Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the Figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any Equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant Values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

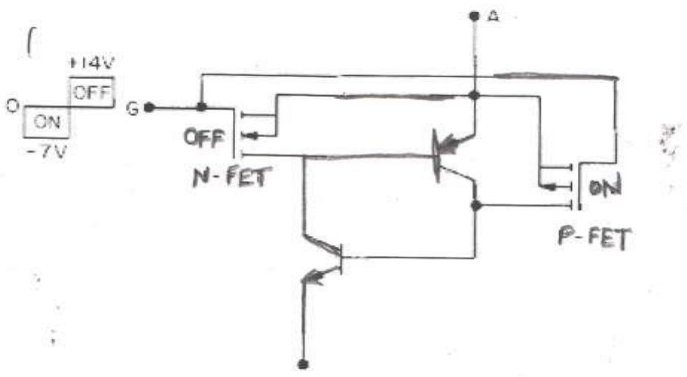
Q1.

a) Answer any three: **12M**

1) Describe turn ON and turn OFF method for MCT.

Ans:

***Note:* Diagram is optional**



MCT turn ON: **02M**

If the gate of the MCT is negative with respect to anode a p-channel is created in p-FET and p-channel ON FET causes the forward biasing of n-p-n transistor.(base drive to n-p-n transistor), the n-p-n transistor applies base drive to p-n-p transistor and regenerative action starts and the device is latched(turns ON).

MCT turn OFF : **02M**

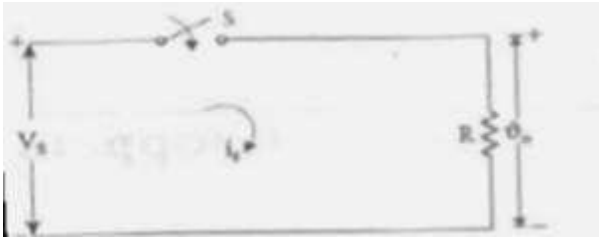
If the gate of MCT is positive with respect to anode, turn off the ON FET and N-channel is created in n-FET and n-channel FET turns ON which short circuit the base emitter junction of p-n-p transistor, this diverts the base drive of the transistor through OFF FET and breaks the regenerative process and the device will turn off.

2) Describe the effect of duty cycle on chopper output voltage.

Ans:

Circuit diagram:

Note:(DIAGRAM & WAVEFORM IS OPTIONAL)



Explanation: **03M**

The average value of output voltage V_o can be controlled by periodic opening and closing of the switches. In time control, the value of $\frac{T_{on}}{T}$ is varied.This effected in two ways. Variable frequency operation and constant frequency operation.

When the switch S is closed the supply voltage V_s
Appears across the load and when it is open, the load is disconnected form the supply. Thus the average dc output voltage is controlled by controlling the switch-On period Ton and the switch-off Period T_{off}. Hence the average value, V_{dc} of the output voltage Vo in figure depends on T_{on} and $T_{off.}$

$V_o = [T_{on} / (T_{on} + T_{off})]V_s$

$V_o = D.Vs$

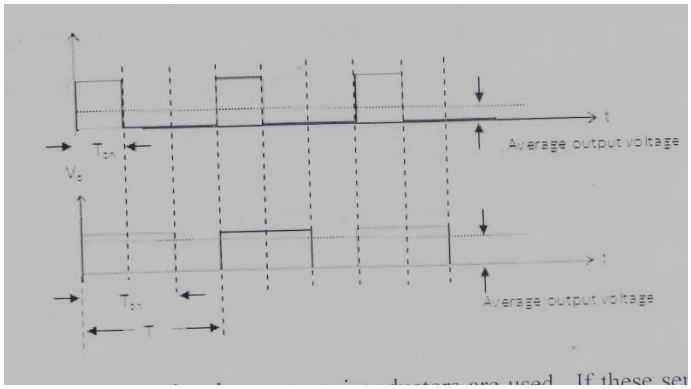
D is called as the duty cycle.

Duty cycle $D=\frac{T_{on}}{T}$.

As Ton increases, the output voltage Vo increases

The effect of change in the on time and duty cycle of the chopper is shown in below, which shows that increase in on time (or increase in duty cycle) will increase the average load voltage.

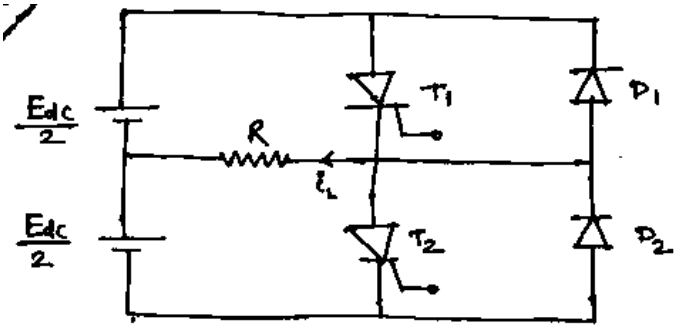
Waveform: **01M**



3) Draw the circuit diagram of half bridge inverter with resistive load. Draw its voltage and current waveform.

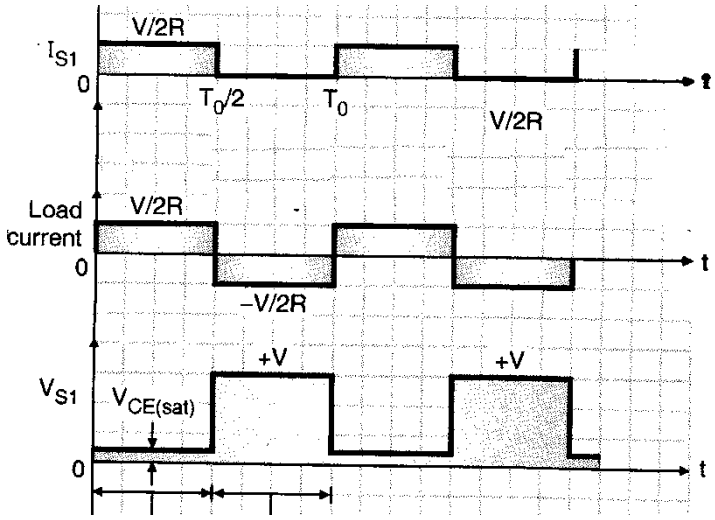
Ans:

Circuit diagram:- **02M**



@ Single phase half bridge inverter

Voltage and Current waveform:- **02M**



4) Compare servo type and solid state type stabilizer w.r.t operating principle, efficiency, applications and distortion.

Ans: **01M each**

Parameter	Servo type	solid type
Operating principle-	Servomotor is coupled to the tap of the autotransformer	Phase control (SCR static switches select transformer tap)
Efficiency	less	high
Application	Computers, Recorders	TV, refrigerator
Distortion	No distortion	More distortion

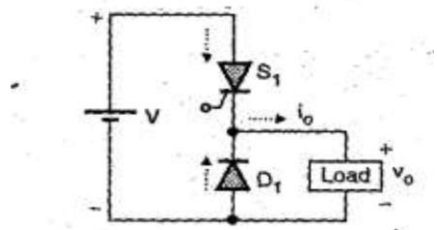
Q1)

b) Answer any one of the following: **06M**

1) Describe the working of class A chopper using SCR with circuit diagram and waveforms.

Ans:

Circuit diagram: **02M**

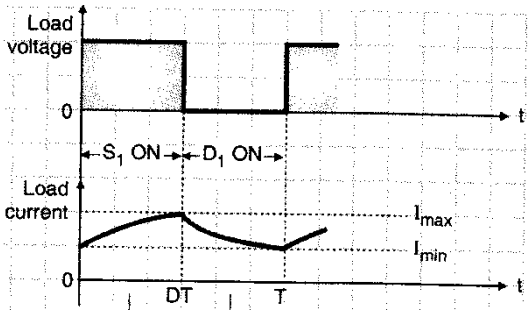


(a) Type A chopper configuration

Explanation: **02M**

- Type A chopper operates with periodic opening and closing of S1.
- S1 and freewheeling diode D1 conduct only in one direction.
- Assume the load is inductive.
- When S1 is closed load voltage is positive, load current is also positive and inductor will store energy.
- When S1 is commutated, there is a change in current.
- Inductor opposes this change and reverses it's polarity.
- This forward biases the diode D1 and freewheeling action takes place.
- Average output voltage and average output current are +ve. Chopper operates in I-quadrant.

Waveforms: **02M**

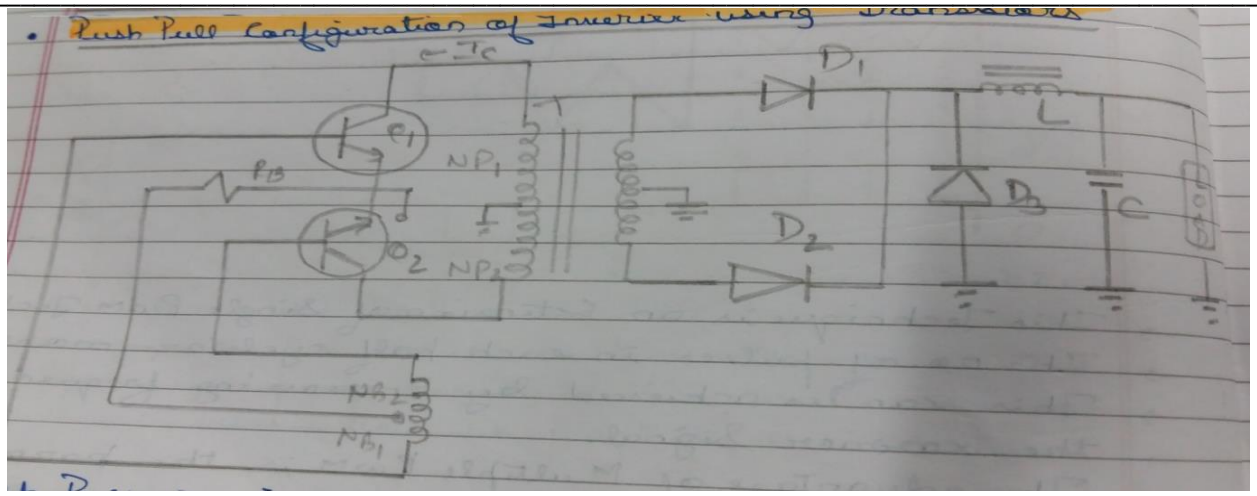


2) Draw the circuit diagram of push pull inverter with RL load. Describe its working.

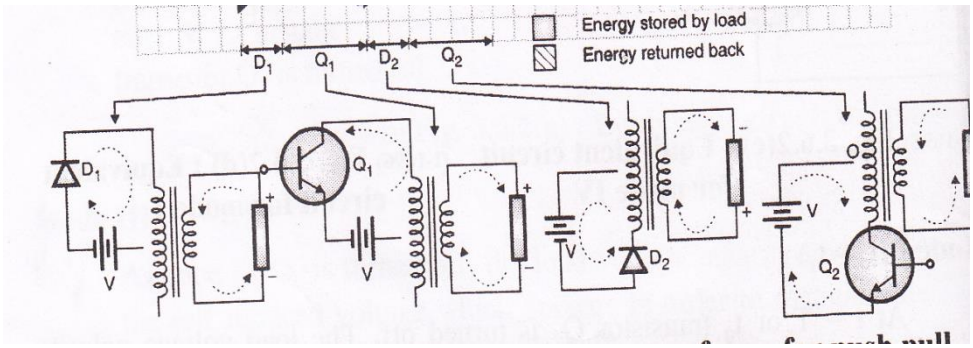
Ans:

Circuit diagram of push pull inverter:- **03M**

A freewheeling diode has to be connected across RL load.



OR



Working: **03M**

It uses two transistors Q1 and Q2. Diodes D1 and D2 are used for rectification. It also uses center tapped transformer and LC filter**.**

- When Q1 starts to conduct , voltage developed across NP1 appears across NB1 in such a way so as to drive Q1 into saturation.
- A reverse voltage appears across NB2 and turns off the conducting transistor Q2. The freewheeling diode conducts to dissipate the stored energy in the load.

Q2. Answer any two of the following: **16M**

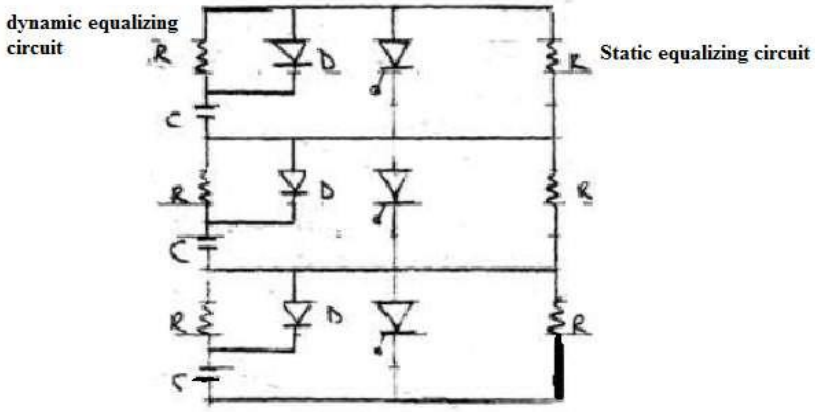
1) Draw 3 SCRs series connection diagram. Describe the role of static and dynamic equalizing network. State the need of series and parallel connection of SCR.

Ans:-

Need of series and parallel connections of SCR:- **02M**

- The required voltage and current rating are lower than the maximum limits.
- The designer is forced to use lower rated SCRs for economy and reliability.
- These lower rated SCRs have to be connected in series and parallel combinations to suit the voltage and current requirements.
- Series is used for high voltage low current and parallel is used for low voltage and high current applications

Circuit diagram: **03M**



Explanation: **03M**

Consider the case of three SCRs connected in series which have different characteristics.

- When voltage is applied across such a combination, then the SCR with the highest turn-on time will share the maximum blocking voltage because the other two SCRs must have already turned on.
- Similarly when reverse voltage is applied across this string SCR with the least recovery time will go to the blocking state first and the other two SCRs will still be conducting.
- These two conditions are unfavorable. Hence static and dynamic equalizing circuits are used. Static equalizing circuit consists of a shunt resistor across each SCR. This reduces the effect of unequal blocking resistances.
- The dynamic equalizing circuit consists of an R-C snubber circuit and a diode. (It is used to control the voltage distribution when the SCRs are in the blocking state.) To equalize voltage during transient state ie during turn on and turn off of SCRs.

2) Compare On – line and Offline UPS w.r.t to input voltage, DC voltage, output frequency, applications, distortion, output w/f transient recovery.

Ans:-

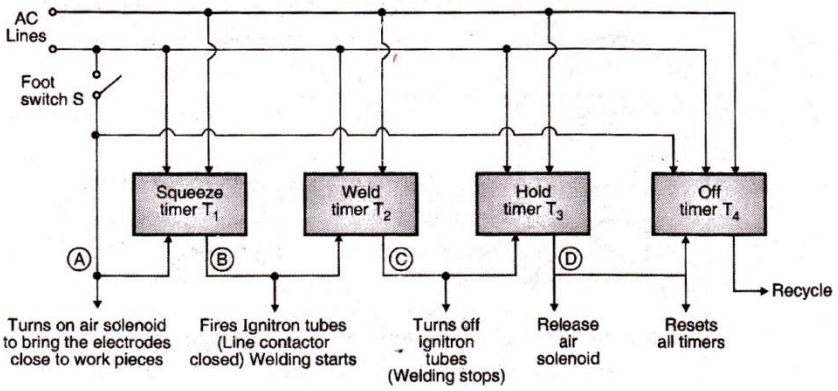
Note:Mark distribution is given in table

Sr. No.	Parameter	ON Line UPS	OFF Line UPS	MARK Distribution
1.	**Input Voltage**	Sinusoidal	Sinusoidal	**01M**
2.	**DC Voltage**	Battery voltage	Zero Voltage	**01M**
3.	**Output frequency**	50 Hz	Approximately 50Hz	**01M**
4.	**Application**	Critical loads like medical	General Purpose Loads like domestic load	**02M**
5.	**Distortion**	Low	High	**1½M**
6.	**Output waveform transient recovery**	Less Recovery time	More Recovery time	**1½M**

3) Draw block diagram of sequential timer for resistance welding. Describe function of each block. List different signal generated.

Ans:

Diagram: **04M**



Functions: **02M**

- Squeeze timer- it turns on the solenoid valve and squeezes the welding electrodes together.
- Weld timer- it operates to initiate the welding current
- Hold timer- it will produce control signals to hold the welding current.
- Off timer- during this time the operator can shift the work-piece to a new spot.

The sequential timer provides the following signals: **02M**

- Signal to squeeze the welding electrodes together.
- Signal to start the flow of welding current
- Signal to stop the flow of welding current
- Signal to separate the electrodes.

Q3. Answer any four: **16M**

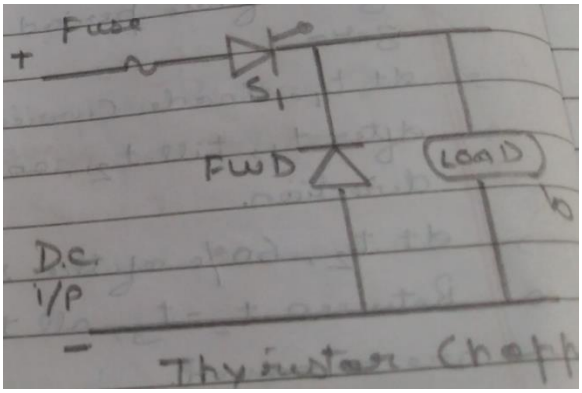
1) Describe how SCR can be protected from over current with suitable labeled diagram.

Ans: **Circuit diagram: 02M and Explanation: 02M**

***Note:* Any one circuit may be considered**

Fuse:

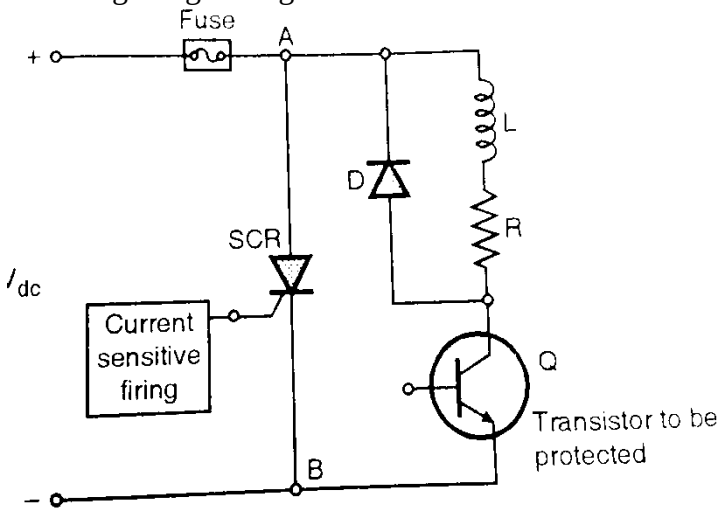
Fuse may be used in the case of over current or short circuit due to a fault, the fuse blows and protects the semiconductor devices.



OR

Crowbar protection:

It is used to protect device where a large current or power is involved. In power converters, fault may take place which result in large fault currents. This fault current must be cleared quickly in order to protect the power devices from getting damaged



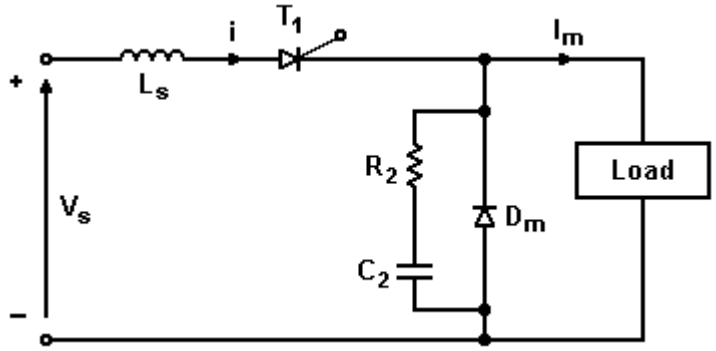
Explanation:

- SCR is used which is normally in off state.
- There are a voltages or current sensitive firing circuit.
- If the current through Q goes above a preset value, then the SCR will be turn ON.
- The SCR will act as a closed switch and will short circuit points A and B.
- So in fault condition, SCR turns ON and will below the fuse and the transistor is protected

OR

$\frac{di}{dt}$ Protection:

Circuit diagram:



Explanation:

A thyristor require minimum time to spread the current conduction uniformly throughout the junctions. If the rate of rise of anode current is very fast compared to the spreading velocity of a turn on process, a localized hot spot heating will occur due to high current density and the device may fail as a result of excessive temperature. The practical device must be protected against high $\frac{di}{dt}$. The inductor Ls which limits $\frac{di}{dt}$ sometimes called series snubber.

Assume under steady state operation D_m conducts, when thyristor. T_1 is off. If T_1 is fired when Dm is still conducting,$\frac{di}{dt}$ can be very high and limited only by the stray inductance of the circuit.

In practice, the $\frac{di}{dt}$ is limited only by adding a series inductor Ls as shown in fig.

The forward $\frac{di}{dt}$is

$$\frac{di}{dt}=\frac{Vs}{Ls}$$

2) Draw the circuit diagram and explain the working of isolated SMPS.

Ans:

Note: Any one type is to be considered

Fly-back converter

Circuit diagram: **02M**

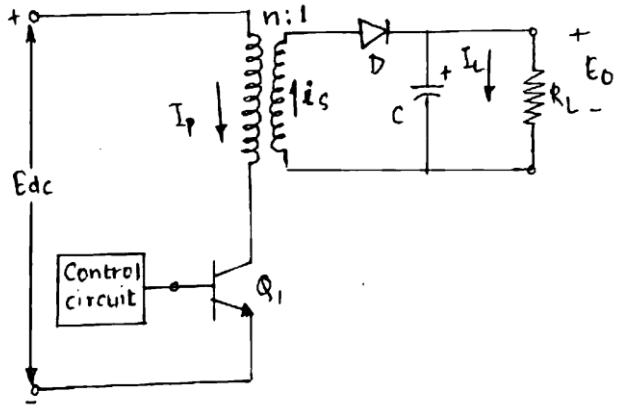


Fig: Flyback converter

Explanation: **02M**

Mode I :

When transistor Q1 is ON at t=0, primary current starts to build up in the primary winding, storing energy. Due to the opposite primary arrangement between the input & output windings of the transformer choke, there is no energy transferred to the load since diode D is reversed biased. Transistor Q1 is turned off abruptly at instant t=t1. The equivalent circuit for this mode is shown in figure

Mode II:

When the transistor is turned off at t=t1, the polarity of the windings reverses due to the collapsing magnetic field. Now, diode D is conducting, charging the output capacitor C and delivering current IL to load .The voltage across Q1 is the sum of input supply voltage (Edc) and the self- induced voltage across the primary winding (Ldi/dt) , therefore it is higher than the supply voltage (Edc).

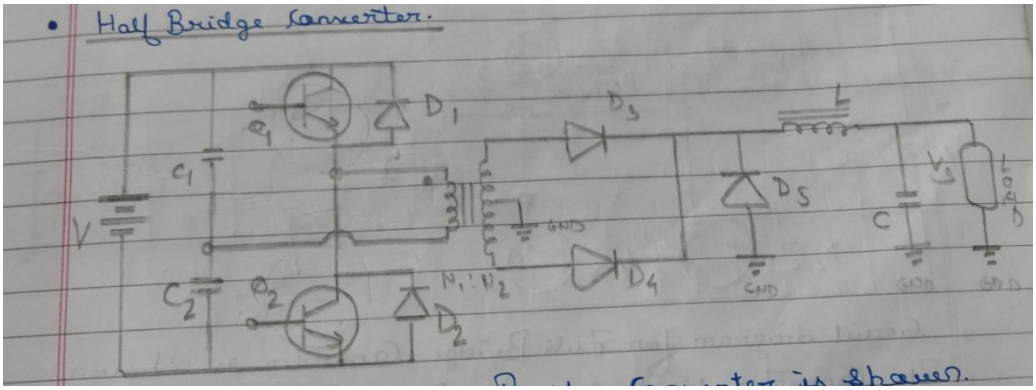
Mode III:

In this mode transistor and diode both are in the off state. Therefore, primary and secondary currents are zero. As there is no voltage drop across primary winding of the transformer, the voltage across the transistor Q1 is equal to the dc supply voltage(Edc). The secondary voltage is zero. The one cycle operation completes in this mode and repeats itself.

OR

Half bridge converter:

Circuit diagram: **02M**



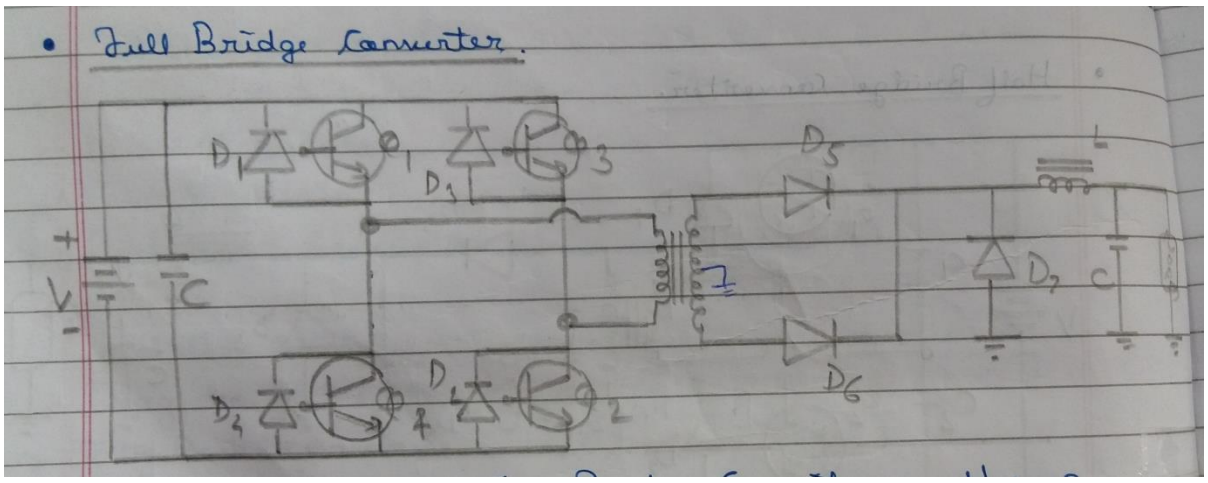
Explanation: **02M**

It is a D.C to A.C converter. This output is rectified and filtered by the LC filter. When Q1 is turned ON, voltage across C1 i.e. V/2 appears across the primary of the transformer. D3 is forward biased and D4 is reverse biased. When Q2 is turned ON, voltage across C2 i.e. V/2 appears across the primary of the transformer. D4 is forward biased and D3 is reverse biased.

OR

Full bridge converter:

Circuit Diagram: **02M**

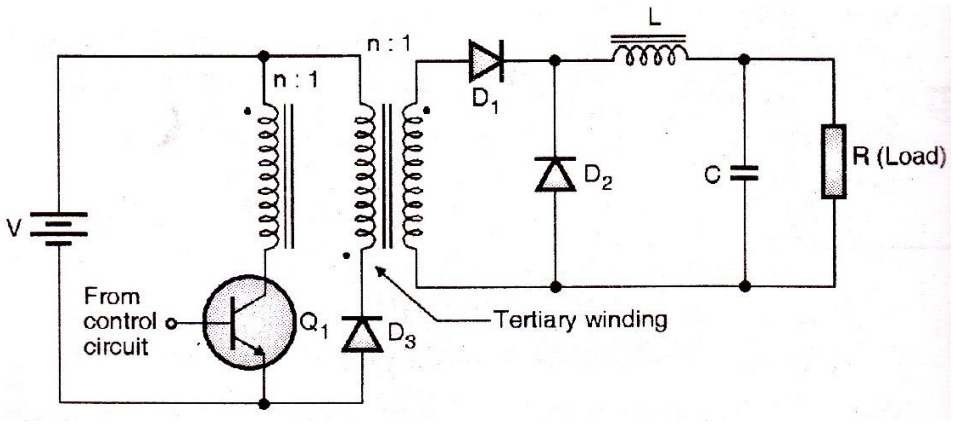


Explanation: **02M**

It is a D.C to A.C converter. This output is rectified and filtered by the LC filter. When Q1 and Q2 are turned ON simultaneously, voltage appears across the primary of the transformer. D5 is forward biased and D6 is reverse biased. When Q3 and Q4 are turned ON, voltage appears across the primary of the transformer. D6 is forward biased and D5 is reverse biased.

OR

Forward Converter:- (Derived from step Down converter) **02M**



Operation:- **02M**

If you compare the circuit diagram of forward converter with that of a fly-back converter you will find that the configurations are exactly identical to each other except for the winding directions of primary and secondary windings(see the dots on these windings).The operation of the circuit can be explained by dividing it into two modes.

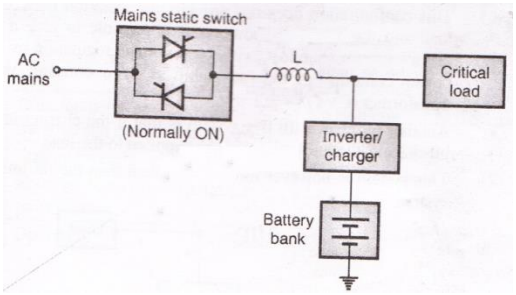
1. **Mode I (Q_1 ON) :**
   - As soon as Q_1 is turned on, the supply voltage "V" is applied across the primary winding of the transformer.
   - Due to this constant voltage, the primary current increases at a constant rate.
   - Due to the winding polarity as shown in fig., the induced voltage in the secondary winding will forward bias diode D_1 and the secondary current starts flowing.

2. **Mode II (Q_1 OFF):**
   - When the power switch Q_1 is turned off, the primary voltage will change its polarity as shown in fig.
   - The secondary voltage also will change its polarity.
   - Diode D_1 is reverse biased and D_2 is forward biased due to the induced voltage in the filter inductance and the current flows through the load as shown in fig.

3) Draw the block diagram of line interactive UPS. Describe it's working.

Ans:

Block diagram of LINE Interactive UPS:- **02M**



Working: **02M**

Mode 1:

The static switch is closed and the load gets connected directly to the ac mains. The inverter /charger block acts as a charger and charges the battery.

Mode 2:

When the mains fail the static switch opens, the inverter /charger block acts as an inverter and the battery supplies power to the load through the inverter**.**

4) Draw and describe the working of Class C –chopper using SCR's with proper w/fs.

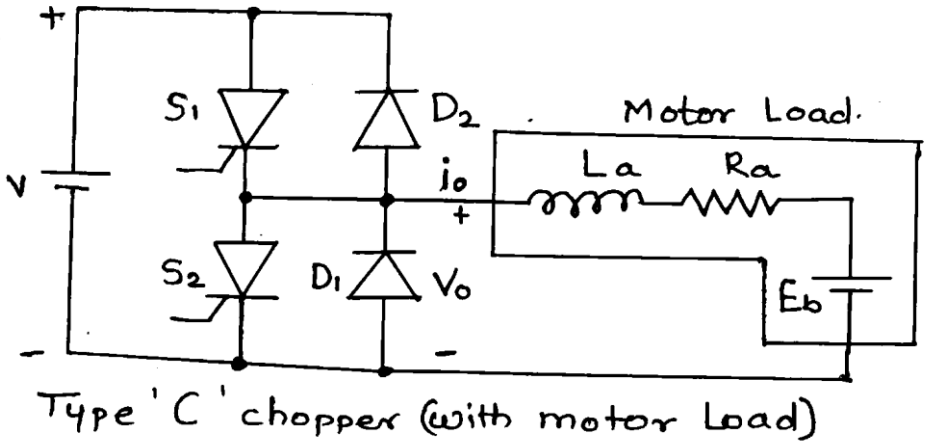
Ans:

Explanation: **01M**

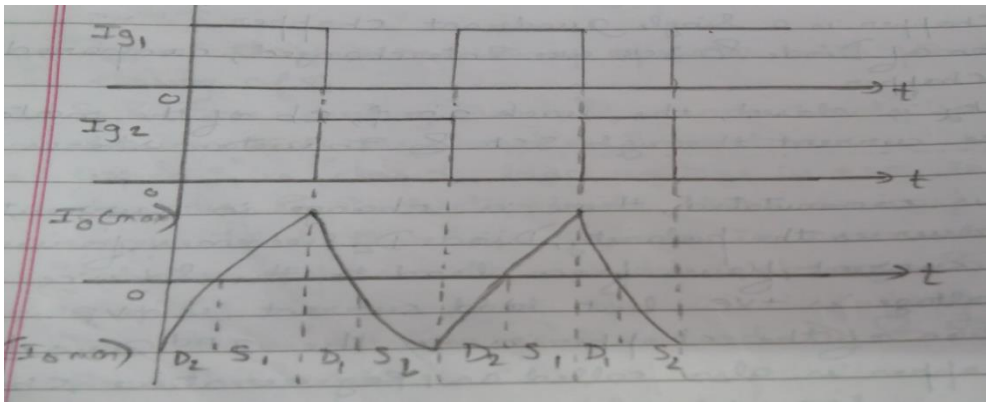
Type C chopper:

- Thyristor S1 and diode D1 operates as a type A chopper .
- Thyristor S2 and Diode D2 works as a type B chopper.
- When Thyristor S1 is triggered, diode D1 conducts and the load current is positive.
- When thyristor S2 is ON , Diode D2 conducts and the load current is negative .

Circuit diagram: **02M**



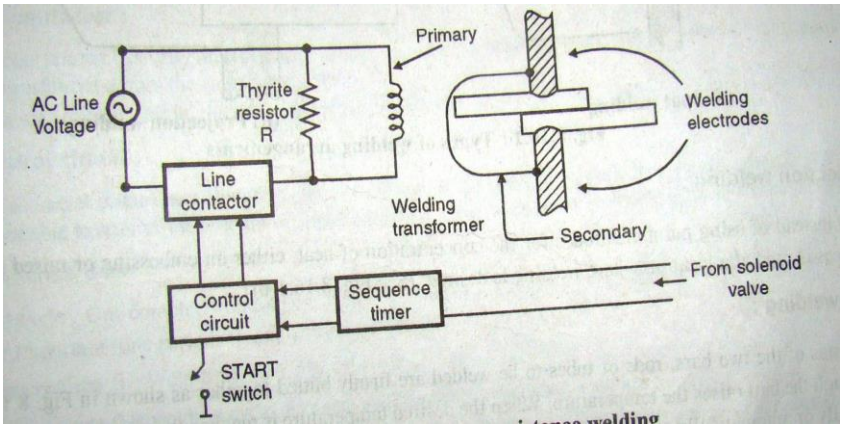
Waveforms: **01M**



5) Draw the block diagram of AC resistance welding and describe it.

Ans:

Block diagram:- **02M**



Explanation:- **02M**

- The operating principle is based on heating effect of current. Heat is produced due to the resistance offered by the metals sheets to the current passing through them.
- Heat produced is utilized for welding and Heat = $\int i^2 R\, t$
- The line contactor is basically a controlled switch which connects the ac mains voltage across the primary winding of the welding transformer.
- The welding transformer is a step down transformer which supplies a reduced voltage on the secondary side but increases the secondary current which is the welding current.
- The current is usually in the range of several hundred to several thousands of amperes, depending on the nature of current.

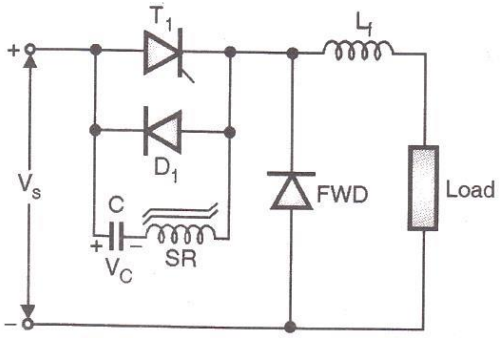
Q4.

a) Answer any three. **12M**

1) Describe the operation of Morgan's chopper with circuit diagram.

Ans:

Circuit diagram: **02M**



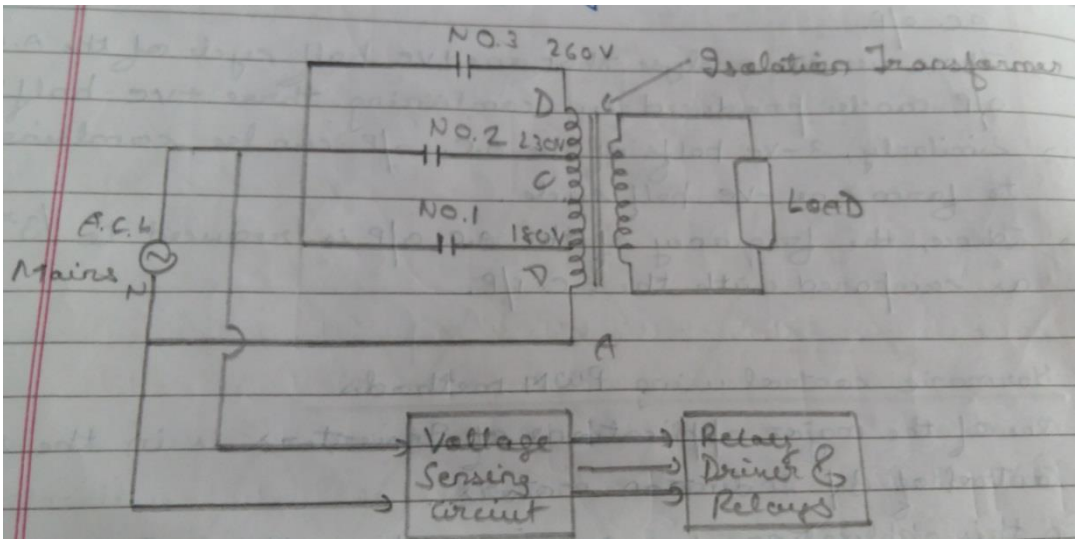
Explanation: **02M**

- Initially SCR T1 is in the OFF state.
- C1 is charged to the supply voltage E_{dc} and the reactor SR is positive saturated.
- When T1 is triggered, capacitor discharges through T1 and SR.
- After a short period, charge on the capacitor is reversed and the reactor is negatively saturated.
- The impedance of the reactor reduces.
- The reverse voltage of capacitor appears across T1 and turns it off.

2) Draw and describe the working of relay type stabilizer with diagram.

Ans:

Diagram: **02M**



Working: **02M**

- The primary winding is divided into several taps.
- End A of transformer is connected to neutral.
- The line terminals B,C,D are connected to the taps through the normally open contacts of the relay.
- The transformer works as step up, step down or isolation transformer.
- The voltage sensing circuit senses the input voltage and the relay driver circuit operates the relay.
- If there is an over voltage, say 260 V, NO3 will be closed and the output voltage will be reduced.
- If there is an under voltage, say 180 V, NO1 will be closed and the output voltage will be increased.
- Output is discontinuous control type and not suitable for critical load.

3) What is the need for protection circuits for power devices? List different types of protection circuits.

Ans:-

Need for protection circuits for power devices: **02M**

To provide protection against over voltage, over current, di/dt, dV/dt, and over temperature.

In the converter circuit voltage transient get generated due to reverse recovery process of the power devices and switching take place in presence of supply and load inductance. The short circuit fault condition or the cross conduction taking place in convertor circuit will result in heavy fault current flowing through the devices. So we require protection circuit.

Types of protection circuits: (Any two types) **01M each**

- **Fuse** and circuit breakers are used for over current protection which are power dependent and have complicated circuit.
- Fuse is connected in series and as fault current increases it melts.
- **Crowbar circuit** can also be used for over current protection
- di/dt protection and dv/dt protection provided by snubber circuit
- **Selenium diode** MOV can be used for overvoltage protection which are voltage dependent nonlinear resistors and have simple circuit.
- It senses over voltages due to transients or spikes.
- Over voltage protection devices are selenium diodes and varistors (Varistors).
- Snubber circuits

4) State different PWM techniques in inverter. Describe any two.

Ans:

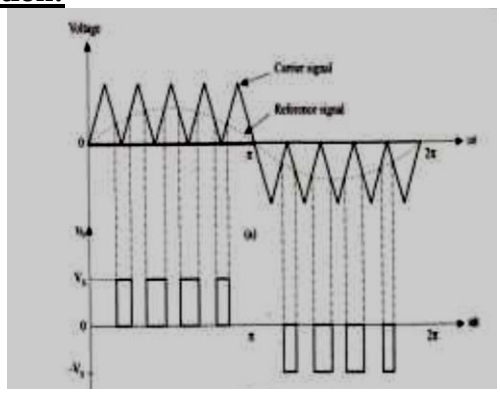
Types: **01M**

The commonly used PWM techniques are as follows:

1) Sinusoidal pulse width modulation
2) Single pulse width modulation
3) Multiple pulse width modulation

Diagram and Explanation: (any two) **1½M each**

1. Sinusoidal Pulse width modulation:



- The PWM waveform generated at the output of the controlled circuit is used to drive transistors or other semiconductor devices connected in the inverter circuit.
- This type of modulation is realized by comparing a control signal consisting of rectified sinusoidal wave of variable magnitude Am and frequency fm= 1/T equal to frequency of inverter & a triangular wave of fixed amplitude and frequency.
- The comparator output is high when the magnitude of sine wave is greater than that of triangular wave. The modulation index of PWM signal is defined as the ratio of: Am/ Ac.The carrier frequency ratio is defined as the ratio of fc to fm.
- This method reduces the harmonics present in the output waveform. A pure quasi square wave is obtained.
- For further reduction in harmonics filter can be used.

2. Single pulse width nodulation:

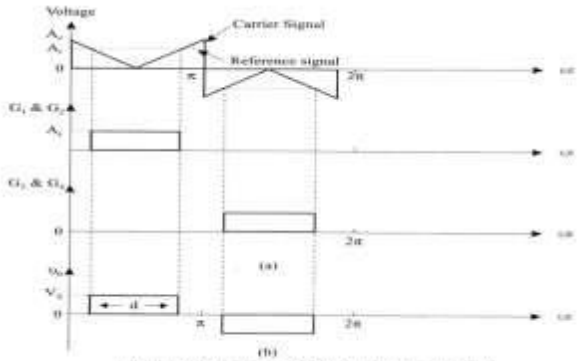


Figure Waveforms of single-pulse width modulation: (a) gate signal generation; (b) output voltage.

- In single -pulse-width modulation control, there is only one pulse per half-cycle and the width of the pulse is varied to control the inverter output voltage.
- The gating signals are generated by comparing a rectangular reference signal of amplitude Ar with a triangular carrier wave of amplitude Ac.

3. Multiple Pulse Width Modulation:

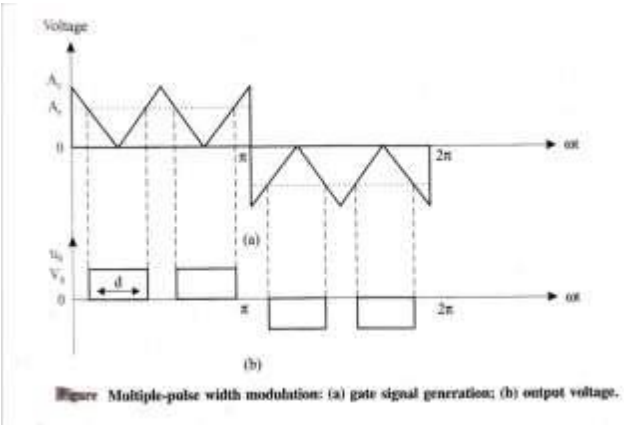


Figure Multiple-pulse width modulation: (a) gate signal generation; (b) output voltage.

- In this method of pulse-width modulation, the harmonic content can be reduced using several pulses in each in each half-cycle of output voltage.
- By comparing a reference signal with a triangular carrier wave, the gating signals are generated for turning-on and turning-off of a thyristor. fc>fm.

b) Answer any one: **06M**

1) Describe how output voltage and harmonics can be controlled using PWM control method of inverters.

Ans:- **Diagram 02M and explanation 04M**

Note:- Any one method can be considered

- The most efficient of controlling the gain and output voltage is to incorporate pulse width modulation control within the inverter .the commonly used PWM techniques are as follows

1) Single pulse width modulation

2) Sinusoidal pulse width modulation
3) Multiple pulse width modulation

This method reduces the harmonics present in the output waveform. A pure quasi square wave is obtained.For further reduction in harmonics filter can be used.

Types of pulse width modulation:

1) Single Pulse-Width Modulation:-

In single -pulse-width modulation control, there is only one pulse per half-cycle and the width of the pulse is varied to control the inverter output voltage. The gating signals are generated by comparing a rectangular reference signal of amplitude A_r with a triangular carrier wave of amplitude Ac.

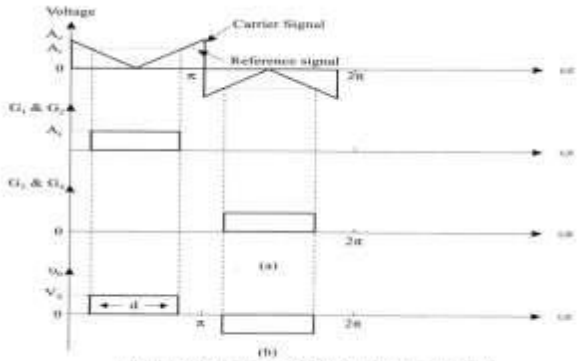


Figure Waveforms of single-pulse width modulation: (a) gate signal generation; (b) output voltage.

2) Multiple Pulse-Width Modulation:-

In this method of pulse-width modulation, the harmonic content can be reduced using several pulses in each in each half-cycle of output voltage. By comparing a reference signal with a triangular carrier wave, the gating signals are generated for turning-on and turning-off of a thyristor. fc>fm.

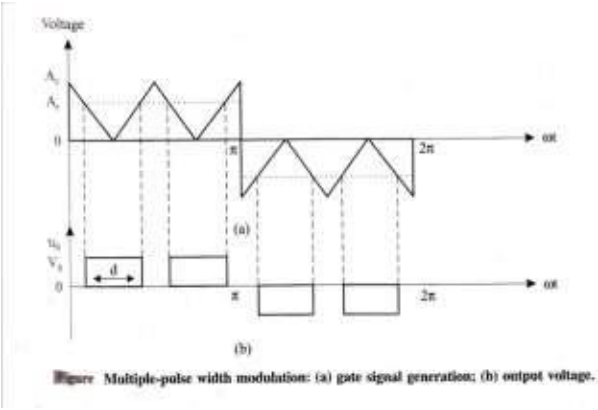
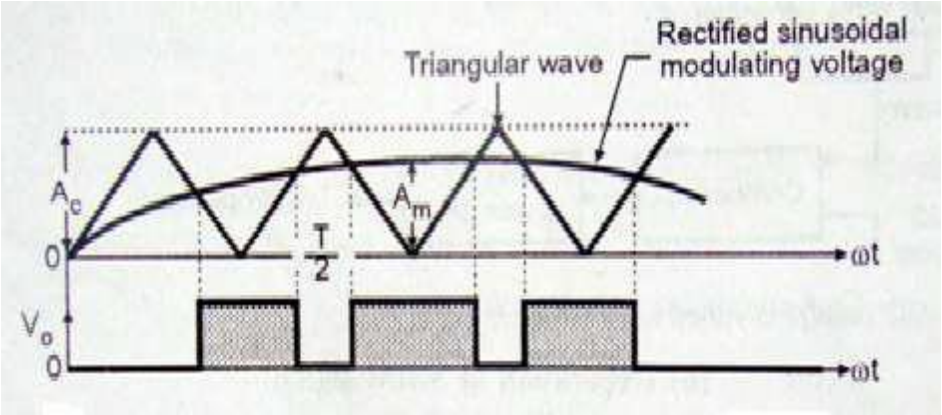


Figure Multiple-pulse width modulation: (a) gate signal generation; (b) output voltage.

3) Sinusoidal Pulse-Width Modulation:-

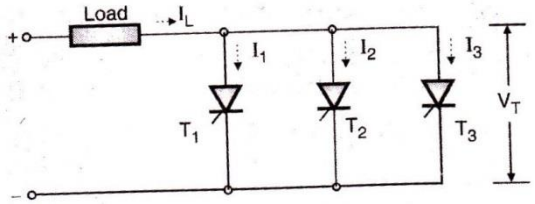
Instead of maintaining the width of all pulses the same as in the case of multiple-pulse modulation, the width of each pulse is varied in proportion to the amplitude of a sine wave The gating signals are generated by comparing a sinusoidal reference signal with a triangular carrier wave of frequency fc. The six-step waveform has a zero-voltage step between the positive and negative sections of the square wave such that the harmonics that are multiples of three are eliminated . When carrier based PWM techniques are applied to six-step waveforms, the basic overall shape, or envelope, of the waveform is retained so that the 3rd harmonic and its multiples are cancelled.



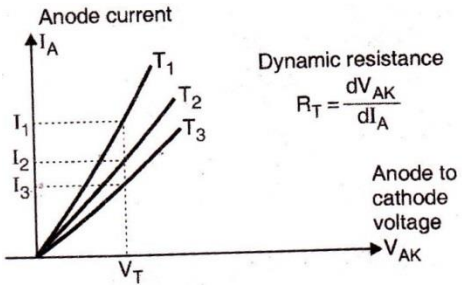
2) Draw the circuit diagram of parallel connections of three thyristors and describe with forward characteristics.

Ans:

Parallel connection of SCR: **02M**



Forward Characteristics: **02M**



Explanation: **02M**

- Figure shows the dynamic characteristics of SCR connected in parallel. Since the voltage drop across the devices must be same , the SCR with lower forward resistance will share more current.
- This unequal sharing of voltages and currents can be corrected by external equalizing circuits. SCRs are connected in parallel to improve the current rating...Due to unequal dynamic resistance the sharing of current will not be equal which causes heating of the SCRs and thermal runaway. Hence, all the SCRs operated in parallel should be at the same temperature by having a common heat sink.

Q.5 Answer any two **16M**

1) State the need of energy storage resistance welding. Describe the working of capacitor energy storage welding with waveforms.

Ans:

Need of the energy storage system: **01M**

In conventional single phase welding system, large voltage drop and the associated flicker of light due to short period heavy current drainage from the supply system. This drawback is eliminated in the energy storage system.

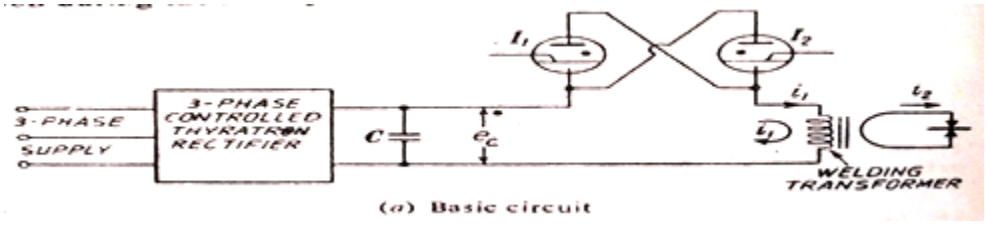
Operation: **03M**

Capacitor Energy storage welder:

The basic current is shown in fig. below

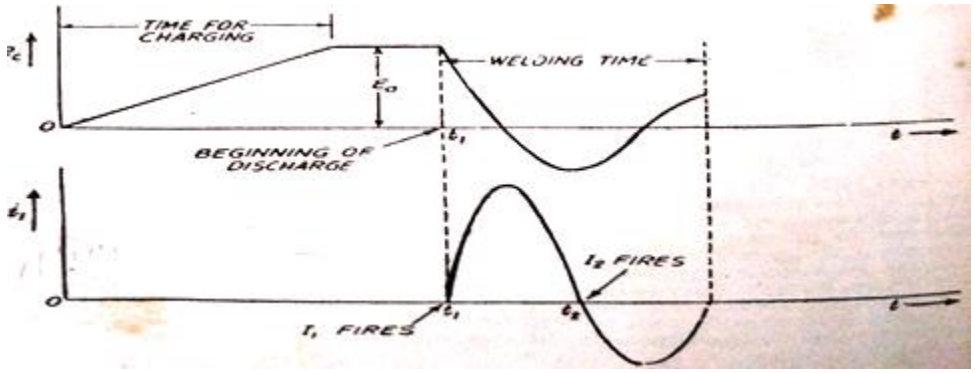
Here C represents a bank of capacitor of value 300 to 300 μ F . A controlled thyratron rectifier charges C to a potential of several thousand volts. At the instant of desired weld, thyratron T1 is fired and the energy stored in the capacitor C gets transferred to the welding transformer primary. This sudden pulse of current in the primary of the welding transformer produces a very brief duration high magnitude secondary current . The ac equivalent circuit of the welder during discharge of the capacitor is shown in fig , wherein R is the resistance of primary winding plus the secondary load reflected to the primary.

Diagram: **02M**



(a) Basic circuit

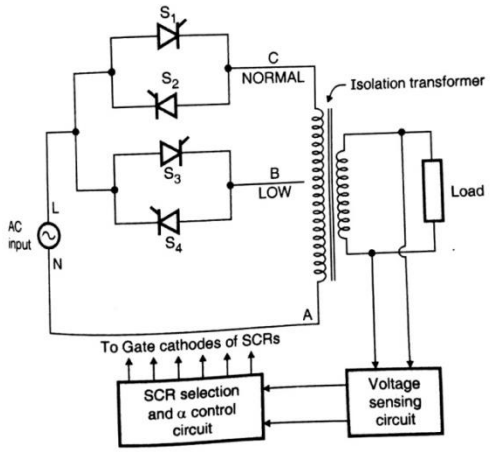
Waveform: **02M**



2) Draw the circuit diagram of phase control method used in Ac voltage stabilizer. Describe its operations. List any two advantage. And disadvantage. And any two applications of it .

Ans:

Diagram: **03M**



Operation: **02M**

- The circuit consists of a tapped transformer along with back to back connected SCRs in pair for each tap.
- The sensing circuit senses the output voltage and selects a particular tap by triggering the corresponding pair of SCRs. e.g. if the voltage required is 230V then SCR1 and 2 will be triggered.
- The smooth adjustment in the output voltage is then obtained by automatic adjustment of firing angle of the selected pairs of SCRs.
- Thus the output voltage can now be adjusted in step less manner.
- If the load voltage required is less, than other pair of SCRs is triggered.

Disadvantags.:1M, Advntages.:1M, Applications:1M

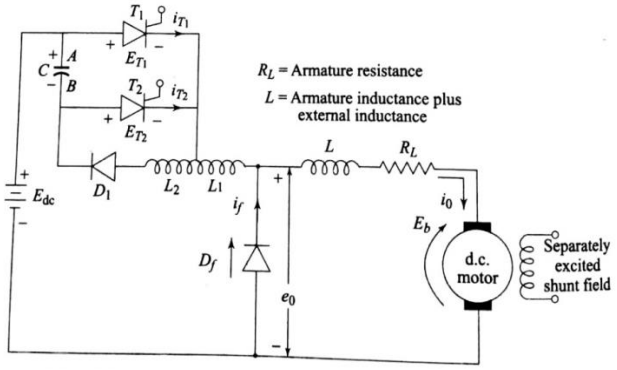
Advantage	Disadvantage	Application
1.Better output voltage regulation	1.Poor input power factor	1.TVs
2.Fast dynamic response	2.Need of filters due to distorted waveforms	2.Refrigerators
	3.Costly	

3) Draw and describe the working of Jones chopper with proper waveforms.

Ans:

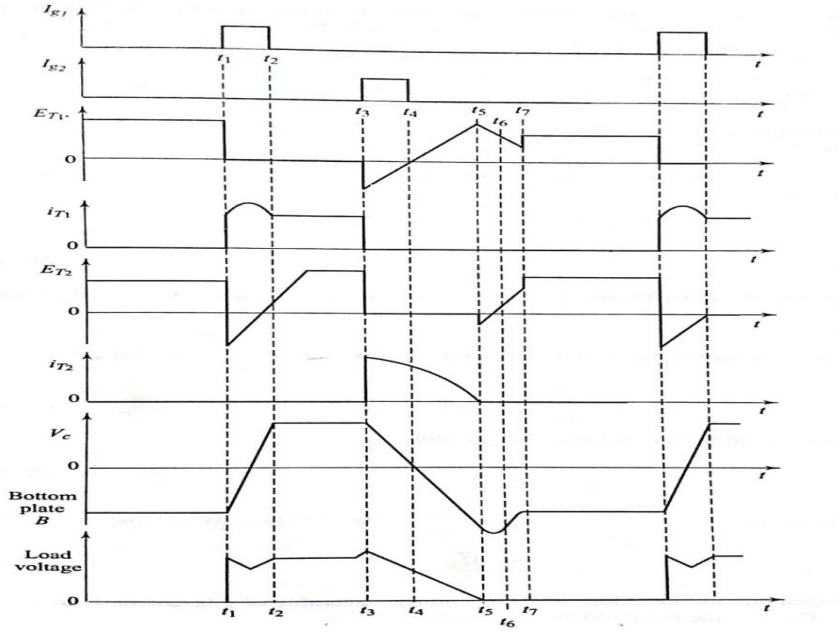
Diagram: **03M**

Note:Any other valid diagram also can be considered



Waveforms: **02M**

Note:-If only voltage across both SCRs are drawn, it can be considered



Operation: **03M**

Let us assume, that initially capacitor C is charged to a voltage Edc with the polarity shown in the fig.(a)

Mode 1:

- At time **t = t1,SCR T1 is triggered,** a load current flows through T1, L1 and the load.
- Simultaneously at time **t = t1,** current flows through the path C_A-T1 - L2 - D1 - C_B and capacitor C discharges and reverses its polarity i.e. plate B is positive and plate A is negative.
- There are two currents flowing through the thyristor T1.

$$i_{T1} = io + ic$$

- However, diode D1 prevents further oscillations of the resonating L2 C resonating circuit.
- Hence, capacitor C holds its charge until SCR T2 is triggered (t2 - t3).
- In fig b the capacitor voltage waveforms are drawn at the bottom plate B of the capacitor.

Mode 2:

- Now, at time **t = t3, SCR T2 is triggered**.
- Current flows through the path C_B - T2 - T1 - C_A.
- The capacitor voltage with reverse polarity is applied across the thyristor T1which reverse biases SCR T1 and turns it OFF.
- The time duration from t3-t4 is the circuit turn-off time presented to SCRT1.
- The capacitor again charges up through supply, C, SCR T2, L1, load with the plate A positive and SCR T2 turns OFF because the current through it falls below the rated holding current value when capacitor C is recharged.
- The load current flows through the freewheeling diode D_f until the thyristor T1 is turned ON again, and thus, the cycle repeats itself.

Mode 3:

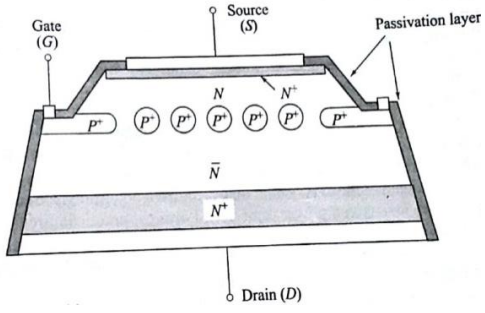
- At **t = t5**, the bottom plate B of the capacitor C reaches a peak value.
- Since at t5, the capacitor is charged to a voltage greater than Edc, the load voltage = 0, the diode D1 is again forward biased. Capacitor C now discharges to a value lower than Edc.
- The use of autotransformer insures that whenever current is delivered from DC source to the load, a voltage is induced in L2 in the correct polarity for charging the commutating capacitor to a voltage higher than Edc.
- Thus, the autotransformer measurably enhances the reliability of the circuit.

Q.6 Answer any four: **16 M**

1) Draw the constructional diagram of SIT and describe its operation.

Ans:

Diagram: **02M**



Operation: **02M**

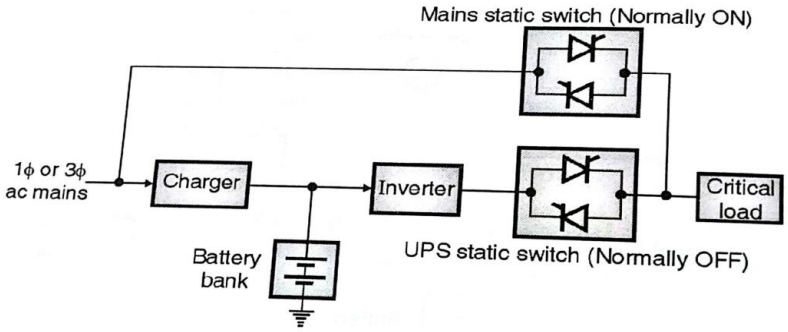
- Fig. shows the cross sectional view of SIT .
- The Static Induction Transistor (SIT) is a vertical structure, short multichannel device with a buried gate within the drain and source N-type epitaxial-layer.
- SIT is identical to JFET except for vertical and buried gate construction.
- It is a Normally ON device.
- Turned ON by applying positive Gate voltage.
- Turned OFF by applying negative gate voltage.

- The low gate resistance and low gate to source capacitance make for a fast switching device.
- The SIT is capable of hundreds of amps and thousands of volts, typically 300A, 1200V.
- Due to **Normally ON** characteristics and **High ON state voltage drop**, use of SIT is limited to general power conversion.
- It is said to be capable of an incredible frequency of 10 GHz

2) Draw the OFF line UPS and describe the function of each block.

Ans:

Diagram:- **02M**



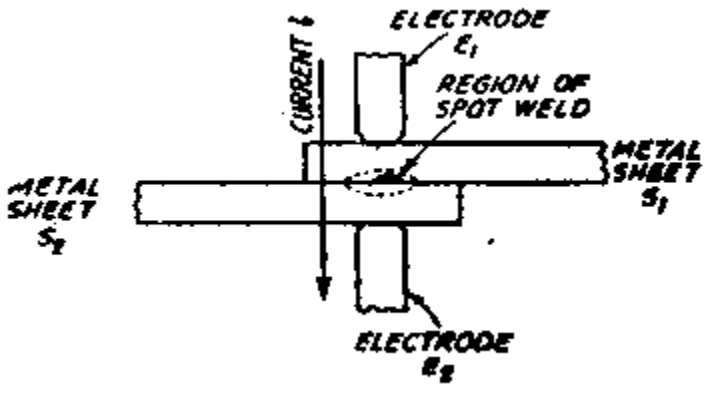
Function:- **02M**

- A rectifier and charger converts a single phase or three phase a.c voltage into d.c., which supplies power to the inverter as well as the battery bank (to charge it).
- The inverter gets a dc input voltage from the rectifier when the ac mains is ON, and from the battery bank when the ac mains is OFF.
- Inverter converts this dc voltage into ac voltage through a suitable filter and applies it to the load.
- In this, UPS static switch is normally OFF.
- Mains static switch is Normally ON and supplies power to the load.
- When mains fail, the UPS static switch which is normally OFF is made ON and directly connected to the load.
- A static switch will connect or disconnect the battery from the input of the inverter depending on the status of ac mains.

3) With neat diagram describe the principle of resistance welding.

Ans:

Diagram:- **02M**

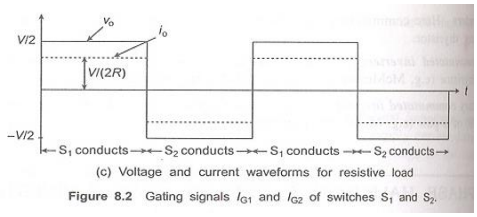
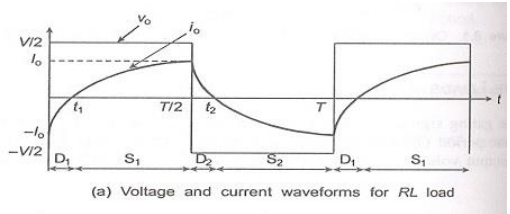
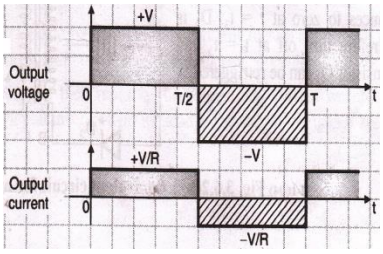
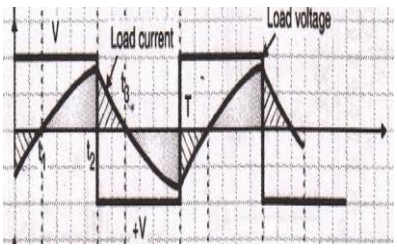


Principle:- **02M**

- Fig shows the basic arrangement for making a weld.
- The two overlapping metal sheets S_1 and $S_2$to welded are tightly clamped and kept in position between two electrodes E_1 and E_2 to which is supplied short duration low voltage high current supply. As a result of this current, the temperature of the common surfaces of sheets in region shown by dotted curves increases until the two pieces of the metal fuse together under the pressure of the electrodes.

4) Compare half bridge and push pull inverter w.r.t use of power device, use of o/p transformer, load voltage and load current.

Ans:

Parameter	Half bridge	Pushpull	Mark Distribution
Use of power device	Yes, two IGBTs/SCR/MOSFET	Yes, two power MOSFET/power transistor	**01M**
Use of output transformer	No	yes	**01M**
Load voltage & load current	**R-Load**  (c) Voltage and current waveforms for resistive load Figure 8.2 Gating signals I_{G1} and I_{G2} of switches S_1 and S_2. **OR** **RL-Load**  (a) Voltage and current waveforms for *RL* load	**R- load**  **OR** **RL load**  	**Load voltage W/F 01M** **Load current W/F 01M**

5) Draw Mc-Murray Bedford inverter with resistive load and describe the working.

Ans:

NOTE:- Any one either half or full bridge can be consider

I) Mc-Murray Bedford Half bridge inverter:- **02M**

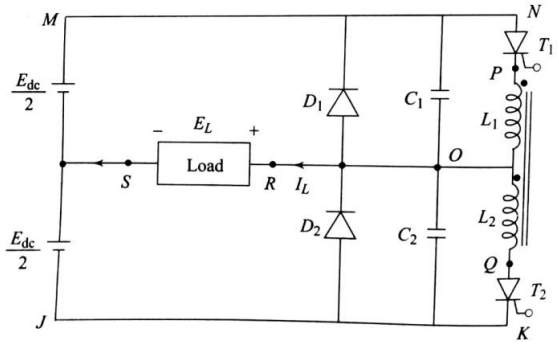


Fig. 9.49 *McMurray–Bedford half-bridge inverter ($C_1 = C_2 = C$ and $L_1 = L_2 = L$)*

Operation: **02M**

MODE 1:

- This mode begins when thyristor T1 is triggered , when T1 is turned ON, upper DC source supplies load current $+I_L$ through the load (+Edc/2,T1,L1, Load, -Edc/2)
- As the load current is almost constant, the voltage drop across the commutating inductance is negligible.
- With zero voltage drop across L1 and T1,the voltage across C1 is zero, and the voltage across C2 is Edc.

MODE 2:

- This mode begins when thyristor T2 is triggered to turn OFF thyristor T1.
- Node Q gets connected to K or J i.e. to the negative terminal of the supply.
- The voltage across C2, V_{c2}=Edc appears across L2.
- As inductors L1 and L2 are magnetically coupled, equal voltage is induced across L1 with point P positive.
- Node P is positive with respect to node N i.e. thyristor T1 is subjected to reverse voltage of –Edc i.e. T1 turns OFF.
- Load current which was flowing through T1 and L1 now transfers to the winding L2 and T2 in order to maintain the energy stored in the inductor.
- Both the capacitors C1 and C2 supplies constant load current IL.
- Half of I_C1 flows from load and other half flows from L2. The same is also true for I_C2.
- Ic1= Ic2
- Capacitor C1 is now getting charged; at the same time capacitor C2 getting discharged at the same rate and oscillating current is setup in the closed loop formed by C2, L2 and T2 as the capacitor C2 is placed across L2.
- At the same time Vc2 across C2 falls to zero.

MODE 3:

- This mode begins when capacitor C1 is charged to a supply voltage Edc. Therefore no current flows through C1 i.e. Ic1=0.

OR

II) MC MURRAY BED FORD FULL BRIDGE INVERTER: **02M**

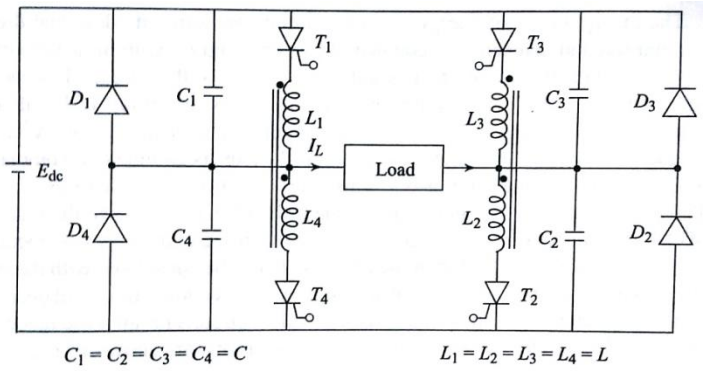


Fig. 9.52 *McMurray–Bedford full-bridge inverter*

Operation: **02M**

- It uses 4 SCRS and 4 diodes.
- When T1 and T2 are turned ON, the direction of load current is from A to B and the inductor stores energy.
- When T1 and T2 are turned OFF, inductor reverses its polarity.
- D3 and D4 becomes forward biased.
- When T3 and T4 are turned ON, the direction of load current is from B to A and the inductor stores energy.
- When T3 and T4 are turned OFF, inductor reverses its polarity.
- D1 and D2 become forward biased.