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Q (1) a:

Ans (a):- Darlington Amplifier:-

The emitter follower circuit which was just discussed lacks to meet the requirements of the current gain (A_i) and the input impedence (Z_i). In order to achieve increase in the overall values of circuit current gain and input impedence, two transistors are connected as shown in the following circuit diagram, which is known as Darlington configuration.

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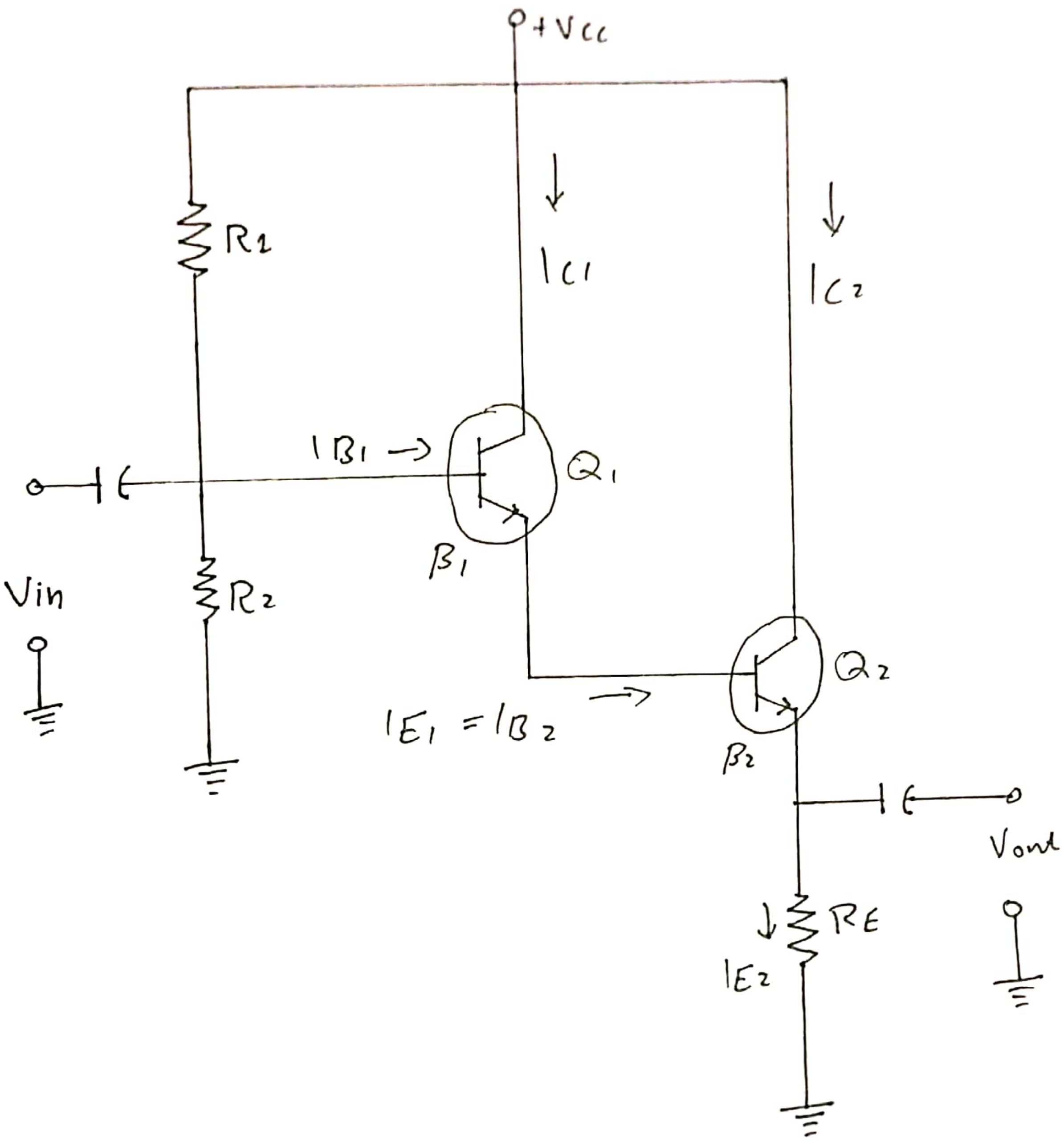

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As show in the above figure, the emitter of the first transistor is connected to the base of the second transistor. The collector terminals of both the transistors are connected together.

- Biasing Analysis:-

Because of this type of connection, the emitter current of the first transistor will also be the current of the second transistor. Therefore, the current gain of the pair is equal to the product of individual current gain

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i.e,

$$\beta = \beta_1 \beta_2$$

voltage across R_2,

$$V_2 = \frac{V_{CC}}{R_1 + R_2} \times R_2$$

voltage across R_E,

$$V_E = V_2 - 2V_{BE}$$

current through R_E,

$$I_{E2} = \frac{V_2 - 2V_{BE}}{R_E}$$

transistor are directly coupled,

$$I_{E1} = I_{B2}$$

Now

$$I_{B2} = \frac{I_{E2}}{\beta_2}$$

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Therefore

$$I_{E1} = \frac{I_{E2}}{\beta_2}$$

which means

$$I_{E1} = I_{E1}\beta_2$$

we have

$$I_{E1} = \beta_1 I_{B1} \quad \text{since } I_{E1} \cong I_{C1}$$

Hence

$$I_{E2} = I_{E1}\beta_2$$

can write

$$I_{E2} = \beta_1 \beta_2 I_{B1}$$

current gain can be given as

$$\beta = \frac{I_{E2}}{I_{B1}} = \frac{\beta_1 \beta_2 I_{B1}}{I_{B1}} = \beta_1 \beta_2$$

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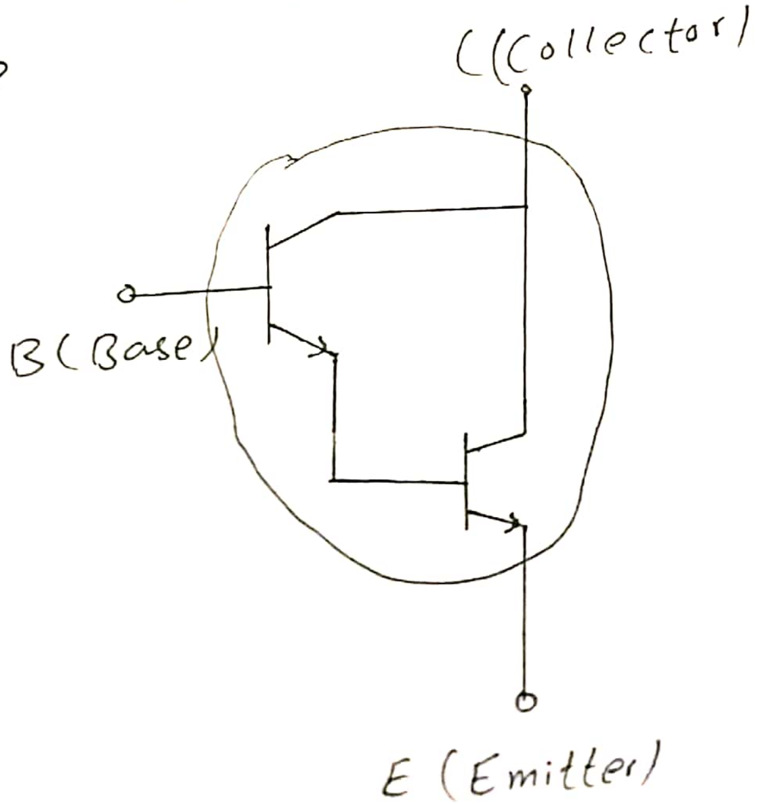
Input impedance of the darlington amplifier is

$$Z_{in} = \beta_1 \beta_2 R_E \quad \ldots\ldots \text{ neglecting } r'_e$$

In practice, these two transistor are placed in a single housing and the three terminals are taken out of the housing as shown in the following figure



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This three terminal device can be called as Darling ton transistor. The darling ton transistor acts like a single transistor that has high current gain and high input impedance.

Q(1) b:

Ans :- (b) :- Sol :-

(i) Line regulation :-

$$= \frac{0.062}{4.5} \times 100\%$$

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$$= 1.37\%$$

(ii) Line Regulation in %/V =>

$$= \frac{\frac{0.062}{40} \times 100\%}{4.5}$$

$$= 0.034\%/V$$

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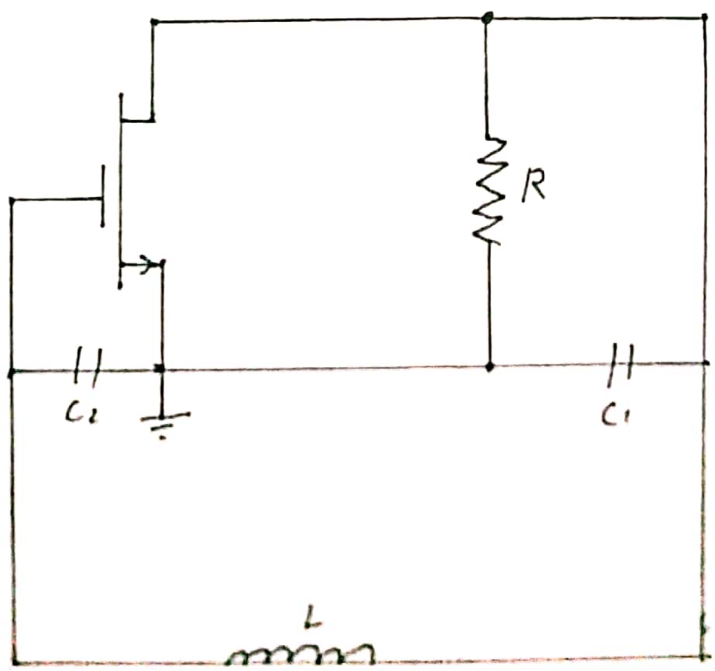
Q(2)

Ans:- Colpitts Oscillator:-

The Colpitts oscillator is a type of oscillator that uses an LC circuit in the feed-back loop.

- The feedback network is made up of a pair of tapped capacitors (C_1 and C_2) and an inductor L to produce a feedback necessary for oscillators.
- The output voltage is developed across C_1.
- The feedback voltage is developed across C_2.



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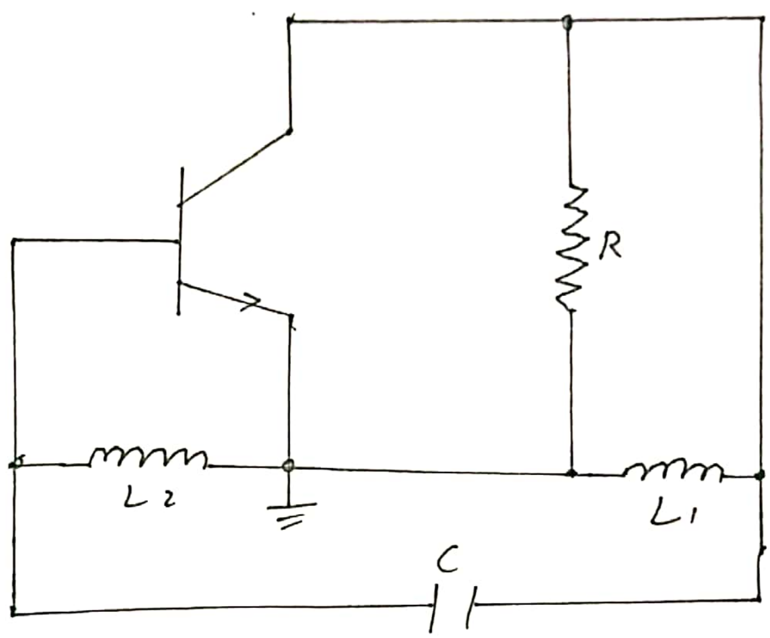
* Hartley Oscillator:-

The Hartley oscillator is almost identical to the colpitts oscillator.



* The primary difference is that the feedback network of the Hartley oscillator uses tapped inductors (L1 and L2) a single capacitor C.

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- The analysis of Hartley oscillator is identical to that colpitts oscillator.
- The frequency of oscillation:

$$\omega_o = \frac{1}{\sqrt{(L_1 + L_2)C}}$$

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Q (3):

Ans:- (a) Class B power amplifier:-

Class B amplifier is a type of power amplifier where the active device (transistor) conducts only for one half cycle of the input signal. That means the conduction angle is 180° for class B amplifier. Since the active device is switched OFF for half the input cycle, the active device dissipates less power and hence the efficiency is improved.

Theoretical maximum efficiency of class B power amplifier is 78.5%.

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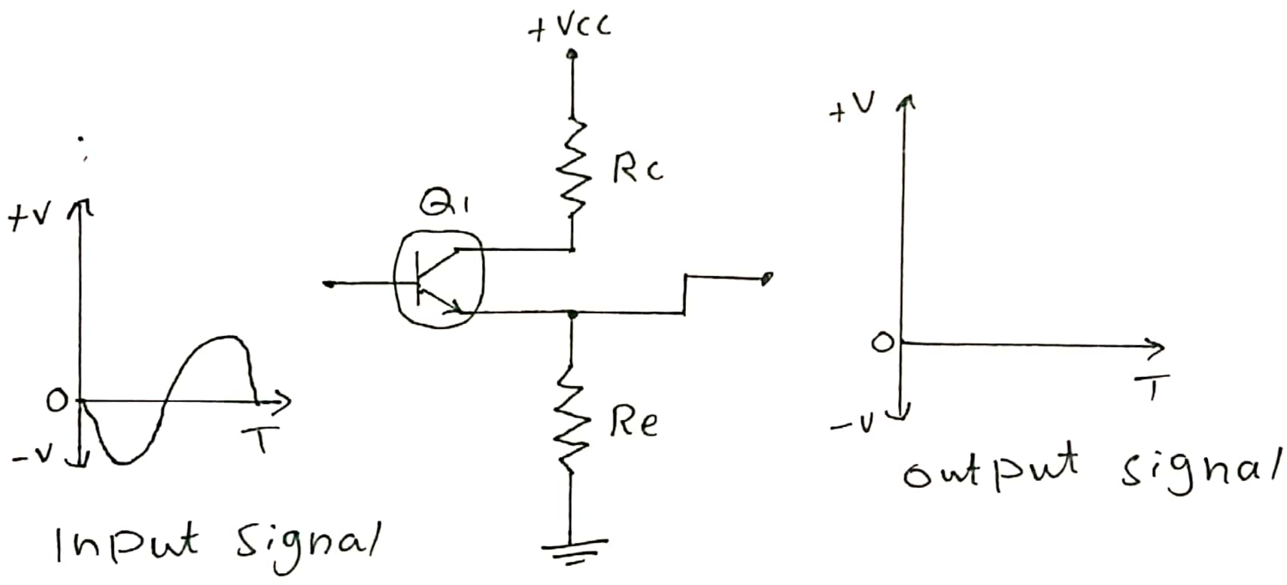
The schematic of a single ended Class B amplifier and input, output waveforms are shown in the figure below.



Single ended Class B amplifier

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Q 3:

Ans (b):- Types of voltage Regulator and their working Principle:-

There are two types of voltage regulators: (1) Linear voltage regulator.
(2) Switching voltage regulator.

* There are two types of Linear voltage regulators: Series and Shunt.

* There are three of switching voltage regulators: Step up, ~~Se~~ Step-down and Inverter voltage regulators.

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- **Linear Regulator:-**

Linear regulator acts as a voltage divider. In the ohmic region, it uses FET. The resistance of the voltage regulator varies with load resulting in constant output voltage.

- **Advantages:-**

Gives a low output ripple voltage.
Low electromagnetic interference and less noise.

- **Disadvantages:-**

Efficiency is very low.
Voltage above the input cannot be increased.

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Series Voltage Regulator:-

A series voltage regulator uses a variable element placed in series with the load. By changing the resistance of that series element, the voltage dropped across it can be changed. And, the voltage across the load remains constant.

Shunt Voltage Regulator:-

A shunt voltage regulator works by providing a path from the supply voltage to ground through a variable resistance. The current through the shunt regulator has diverted away

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from the load and flows uselessly to the ground, making this form usually less efficient than the series regulator.

* **Switching Voltage Regulator:-**

A switching regulator rapidly switches a series device on and off. The switch's duty cycle set the amount of charge transferred to the load. This is controlled by a feedback mechanism similar to that of a linear regulator. Switching regulators are efficient because the series element is either fully conducting or switched off because it dissipates almost no power.

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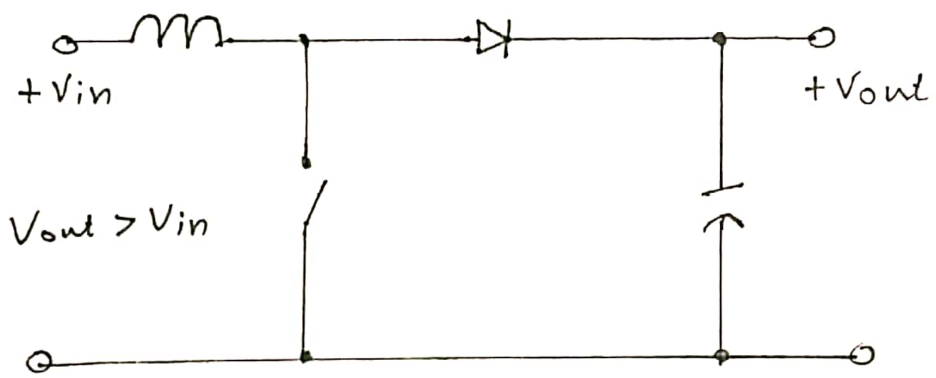
- Step-up Voltage Regulator:

step-up switching converters also called boost switching regulators, provide a higher voltage output by raising the input voltage.



Then $V_{in} I_{in} = V_{out} I_{out}$,

$$I_{out} / I_{in} = (1 - D)$$

- Power remain the same.
- voltage increases.
- current decreases.

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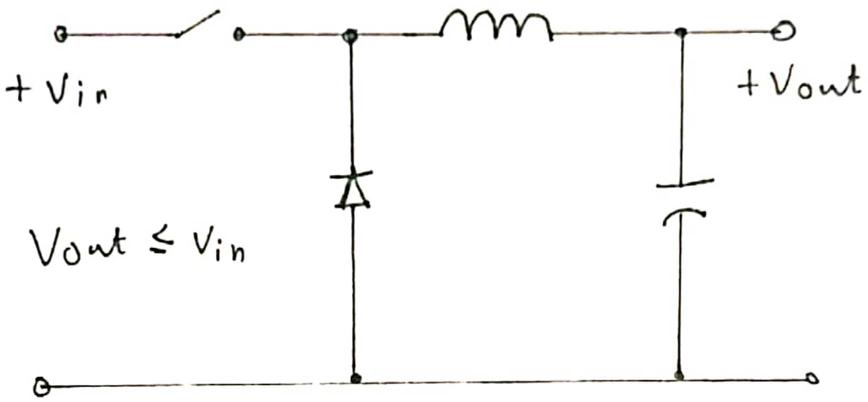
Step Down (Buck) voltage Regulator:-

It lowers the input voltage.



If input is equal to output power, than

$P_{in} = P_{out}$; $V_{in} I_{in} = V_{out} I_{out}$,

$I_{out} / I_{in} = V_{in} / V_{out} = 1/D$

Alternator voltage Regulator:-

Alternators produce the current that is required to meet a vehicle's electrical demands when the engine runs.

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It also replenishes the energy which is used to start the vehicle.
An alternator has the ability to produce more current at lower speed than the DC generator that were once used by most of the vehicles.
The alternator two parts:
(i) Stator :- This is a stationary component which does not move. It contains a set of conductor wound in coils over an iron core.
(ii) Rotor :- This is the moving component that produce a rotating magnetic field by anyone of the following three ways: (i) induction (ii) permanent magnets (iii) using an exciter.

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Q 4:

Ans:- An analog to digital converter (ADC) is an electronic device which converts varying analog signals into digital signals so that they can easily be read by the digital devices.
ADC converts the quantities of real world phenomenon in to digital language which is used in control systems, data computing, data transmission and information processing.

- ADC Process and How ADC work:-

There are two ~~type~~ steps for the analog to conversion:

1: S/H: Sampling and holding:-

An analog signal continuously changes with time, in order to measure the signal we have to keep it steady for a short duration so that it can be sampled. We could measure the signal repeatedly and very fast, and then find out the right time scale. Or preferably we can hold the signal for a specific duration and then digitize the signal and sample the value. For, at least the time required for digitization, it keeps the value stable.

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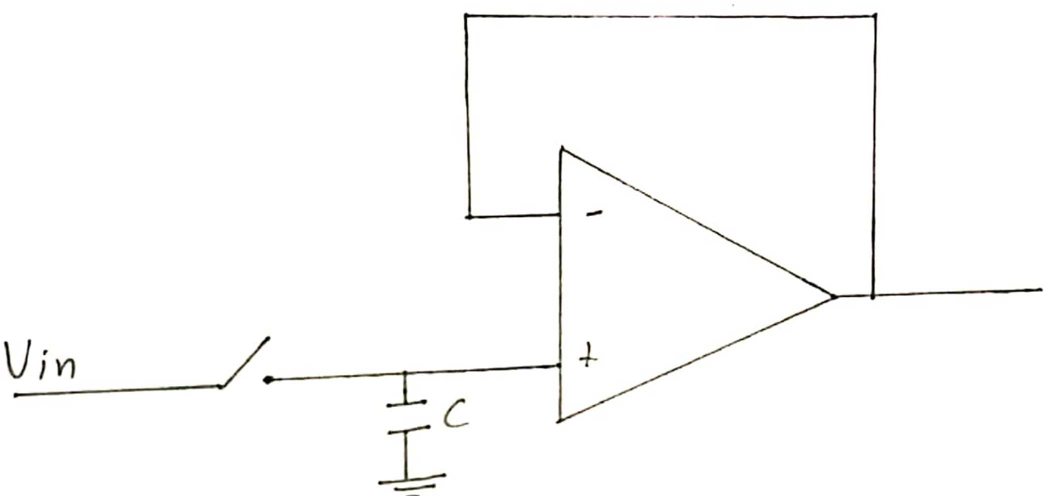
Figure shows the circuit for sampling and holding of a signal.



Sampling and holding circuit

we keep the switch normally open, and when we want to find a measurement, we close the switch momentarily.

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(2). Q/E : Quantizing and Encoding:-

On the output of (S/H), a certain voltage level is present. we assign a numerical value to it. And this value cannot be just any value, it should be from a limited set of possible values. It depends on the range of the quantizer and the range in given in a power of 2 i.e 2^n (2^8 = 256, 2^{10} = 1024 etc).

After identifying the closest value, a numerical value is assigned to it and it is encoded in the from of a binary number

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The binary encoded numbers generated by quantizer are represented by 'n' bits. The resolution of an ADC can also be denoted by 'n' bit.

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Q 5:

Ans:- (a) Key Difference between High Pass and Low pass Filter. The key difference between high pass and low pass filter is that the high pass filter circuit passes signals of the frequency higher than the cut off frequency while the low Pass filter passes signals of the frequency lower than the cut off frequency.

Q 5:

Ans (b) Active and passive filters:-

Active and passive filters are differentiated by the passivity of the components used in the filter circuit. If a component consumes power or incapable of power gain then it is known as a passive component. Components that are not passive are known as active components.

Q (6)

Ans:- Sol:-

Given data:-

$A_{ol} = 400,000.$

$A_{cm} = 0.6$

Required:

$CMRR = ?$

Sol:-

$$CMRR = \frac{A_{ol}}{A_{cm}} = \frac{400,000}{0.6}$$

$$\Rightarrow 666,666.6$$

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Expressed in decibels:-

$$CMRR = 20\ Log(666,666.6)$$

$$\Rightarrow 116.47\,dB$$

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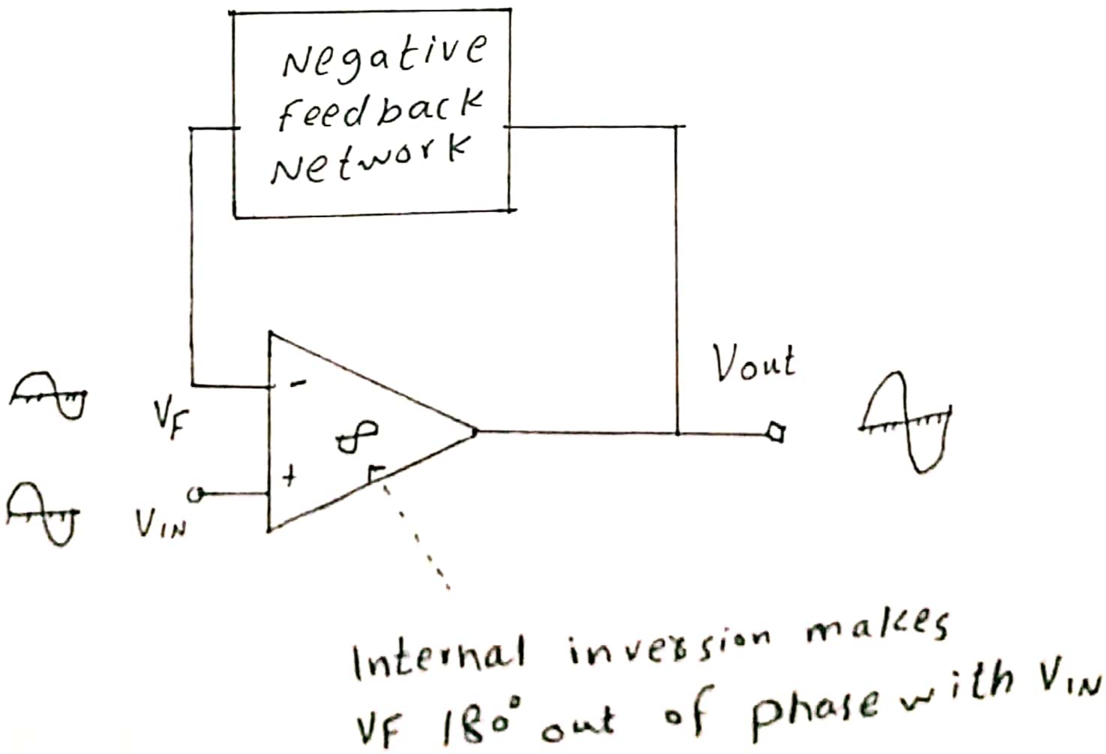
Q 7:

Ans (a) Negative Feedback:-

Negative feedback is the process where by a portion of the output voltage of an amplifier is returned to the input with a phase angle that opposes (or subtracts from) the input signal.

- Inverting (-) input effectively makes the feedback signal 180' out of phase with the input signal.



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