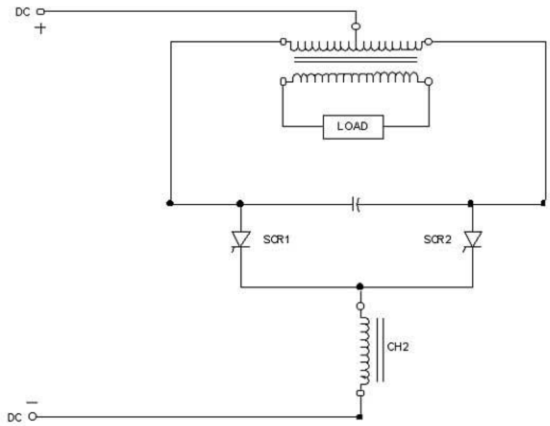


   The single phase parallel inverter circuit consists of two SCRs T1 and T2, an inductor L, an output transformer and a commutating capacitor C. The output voltage and current are Vo and Io respectively. The function of L is to make the source current constant. During the working of this inverter, capacitor C comes in parallel with the load via the transformer. So it is called a parallel inverter. The operation of this inverter can be explained in the following modes.

Mode I

In this mode, SCR T1 is conducting and a current flow in the upper half of primary winding. SCR T2 is OFF. As a result an emf Vs is induced across upper as well as lower half of the primary winding.

In other words total voltage across primary winding is 2 Vs. Now the capacitor C charges to a voltage of 2Vs with upper plate as positive.



Mode II

At time to, T2 is turned ON by applying a trigger pulse to its gate. At this time t=0, capacitor voltage 2Vs appears as a reverse bias across T1, it is therefore turned OFF. A current Io begins to flow through T2 and lower half of primary winding. Now the capacitor has charged (upper plate as negative) from +2Vs to -2Vs at time t=t1. Load voltage also changes from Vs at t=0 to –Vs at t=t1.

Mode III

When capacitor has charged to –Vs, T1 may be tuned ON at any time . When T1 is triggered, capacitor voltage 2Vs applies a reverse bias across T2, it is therefore turned OFF. After T2 is OFF, capacitor starts discharging, and charged to the opposite direction, the upper plate as positive.

4. Discuss the working of full wave RC firing circuit for SCR

It includes variable resistor, two diodes,SCR(Silicon Controlled Rectifier), Capacitor, Load resistor.

The circuit diagram of an RC Triggering is shown below (Figure 2).

Figure 2 shows an R-C-Diode circuit giving full half-cycle control (180 electrical degrees). On the positive half-cycle of SCR anode voltage the capacitor charges to the trigger point of the SCR in a time determined by the RC time constant and the rising anode voltage. The top plate of the capacitor charges to the peak of the negative voltage cycle through diode D2 on the negative half-cycle, resetting it for the next charging cycle.

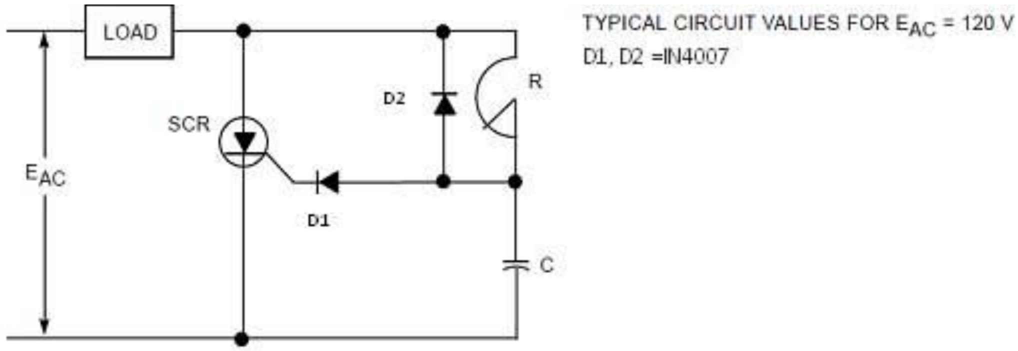


Figure 2: Simple Half-wave RC Phase Control – Circuit Schematic

Working of Capacitor

During negative half cycle capacitor charges in reverse direction when the supply voltage increases towards positive side the capacitor voltage also recharges in opposite direction. When this capacitor voltage reaches threshold voltage SCR will turn on and capacitor discharges through diode D2 and its voltage become very small positive voltage. Firing angle can be varied from 0 to 180 degree.

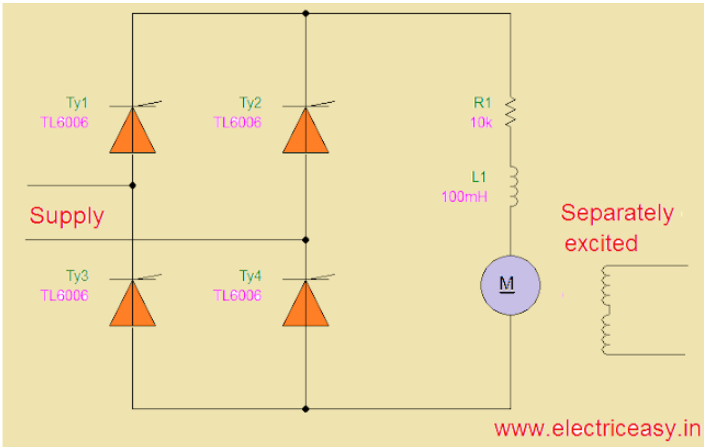
5. Explain single phase full converter DC drives

<u>SINGLE PHASE FULL CONVERTER DRIVE</u>

Single phase full converter is a two quadrant converter. The output current is not reversed due to presence of thyristors (Unidirectional in nature)

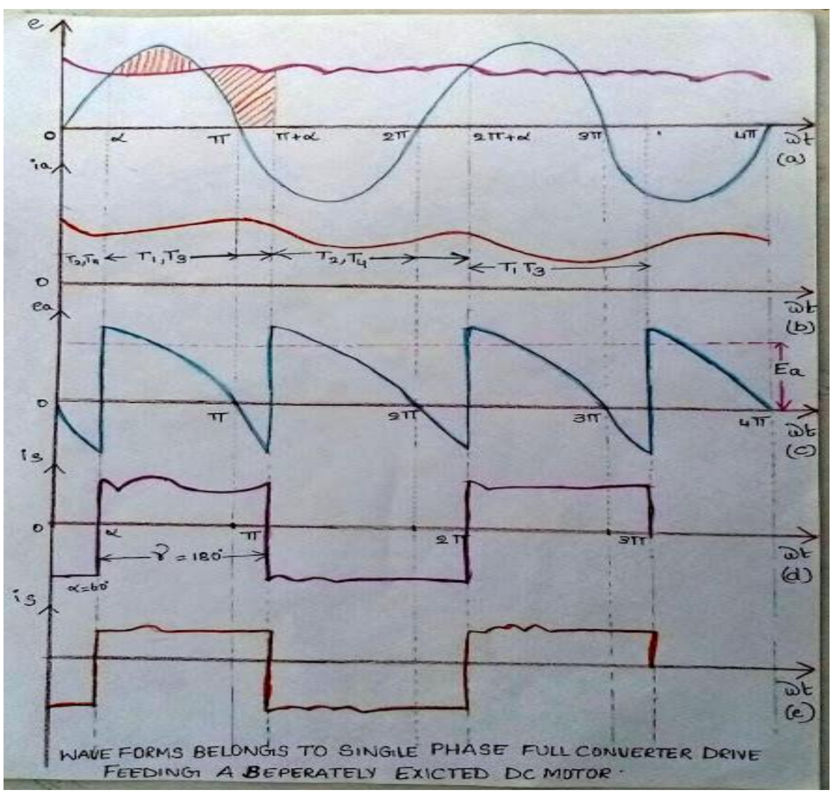
* This full converter is limited to application up to 20HP

* The basic circuit diagram of single phase full converter drive is given below:



Current mode operation:

*The circuit is activated by giving AC supply. The thyristors which are connected in bridge connection are unidirectional in nature, due to this property the output current does not take back path, only voltage may reverse.



* For positive half cycle of AC supply the current travelling direction in the circuit is given by (+)e - T1 - Ra - La - eb - T2 - e(-).

* For negative half cycle of AC supply the travelling path of current is given as (-)e - T4 - Ra - La - eb - T3 - e(+).

* In full converter T1 and T3 are Triggered at firing angle α and thyrisytor T2 and T4 are triggered at $\pi+\alpha$

* Thyristor T1 and T3 conducts during the interval $\alpha < \omega t < \pi+\alpha$

* Thyristor T2 an T4 conducts during the interval $\pi+\alpha < \omega t < \alpha$

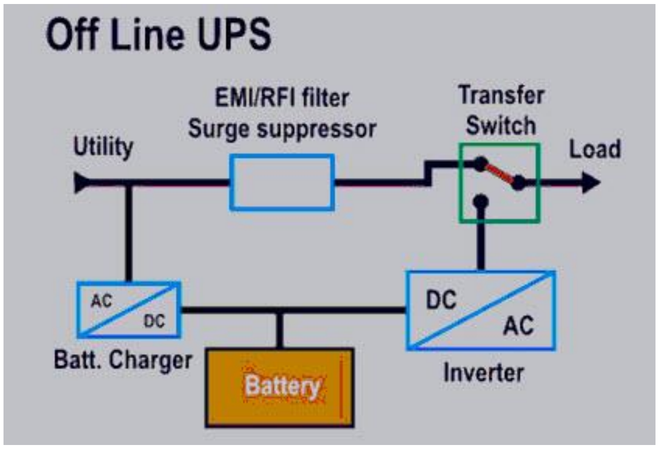
* Natural commutation is taken into account here it means after conduction of T2 and T4 the supply voltage appears across T1 and T3 has a reverse biased voltage and turns them OFF automatically. This process is named as Natural commutation.

* The voltage and current waveforms for firing angle greater than 90 degress.

6. Explain the working of OFFLINE UPS

The Standby UPS

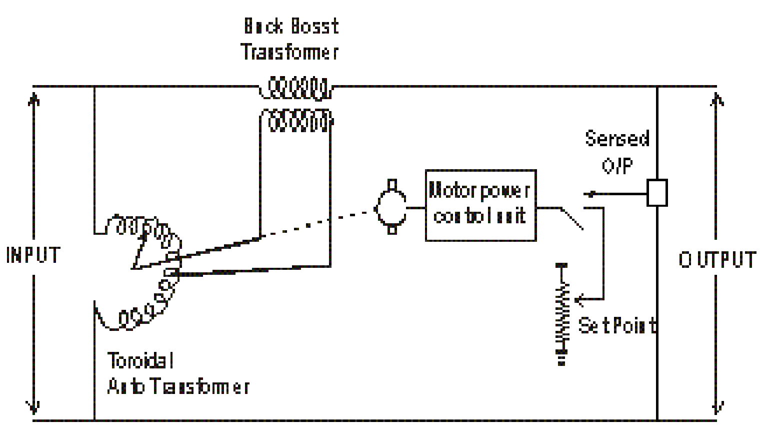
The standby Uninterruptible Power Supply is also called as off line UPS, that is generally used for PCs. The block diagram of this UPS is shown below. This UPS includes a battery, an AC or DC & DC or AC inverter, a static switch and a LPF which is used to decrease the switching frequency from the o/p voltage & a surge suppressor.The standby UPS system works with the switch arrangement to select the AC i/p as a primary power source, and interchanging to the battery & inverter as backup sources in case of primary power gets disrupted. The inverter normally relies on standby, only triggering when the power fails and the transfer switch routinely switches the load to the backup units. This kind of UPS system offers a small size, high degree of efficiency, & pretty low costs, making of this UPS is easy.



7. Draw and explain the block diagram of static servo stabilizer

Components of Servo stabilizer or Automatic Voltage regulator.
Servo motor controlled Automatic voltage stabilizer consists of following components (Please refer servo stabilizer circuit diagram shown below):

1. Buck/Boost Transformer: Buck/Boost transformer connected between mains input and out of stablizer of load terminals. One terminal of primary of buck boost transformer permanently connected to fixed tapping of autotransformer while another end connect to motor shaft.
2. Auto transformer: It has toroidal shape and auto transformer connected between neutral point and phase of input power supply.



Servo stabilizer Circuit Diagram

1. Motor: One end of Primary of Buck Boost transformer connected to shaft of this motor with arm and brush mechanism. When motor moves then this arm

shaft moves across winding of autotransformer to increase or decrease number of winding. Motor is generally AC Synchronous motor or DC servo motor which is connected and it is fitted on top of autotransformers centre point.

2. Motor Driver: It is purely electronic circuitry which controls movement of motor. It consisting of PCBs consisting of solid state circuitry made up of capacitor, register, transistor Amplifier, microprocessor and ICs.
3. Control Circuitry Power supply: Control Circuitry PCB boards needs constant DC power supply. Control circuitry Power supply make available power for PCB boards. It consists of Rectifier (to convert AC to DC) and step down transformer.

Working of Servo stabilizer or stablizer.

To understand working of servo stabilizer please not that voltage across secondary of Buck Boost transformer is nothing but output voltage of stabilizer. It work as follow:

- Voltage received from main at input of automatic voltage regulator is continuously sensed by accessories circuitry and gives feedback to Main control circuitry which consists of Microprocessor. This microprocessor continuously receives values of input voltages. Whenever there is high or low voltage at input of AVR automatic voltage regulator, the microprocessor gives trigger to motor driver.
- Based on amount of high voltage or low voltage observed at input, “motor driver” moves servo motor across winding of autotransformer so as to increase of decrease no of winding and hence voltage across primary of buck boost transformer. It is since Servo motor shaft is connected to primary of buck boost transfer. And hence when there is change in voltage across primary of buck boost transfer then induce voltage across its secondary also changes. The motor moves in such a way that proper voltage should be observe across primary of Buck Boost transformer so that voltage across secondary should be equal to set or desired output voltage of servo stabilizer. And voltage across secondary of Buck Boost transformer is output voltage of stabilizer.
- This process takes place continuously so as to correct input voltages.

- In case of 3 Phase automatic Voltage Regulator is independent phase controlled then it will have above arrangement for all three phases separately. It means it is as good as 3 number of Single phase servo stabilizer in one unit.

PART-C
(Maximum marks: 60)

III. Answer any one full question from each unit. Each question carries 15 marks.

UNIT-I

I. a) Explain different trigerring methods of SCR (8)

1. Voltage triggering:
The method of triggering in which the triggering of SCR or thyristor is caused by the applied voltage across anode and cathode terminals, is known as Voltage triggering.

When a thyristor is in forward biased and applied voltage across anode and cathode is increased, then the depletion layer of reverse biased junction decreased. At breakdown voltage, the depletion layer is totally destroyed and as a result the thyristor triggers and comes to ON state and start conducting heavily due to increase in number of charge carriers.
Because this triggering is caused by Voltage, thats why its called Voltage triggering.

2. Thermal Triggering:

The triggering method in which triggering is caused by the thermal effect i.e. by increasing the junction temperature, is called Thermal triggering.

We know that conductivity of semi-conductor materials increases with increase in temperature. Here we make use of this property. When the junction is reverse biased and the applied voltage across anode and cathode is near to breakdown voltage then we increases the temperature of the junction as a result the due to formation of electron-hole pairs, the thyristor starts conducting.

In this case we should not increase the temperature to a high value, because this may cause damage to device. So, in this method the SCR or thyristor is triggered by thermal properties, therefore it is called thermal Triggering.

3. Radiation Triggering :

The method in which the triggering of a SCR or thyristor is caused by radiation i.e. by the bombardment of energy particles , for example Neutrons, photons etc.

In this method the triggering is done with the help of Radiation or by bombardment of energy particles. The thyristor is bombarded by energy particles like neutrons or photons. Due to the radiation, the electron-hole pairs are generated in the device. These pairs causes the flow of current in the device. Thus thyristor comes to ON state and hence triggered.

4. dv/dt triggering:

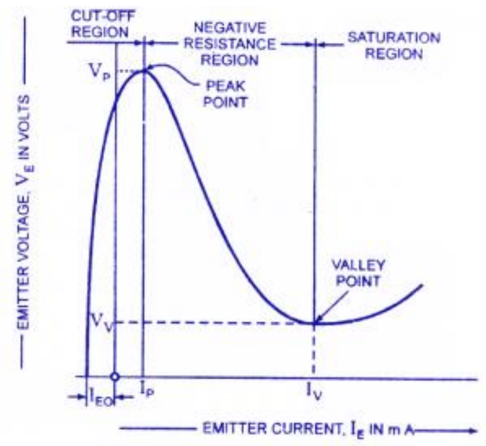
The triggering method in which we make use of high rate of increase of voltage(or dv/dt i.e. rate of change of voltage with respect to time). When a thyristor is optimised for a critical rate of rise of voltage, then if the rate of rise of voltage increases, the thyristor will be triggered and start conducting.

5. Gate Triggering:

The triggering method in which triggering of SCR or thyristor is caused by applying a signal between gate and cathode, is called Gate triggering.

b) Explain the characteristics of UJT **(7)**

UJT Characteristics



Static Emitter-Characteristic For a UJT

The static emitter characteristic (a curve showing the relation between emitter voltage $V_E$and emitter current I_E) of a **UJT** at a given inter base voltage V_{BB} is shown in figure. From figure it is noted that for emitter potentials to the left of peak point, emitter current $I_E$never exceeds I_{Eo} . The current I_{Eo} corresponds very closely to the reverse leakage current I_{Co} of the conventional BJT. This region, as shown in the figure, is called the cut-off region. Once conduction is established at $V_E = V_P$ the emitter potential V_E starts decreasing with the increase in emitter current I_E. This Corresponds exactly with the decrease in resistance R_B for increasing current I_E. This device, therefore, has a negative resistance region which is stable enough to be used with a great deal of reliability in the areas of applications listed earlier. Eventually, the valley point reaches, and any further increase in emitter current I_E places the device in the saturation region, as shown in the figure. Three other important parameters for the UJT are I_P, V_V and I_V and are defined below:

Peak-Point Emitter Current. I_P. It is the emitter current at the peak point. It represents the rnimrnum current that is required to trigger the device (UJT). It is inversely proportional to the interbase voltage V_{BB}.

Valley Point Voltage V_V The valley point voltage is the emitter voltage at the valley point. The valley voltage increases with the increase in interbase voltage V_{BB}.

Valley Point Current I_V The valley point current is the emitter current at the valley point. It increases with the increase in inter-base voltage V_{BB}.

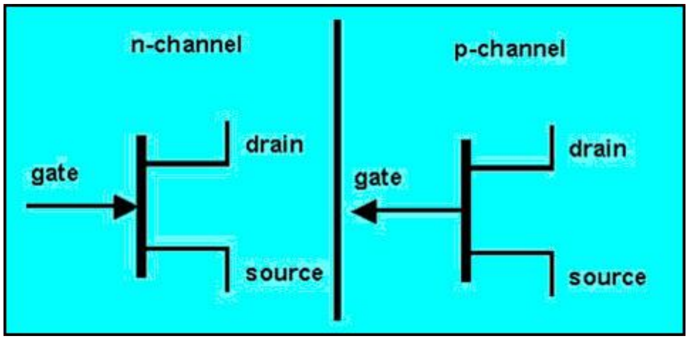
Special Features of UJT. The special features of a UJT are :

1. A stable triggering voltage (V_P)— a fixed fraction of applied inter base voltage V_{BB}.
2. A very low value of triggering current.
3. A high pulse current capability.
4. A negative resistance characteristic.
5. Low cost.

OR

IV a) Explain the working of N channel JFET **(7)**

Junction Field Effect Transistor



Junction field effect transistor is one type of FETs which is used as a switch that can be controlled electrically. Through the active channel, electric energy will flow from between the source terminal and drain terminal. If the gate terminal is supplied with reverse bias voltage, then the flow of current will be completely switched off and the channel gets strained. The junction field effect transistor is generally classified into two types based on their polarities and they are:

- N-Channel junction field effect transistor
- P-Channel junction field effect transistor

N-Channel Operation of JFET

The working of JFET can be explained by discussing about how to turn on N-channel JFET and how to turn off N-channel JFET. For turning ON a N-channel JFET, positive voltage of VDD has to be applied to the drain terminal of the transistor w.r.t (with respect to) source terminal such that the drain terminal must be appropriately more positive than the source terminal. Thus, current flow is allowed through the drain to source channel. If the voltage at the gate terminal, VGG is 0V, then there will be maximum current at the drain terminal and N-channel JFET is said to be in ON condition.

b) Discuss the VI characteristics of SCR **(8)**

Silicon Controlled Rectifier Working

The thyristor working can be understood by considering the three states modes of operation of silicon controlled rectifier. The three modes of operation of thyristor are as follows:

- Reverse blocking mode
- Forward blocking mode
- Forward conducting mode

Reverse Blocking Mode

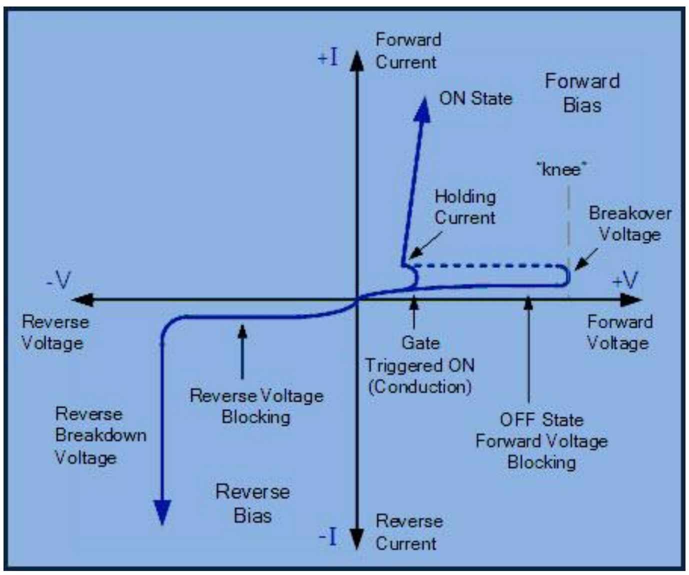
If we reverse the anode and cathode connections of the thyristors, then the lower and upper diodes are reverse biased. Thus, there is no conduction path, so no current will flow. Hence, is called as reverse blocking mode.

Forward Blocking Mode

In general, without any triggering pulse to gate terminal, silicon controlled rectifier remains switched off, indicating no current flow in the forward direction (from anode to cathode). This is because, we connected two diodes (both upper and lower diodes are forward biased) together to form a thyristor. But, the junction between these two diodes is reverse biased, which eliminates the flow of current from top to bottom. Hence, this state is termed as forward blocking mode. In this mode, even though thyristor is having condition like a conventional forward biased diode, it will not conduct as the gate terminal is not triggered.

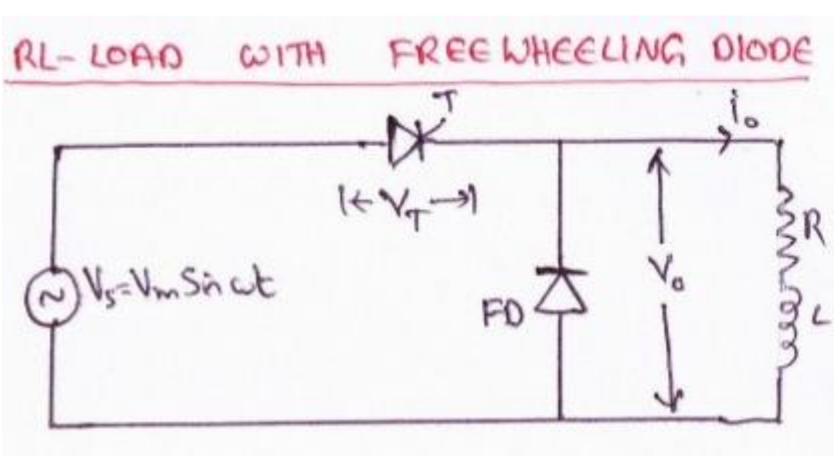
Forward Conducting Mode

In this forward conducting mode, the anode voltage must be greater than the cathode voltage and the third terminal gate must be triggered appropriately for the conduction of the thyristor. This is because, whenever the gate terminal is triggered, then the lower transistor will conduct which switches on the upper transistor and then the upper transistor switches on the lower transistor and thus the transistors activates each other. This process of internal positive feedback of both the transistors repeats until both gets fully activated and then the current will from anode to cathode. So, this mode of operation of silicon controlled rectifier is called as forward conduction mode.

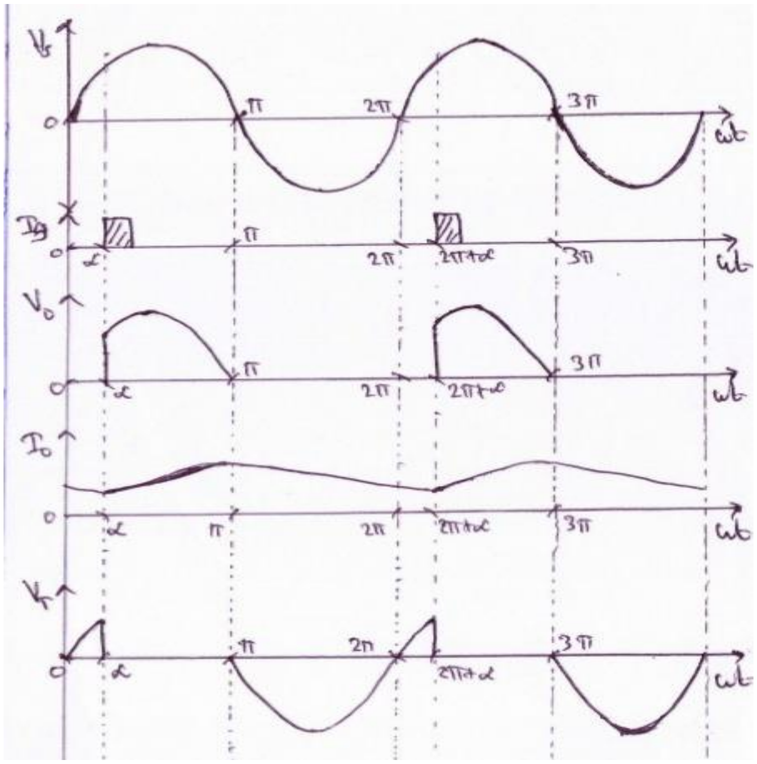


UNIT-II

V. a) Describe with the circuit diagram and necessary waveforms the working of single phase half wave converter with RL load and wheeling diode (8)



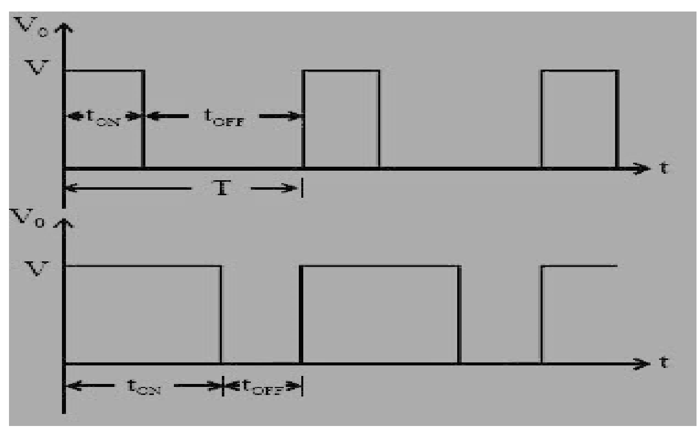
- The circuit consist of a thyristor T, a voltage source Vs, a diode FD across the RL
  load, an inductive load L and a resistive load R.
- During the positive half cycle of the input voltage, the thyristor T is forward biased
  but it does not conduct until a gate signal is applied to it.
- When a gate pulse is given to the thyristor T at $\omega t = \alpha$, it gets turned ON and begins to
  conduct.
- When the thyristor is ON, the input voltage is applied to the load but due to the
  inductor present in the load, the current through the load builds up slowly.
- During the negative half cycle, the thyristor T gets reverse biased. At this instant i.e at
- $\omega t = \pi$, the load current shift its path from the thyristor to the freewheeling diode.
- When the current is shifted from thyristor to freewheeling diode, the thyristor turns
  OFF.
- The current through the inductor slowly decays to zero through the loop R freewheeling
  diode-L.
- So here the thyristor will not conduct in the negative half cycle and turns off at $\omega t = \pi$.
- So the load receives voltage only during the positive half cycle.
- The average value of output voltage can be varied by varying the firing angle α.
- The waveform shows the plot of input voltage, gate current, output voltage, output
  current and voltage across thyristor



b) Explain the constant frequency control used in choppers (7)

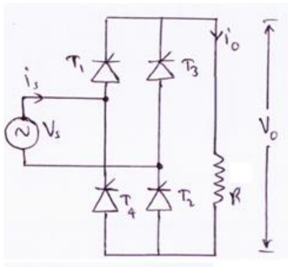
Constant Frequency Operation

- In constant frequency control strategy operation.
- The ON time TON is changed.
- Keeping the frequency, i.e, f=1/T, or time period 'T' constant.
- This operation is also named as PWM (pulse width modulation control).
- Hence, the output voltage can be varied by varying ON time.



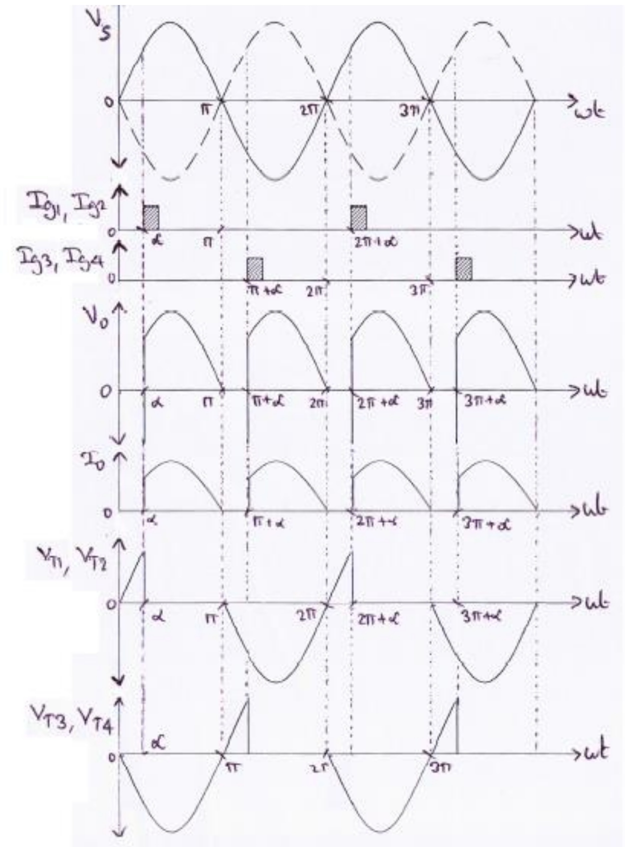
OR

VI a) Describe with the circuit diagram and necessary waveforms the working of single phase full wave converter with R load (8)



- The circuit consist of four thyristors T1, T2, T3 and T4, a voltage source Vs and a R Load.
- During the positive half cycle of the input voltage, the thyristors T1 & T2 is forward biased but it does not conduct until a gate signal is applied to it.
- When a gate pulse is given to the thyristors T1 & T2 at $\omega t = \alpha$, it gets turned ON and begins to conduct.
- When the T1 & T2 is ON, the input voltage is applied to the load through the path Vs- T1-Load-T2-Vs.
- During the negative half cycle, T3 & T4 is forward biased, the thyristor T1 & T2 gets reverse biased and turns OFF
- When a gate pulse is given to the thyristor T3 & T4 at $\omega t = \pi+\alpha$, it gets turned ON and begins to conduct.
- When T3 & T4 is ON, the input voltage is applied to the load Vs-T3-Load-T4-Vs.
- Here the load receives voltage during both the half cycles.
- The average value of output voltage can be varied by varying the firing angle α.

The waveform shows the plot of input voltage, gate current, output voltage, output current and voltage across thyristor.



b) Explain the working of full bridge inverter **(7)**

Single Phase Full Bridge Inverter

- The power circuit diagram for the single phase full bridge inverter is shown in the figure A.
- The SCR triggering circuit and commutation circuit is not shown for simplicity. There are two wire DC supply source, four freewheeling diodes and four SCRs used in this inverter.
- The SCR T1 and SCR T2 are turned on at same time whose frequency is f= 1/T.
- Similarly the SCR T3 and SCR T4 are turned on simultaneously.
- There is 180^0 phase difference between positive group of SCRs (SCR T1 and SCR T2) and negative group of SCRs (SCR T3 and SCRT4).

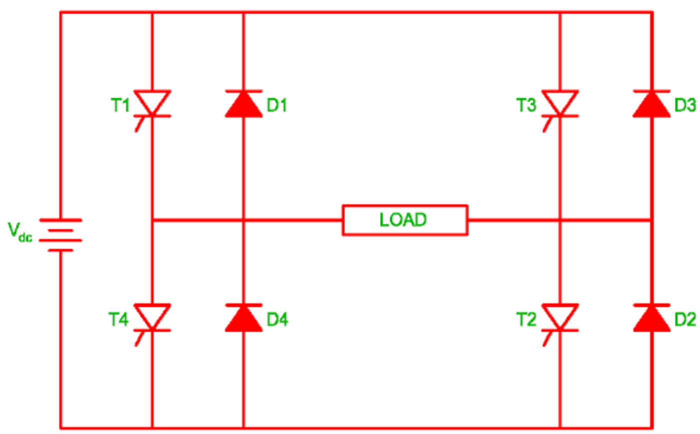


FIGURE A : SINGLE PHASE FULL BRIDGE INVERTER

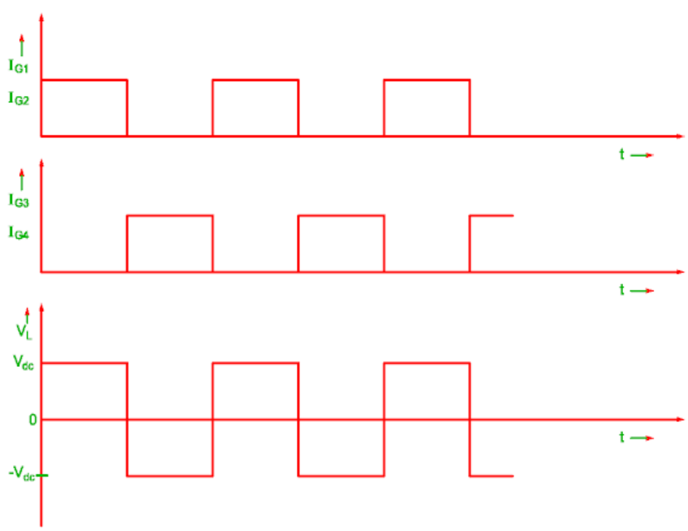


FIGURE B : GATE SINGNALS AND OUTPUT VOLTAGE WAVEFORMS

The working of single phase full bridge inverter is explain as follows

Mode 1

- The load voltage becomes to + V_{dc} when SCR T1 and SCR T2 are turned on at same time.

- Therefore the load current flows through path (+)V_{dc} – SCR T1 – load – SCR T2 – V_{dc}(-).
- The load current and load voltage becomes positive during this period therefore the power flows from supply to load.

Mode 2

- The polarity of voltage across load changes due to inductive load and as soon as the SCR T1 and SCR T2 are turned off in this mode.
- As the diode D3 and D4 conduct, the load current flows through path diode D3 – (+)V_{dc} – V_{dc}(-) – diode D4.
- The power flows from load to supply during this mode.

Mode 3

- The SCR T1 and SCRT2 are turned off whereas SCR T3 and SCR T4 are turned on during this mode.
- The voltage across load becomes – V_{dc} and current flows through path (+)V_{dc} – SCR T3 – load – SCR T4 – V_{dc}(-).
- The power flows through supply to load as the load voltage and load current both are negative during this period.

Mode 4

- The polarity of voltage across load changes as the SCR T3 and SCR T4 are turned off in this mode.
- The load current flows through path diode D1 – (+)V_{dc} – V_{dc}(-) – diode D2 – load due to conduction of freewheeling diode D1 and D2.
- The power flows from load to supply as the direction of load current reverses during this mode.

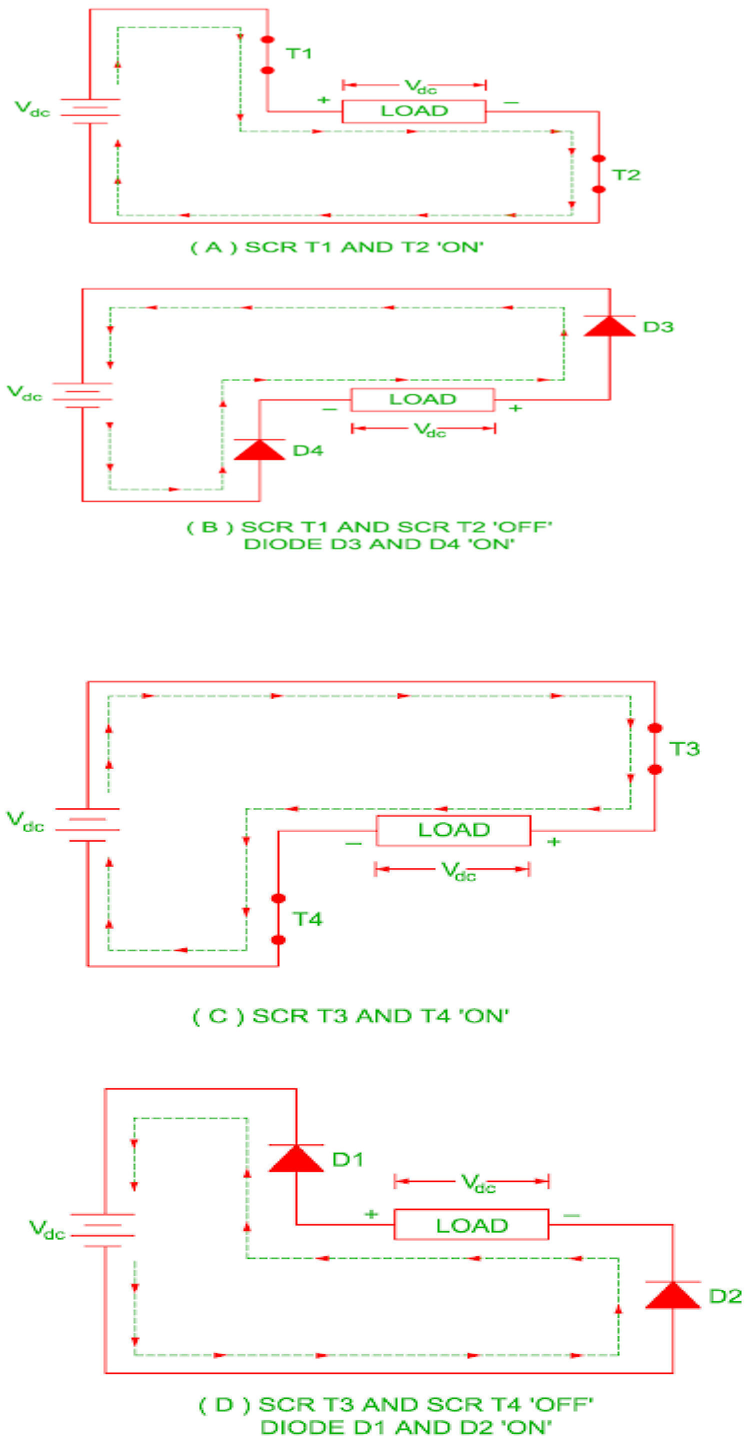


FIGURE C : OPERATION OF SINGLE PHASE FULL BRIDGE INVERTER

- The output voltage of the single phase full bridge inverter is double to that of single phase half bridge inverter.

UNIT-III

VII a) Explain the v/f control of three phase induction motor **(7)**

V / f Control

Whenever three phase supply is given to three phase induction motor rotating magnetic field is produced which rotates at synchronous speed given by In three phase induction motor emf is induced by induction similar to that of transformer which is given by $E \ or \ V = 4.44\phi K.T.f \ or \ \phi = \frac{V}{4.44KTf}$ Where, K is the winding constant, T is the number of turns per phase and f is frequency. Now if we change frequency synchronous speed changes but with decrease in frequency flux will increase and this change in value of flux causes saturation of rotor and stator cores which will further cause increase in no load current of the motor . So, its important to maintain flux , φ constant and it is only possible if we change voltage. i.e if we decrease frequency flux increases but at the same time if we decrease voltage flux will also decease causing no change in flux and hence it remains constant. So, here we are keeping the ratio of V/f as constant. Hence its name is V/ f method. For controlling the speed of three phase induction motor by V/f method we have to supply variable voltage and frequency which is easily obtained by using converter and inverter set.

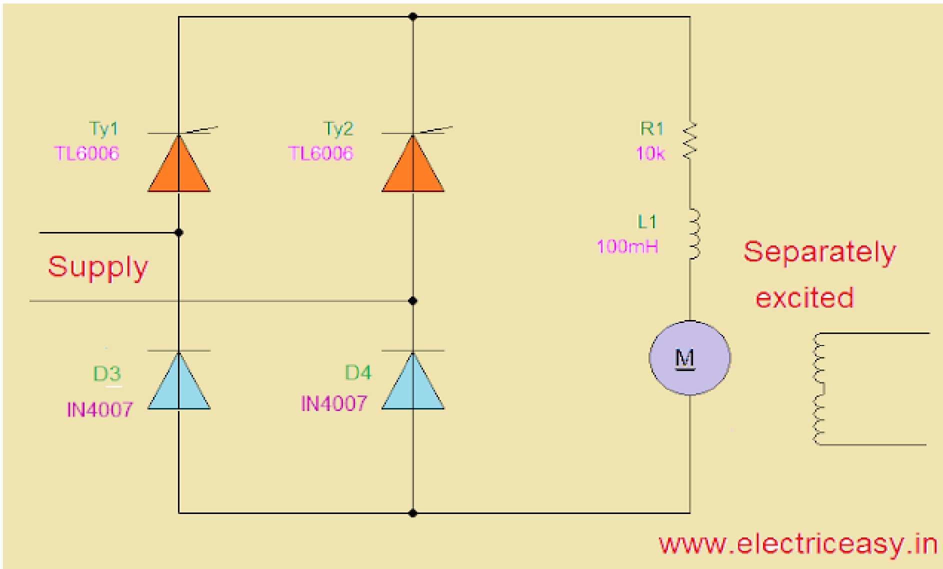
b) Explain the single phase semi converter DC drives (8)

SINGLE PHASE SEMI CONDUCTOR DRIVE

Semi convertors are one quadrant converters; they have one polarity of voltage and current at the DC terminals. The motor current can't be reversed due to thyristors in the converters.

* When AC supply is given the thyristors and diodes combined together and convert AC signal to DC signal.

* The basic circuit diagram of single phase semi conductor drive feeding a separately excited DC motor is given below:



* The power flow through the circuit is positive half cycle is

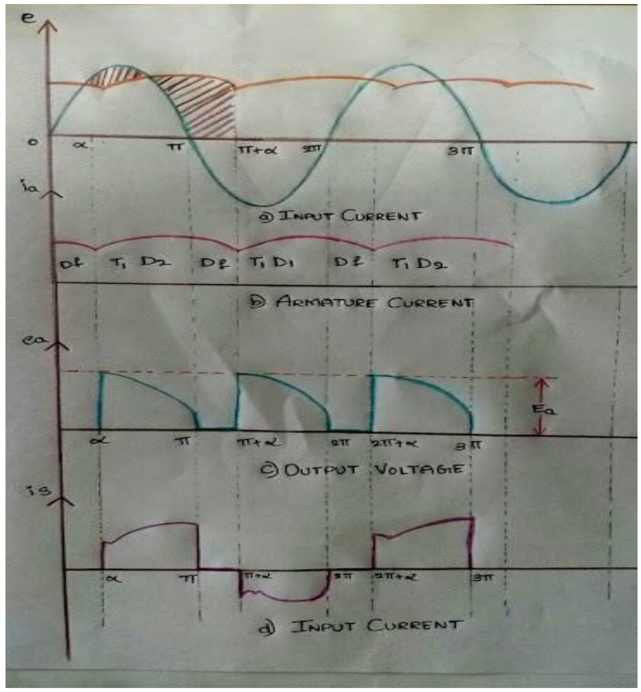
(+)e – T1 – Df – Ra – La – D2 – e(-)

* The negative half cycle power flow is given as

(-)e – T2 – Df – Ra – La – D1 – e(+)

We are supplying AC supply to the circuit which is time variant (changes with time). The armature voltage and current is depends upon the operation conditions Continuous armature current operation:

The below waveforms shows the voltage and current limits of semiconductor drive.



* From wave forms the thyristors T1 is triggered at angle α and T2 is triggered at an angle $\pi+\alpha$ with respect to voltage.
* For period $\alpha < \omega t < \pi$, the motor voltage is equal to supply voltage.
* For period $\pi < \omega t < \alpha$, the motor terminals are shorted through Df making ea Zero.
* Beyond period π, the armature emf reverses the input voltage by changing the polarity, this leads the freewheeling diode Df conducts.
* The armature current is in continuous mode due to the presence of freewheeling diode
* During π to $\pi+\alpha$ period the freewheeling diode recovers the energy from inductance (storage element) and is supplied to load in the form of kinetic energy.
* By using Df the torque developed in the motor is said to be continuous.
* The torque and speed characteristics are given below:

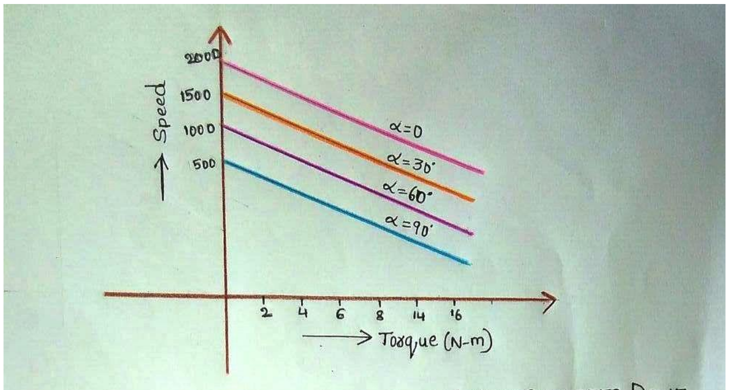


Fig: Torque Speed Characteristics of 1-Ø Semi Converter Drive

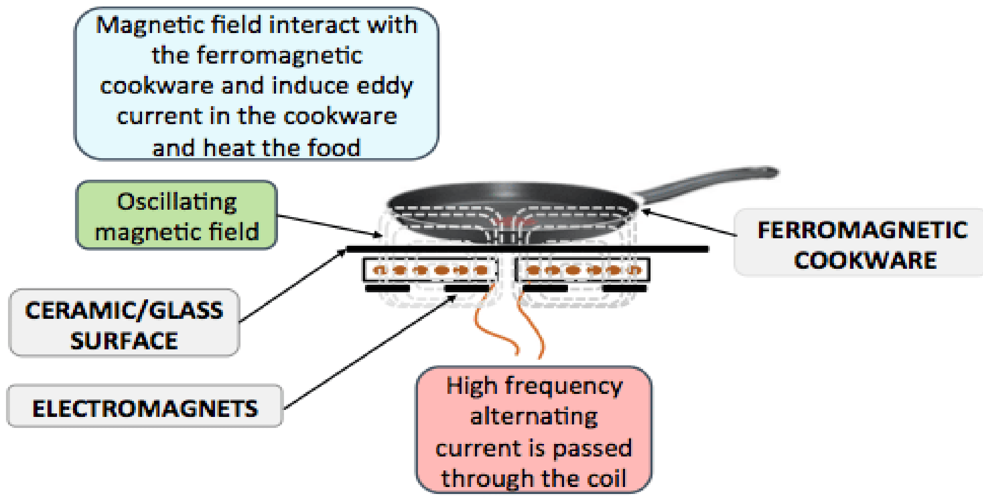
OR

VIII a) Explain the concept of induction cooking system control (8)

Induction Cooking is the process of generating heat directly in a ferromagnetic utensil/pot/cookware by means of electromagnetic induction and subsequent generation of eddy currents. Electromagnetic induction principle was discovered long back in 1831 by Michael Faraday. Electromagnetic induction refers to a phenomenon by which electric current is generated in a closed circuit by the fluctuation of current in another circuit placed next to it.

The ferromagnetic cookware is to be placed/positioned on top of an induction cooktop. Below ceramic or glass surface lies a resonant coil as shown in Figure 1. The induction cooktop and cookware can be considered as a transformer in which cookware act as shorted secondary (load). An alternating is made to flow through the resonant coil, which leads to generation of oscillating magnetic field. The magnetic field induces an electric currents inside the cookware.

The induction cooktop only works with cookware made of certain materials that have specific properties. In order to be heated by the magnetic field, the cookware has to be made of a ferromagnetic material, such as stainless steel or iron.



b) Explain the stator frequency control of three phase induction motor **(7)**

frequency control –

Stator frequency control

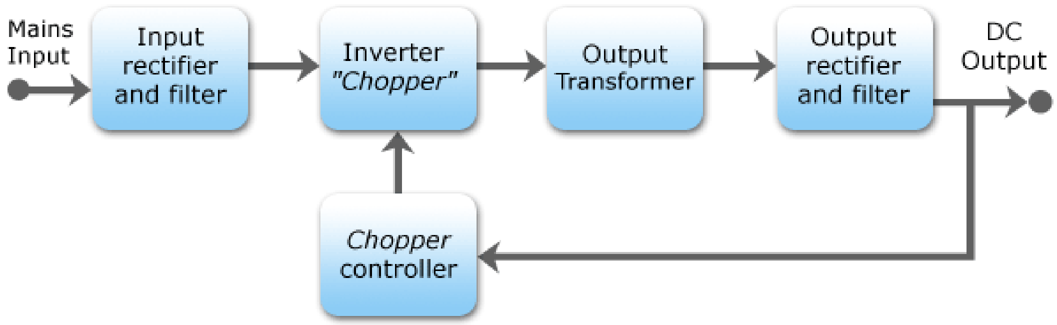
The expression for the synchronous speed indicates that by changing the stator frequency also it can be changed. This can be achieved by using power electronic circuits called inverters which convert dc to ac of desired frequency. Depending on the type of control scheme of the inverter, the ac generated may be variable-frequency-fixed-amplitude or variable-frequency-variable-amplitude type. Power electronic control achieves smooth variation of voltage and frequency of the ac output. This when fed to the machine is capable of running at a controlled speed. However, consider the equation for the induced emf in the induction machine. frequency. Where, N is the number of the turns per phase, φφmm is the peak flux in the air gap and f is the

$$V = 4.44 N \phi_m f$$

In order to reduce the speed, frequency has to be reduced. If the frequency is reduced while the voltage is kept constant, thereby requiring the amplitude of induced emf to remain the same, flux has to increase. This is not advisable since the machine likely to enter deep saturation. If this is to be avoided, then flux level must be maintained constant which implies that voltage must be reduced along with frequency. The ratio is held constant in order to maintain the flux level for maximum torque capability.

UNIT IV

IX a) with the help of block diagram describe the working of SMPS **(8)**



- Convert AC to DC voltage with rectifier
- Which is unregulated DC voltage sent it to filter
- Inverter convert DC to AC with help of power oscillator.
- Output transformer inverts AC voltage up to down to the required output level.
- Output rectifier and filter : AC output from transformer is rectified.
- For lower voltage uses silicon/schottky diodes used and smoothing the rectified output by using filter
- This reduces the amount of the voltage passed through the transformer.
- So the output voltage will be maintained normally.
- Then it is sent to the output of the power supply.

- A sample of this output is sent back as feedback signal for regulation.

b) Explain online ups with the help of a block diagram **(7)**

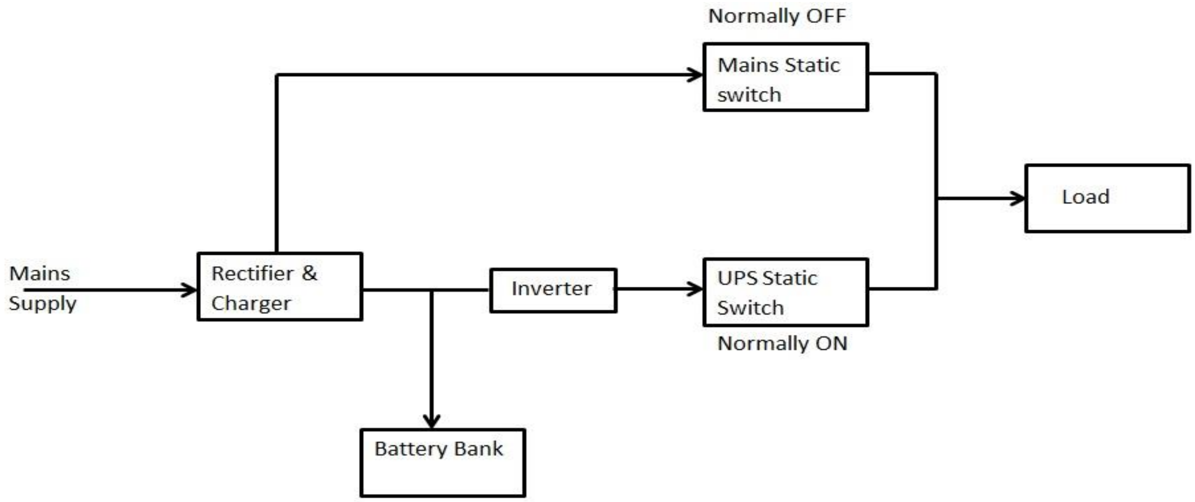
The Static UPS systems can be classified into three main categories:

[i] Online UPS

[ii] Offline UPS

[iii] Line Interactive UPS

ONLINE_UPS



Online UPS System Components:

As shown in the above figure, the major elements of online UPS are (i) Rectifier and Battery charger (ii) Inverter (iii) Static transfer switch (iv) Logic and control system (v) Battery bank (vi) Diagnostics and communication blocks.

In medium & large capacity online UPS systems good amount of power semiconductors like Power MOSFETs, GTOs, MCT, Darlington pairs are used.

Operation of Online UPS System:

During normal or even abnormal line conditions, the inverter supplies energy from the mains through the rectifier, which charges the batteries continuously. In addition to that it can also provide power factor correction.

When the line fails, the inverter still supplies energy to the loads from the batteries.

As a consequence, no transfer time exists during the transition from normal to stored energy modes.

In general, Online UPS system is the most reliable UPS configuration due to its simplicity (only three elements), and the continuous charge of the batteries, which means that they are always ready for the next power outage.

This kind of UPS provides total independence between input and output voltage amplitude and frequency. So high output voltage quality can be obtained.

When an overload occurs, the bypass switch connects the load directly to the utility mains, in order to guarantee the continuous supply of the load, thereby avoiding the damage to the UPS module (bypass operation).

In this situation, the output voltage must be synchronized with the utility phase, otherwise the bypass operation will not be allowed.

Features of Online UPS:

- A well designed online UPS protects against blackouts, surges, sags, spikes, transients, noise and brownouts.
- Previously the price of on-line ups systems is more than other ups systems. Now a days the price reduces drastically.
- Since they continuously regenerate clean AC power, they provide the highest level of protection available, regardless fo utility line condition.
- These kind of UPS have much more complex designs than off-line or hybrid types, while the price, weight and volume are higher.
- The inverter of an online ups system supplies continuous power to the critical load. Under conditions of overload or loads with high in rush currents which is beyond the capacity of the inverter, the static bypass switch provides mains power to the load.

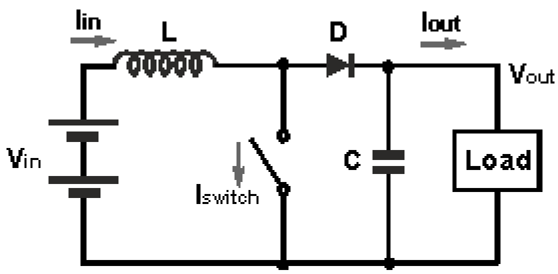
Advantages of On-line UPS System:

- No switching involved
- 100 percent line conditioning and regulation

- Good sustained brownout protection
- Typically sinusoidal output
- Power factor correction and higher reliability

OR

X a) Discuss the working of boost converter **(8)**



A Boost converter is a switch mode DC to DC converter in which the output voltage is greater than the input voltage. It is also called as step up converter. The name step up converter comes from the fact that analogous to step up transformer the input voltage is stepped up to a level greater than the input voltage. By law of conservation of energy the input power has to be equal to output power (assuming no losses in the circuit).

Input power (P_{in}) = output power (P_{out})

Since $V_{in} < V_{out}$ in a boost converter, it follows then that the output current is less than the input current. Therefore in boost converter

$V_{in} < V_{out}$ and $I_{in} > I_{out}$

Principle of operation of Boost converter

The main working principle of boost converter is that the inductor in the input circuit resists sudden variations in input current. When switch is OFF the inductor stores energy in the form of magnetic energy and discharges it when switch is closed. The capacitor in the output circuit is assumed large enough that the time constant of RC circuit in the output stage is high. The large time constant compared to switching period ensures a constant output voltage $V_o(t) = V_o$(constant)

b) Describe the specifications of UPS **(7)**

Voltage	The UPS output voltage must match the requirement of the load. In North America this voltage is 120Vac, in most of Europe 230Vac is used and the rest of the world is 220Vac.
Regulation	The regulation specification is the maximum expected deviation for the normal output voltage (e.g. 120Vac) that is expected over the entire range of operating conditions (e.g. load, temperature, altitude). For Off-Line systems the regulation spec refers to the battery backup mode.
Frequency	The frequency of the UPS output must match the requirements of the load. Switch-mode power supplies have a wide (47 - 63 Hz) range to be able to operate from either 50 or 60Hz. Other loads may require either 50 or 60Hz.
Power Rating	To completely specify a UPS, both the Volt-Ampere (VA) and wattage (Watts) rating must be known. See the section on "Understanding Watts, VA and Power Factor" for an in-depth explanation.
Load Power Factor	A power factor (p.f.) in the 0.6 to 0.8 range is typical. A p.f. rating of 0.6 to 0.7 is good for a switch-mode power supply. A p.f of 0.8 is typical for older UPS equipment designs used before the widespread used of computers.

Load Crest Factor	Most loads used in modern equipment, including computers, require a peak current that is much higher than what is required by a simple load such as a light bulb. The UPS must be able to supply this peak current. The Load Crest Factor is the ratio of the peak to the average (RMS) current.

Type	The most common battery used in UPS equipment is a sealed, lead-acid, maintenance free type. Ni-Cad (Nickel-Cadmium) batteries are a more expensive option. Large UPS systems often use wet, lead-acid storage batteries.
Rating	Batteries are rated by specifying an open circuit DC voltage and a Ampere-Hour (AH) rating.

UPS Battery Specifications

Number of Cells	Battery cells are normally connected in series to form a string. Often battery strings are connected in parallel.