Q1. Explain CVT in detail

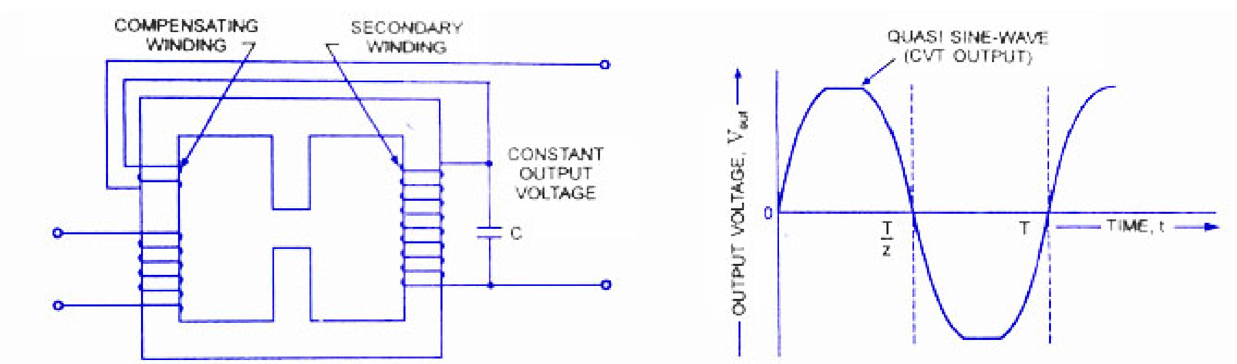
Ans:
The portion of the magnetic core over which the secondary winding is wound is saturated, while the portion over which the primary is wound is not saturated. A capacitor is connected across the secondary winding to tune out the output at a frequency very close to 50 Hz. This capacitor also makes the current in the secondary winding to increase which helps in the saturation of the secondary flux. Since the secondary ac flux is restricted to a saturated value for a large range of the input voltage (170-270 V), a constant voltage is available across the secondary winding. The output voltage will not be of a pure sinusoidal waveform but will be an approximate sinewave with the peaks flattened approaching a square wave. Output voltage waveform of a CVT is shown in figure.

In figure, a compensating winding is shown connected in series to the secondary to improve the CVT performance.

If a CVT is placed at the output of a square wave inverter (in the UPS), care must be taken to control the frequency of the inverter, since the CVT is sensitive to the frequency of its input supply.

The reason we use a CVT and not a voltage stabilizer for computer applications is that in the voltage stabilizer relays are present and when these relays operate (switch), the output voltage may be interrupted for a short time. Such a transient may not be desirable for computers which may cause the computer to reboot. Also, the CVT provides a clean spike-free output voltage. The voltage regulation possible in a CVT also is good.

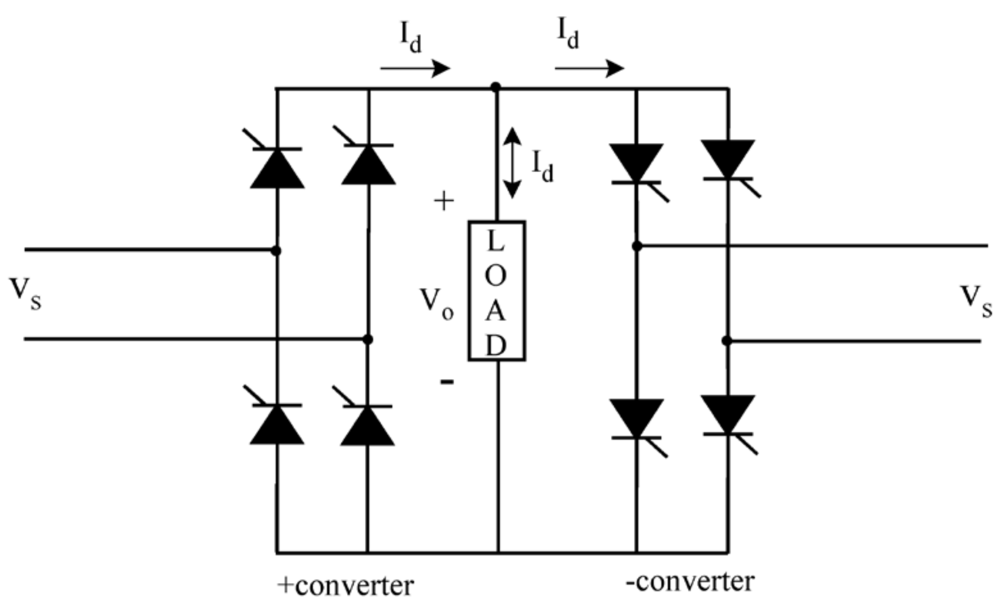
The input voltage ranges 170 to 260 V and output regulation is 230 ± 2 % at no load to full-load. Distortion-approximately 5% under full-load conditions. Rating of 50, 150, 250, 350, 500, 750, 1000, 2000 VA.



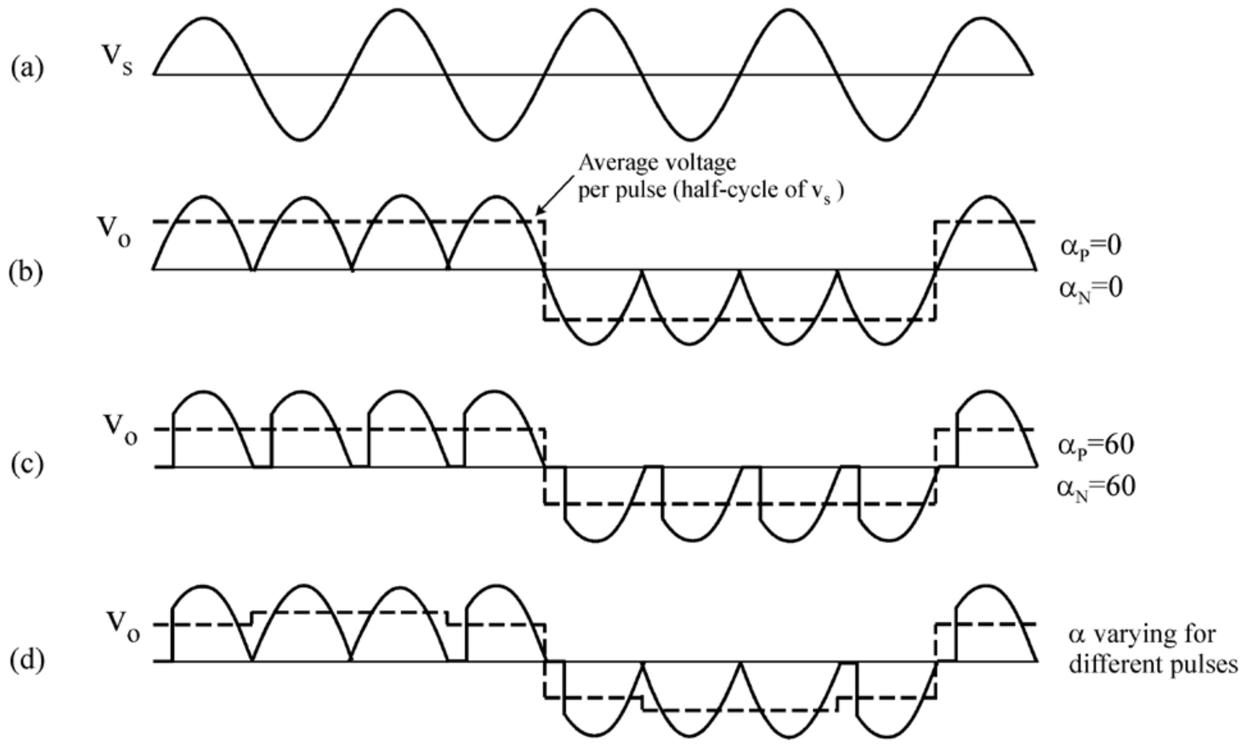
(a) Contructional Details (b) Output Voltage Waveform

The saturation of the core leads to there being harmonic fluxes present. These cause distortion of the output voltage waveform. Therefore to restore the quality of the voltage form the filter circuit is incorporated. Filtering is achieved by. And also a "compensating winding " can be introduced, in which it produces a small voltage that is used to buck the output voltage.

Q2. What is operation principle of Single-phase to Single-phase (1ϕ-1ϕ) Cycloconverter? and what are its applications?
Ans:
1.Operation Principles:
The following sections will describe the operation principles of the cycloconverter starting from the simplest one, single-phase to single-phase (1ϕ-1ϕ) cycloconverter.
1.1. Single-phase to Single-phase (1ϕ-1ϕ) Cycloconverter:
To understand the operation principles of cycloconverters, the single-phase to single-phase cycloconverter (Fig. 2) should be studied first. This converter consists of back-to-back connection of two full-wave rectifier circuits. Fig 3 shows the operating waveforms for this converter with a resistive load.
The input voltage, v_s is an ac voltage at a frequency, f_i as shown in Fig. 3a. For easy understanding assume that all the thyristors are fired at α=0° firing angle, i.e. thyristors act like diodes. Note that the firing angles are named as α_P for the positive converter and α_N for the negative converter.
Consider the operation of the cycloconverter to get one-fourth of the input frequency at the output. For the first two cycles of v_s, the positive converter operates supplying current to the load. It rectifies the input voltage; therefore, the load sees 4 positive half cycles as seen in Fig. 3b. In the next two cycles, the negative converter operates supplying current to the load in the reverse direction. The current waveforms are not shown in the figures because the resistive load current will have the same waveform as the voltage but only scaled by the resistance. Note that when one of the converters operates the other one is disabled, so that there is no current circulating between the two rectifiers.



Single-phase to single-phase cycloconverter



Single-phase to single-phase cycloconverter waveforms
a) input voltage
b) output voltage for zero firing angle
c) output voltage with firing angle $\pi/3$ rad.
d) output voltage with varying firing angle

The frequency of the output voltage, v_o in Fig. 3b is 4 times less than that of v_s, the input voltage, i.e. $f_o/f_i=1/4$. Thus, this is a step-down cycloconverter. On the other hand, cycloconverters that have $f_o/f_i>1$ frequency relation are called step-up cycloconverters. Note that step-down cycloconverters are more widely used than the step-up ones.
The frequency of v_o can be changed by varying the number of cycles the positive and the negative converters work. It can only change as integer multiples of f_i in 1ϕ-1ϕ cycloconverters.

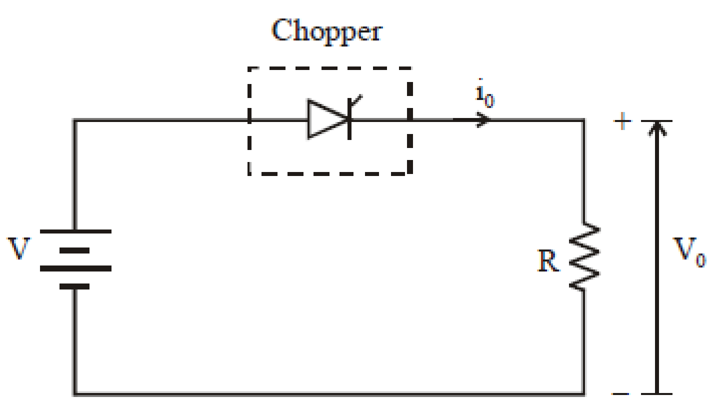
Some applications of cycloconverters are:

- Cement mill drives
- Ship propulsion drives
- Rolling mill drives
- Scherbius drives
- Ore grinding mills
- Mine winders

Q3. What is chopper? Explain step down chopper in detail.
Ans:
A chopper is a static device which is used to obtain a variable dc voltage from a constant dc voltage source. A chopper is also known as dc-to-dc converter. The thyristor converter offers greater efficiency, faster response, lower maintenance, smaller size and smooth control. Choppers are widely used in trolley cars, battery operated vehicles, traction motor control, control of large number of dc motors, etc….. They are also used in regenerative braking of dc motors to return energy back to supply and also as dc voltage regulators.

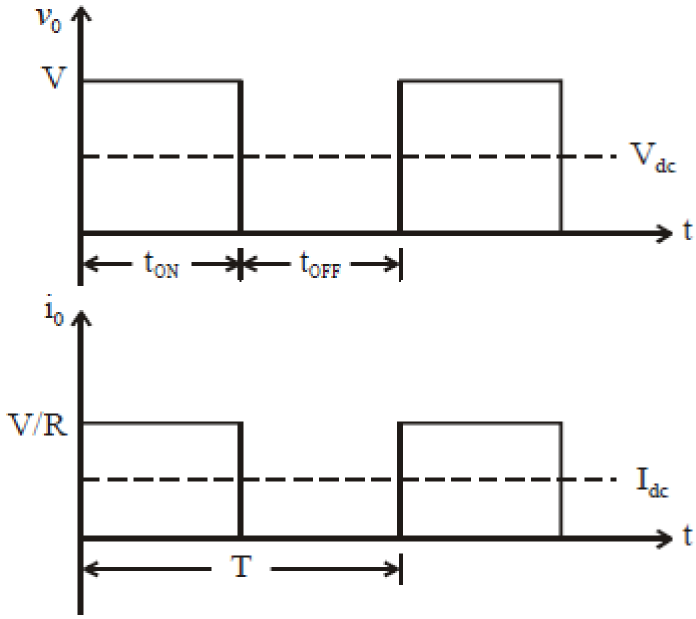
Choppers are of two types:
Step-down choppers
Step-up choppers
In step-down choppers, the output voltage will be less than the input voltage whereas in step-up choppers output voltage will be more than the input voltage.

PRINCIPLE OF STEP-DOWN CHOPPER



Step-down Chopper with Resistive Load

The thyristor in the circuit acts as a switch. When thyristor is ON,supply voltage appears across the load and when thyristor is OFF,the voltage across the load will be zero.



Step-down choppers — output voltage and current waveforms

V_{dc} = average value of output or load voltage

I_{dc} = average value of output or load current

t_{ON} = time interval for which SCR conducts

t_{OFF} = time interval for which SCR is OFF.

$T = t_{ON} + t_{OFF}$ = period of switching or chopping period

$f = \frac{1}{T} =$ frequency of chopper switching or chopping frequency.

Average output voltage

$$V_{dc} = V\left(\frac{t_{ON}}{t_{ON} + t_{OFF}}\right) \qquad ...(2.1)$$

$$V_{dc} = V\left(\frac{t_{ON}}{T}\right) = V.d \qquad ...(2.2)$$

but $\left(\frac{t_{ON}}{t}\right) = d =$ duty cycle $\qquad ...(2.3)$