Department of Electrical Engineering
Assignment
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Course Details

Course Title: Electronic Circuit Design **Module:** 04
Instructor: sir eng mujtaba ihsan **Total Marks:** 50

Student Details

Name: farhan shah **Student ID:** 13180

Q1.	(a) (b)	**Discuss** the darlington connection for multistage amplifiers. The input of a certain regulator increases by 4.5 V. As a result, the output voltage increases by 0.062 V. The nominal output is 40 V. **Evaluate** the line regulation in both % and in %/V	Marks 05+10 CLO 2
Q2.		**Explain** Colpitts and Hartley oscillators.	Marks 10 CLO 2
Q3.	(a) (b)	**Describe** the idea behind class B amplifiers. **Explain the** types of voltage regulators and their purposes.	Marks 06+06 CLO 2
Q4.		**Explain** the working of Flash ADC.	Marks 05 CLO 2
Q5.	 (a) (b)	**Differentiate** between the following: Low pass & high pass filters Active and passive filters	Marks 04+04 CLO 2

Question 1(a):

Discuss the darlington connection for multistage amplifiers.

Answer:

Darlington connection:

In electronics, a multi-transistor configuration called the Darlington configuration (commonly called a Darlington pair) is a compound structure of a particular design made by two bipolar transistors connected in such a way that the current amplified by the first transistor is amplified further by the second one.

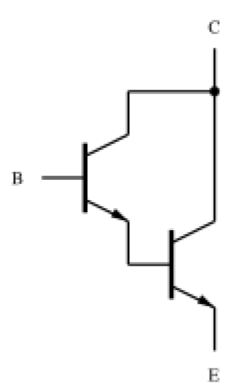
Main feature:

The main feature is that the composite transistor acts as a single unit with a

current gain that is the product of the current gains of the individual transistors

-Provides high current gain than a single BJT

-The connection is made using two separate transistors having current gains of β_1 and β_2 So, the current gain $\beta_D = \beta_1\beta_2$



if

The Darlington connection

provides a current gain of

$$\beta_D = \beta^2$$

Behavior:

A Darlington pair behaves like a single transistor, meaning it has one base, collector, and emitter. It typically creates a high current gain (approximately the product of the gains of the two transistors, due to the fact that their β values multiply together).

Advantages:

A typical Darlington transistor has a current gain of 1000 or more, so that only a small base current is needed to make the pair switch on higher switching currents.

Another advantage involves providing a very high input impedance for the circuit which also translates into an equal decrease in output impedance.

The ease of creating this circuit also provides an advantage. It can be simply made with two separate NPN transistors, and is also available in a variety of single packages.

Disadvantages:

One drawback is an approximate doubling of the base–emitter voltage. Since there are two junctions between the base and emitter of the Darlington transistor, the equivalent base–emitter voltage is the sum of both base–emitter voltages:

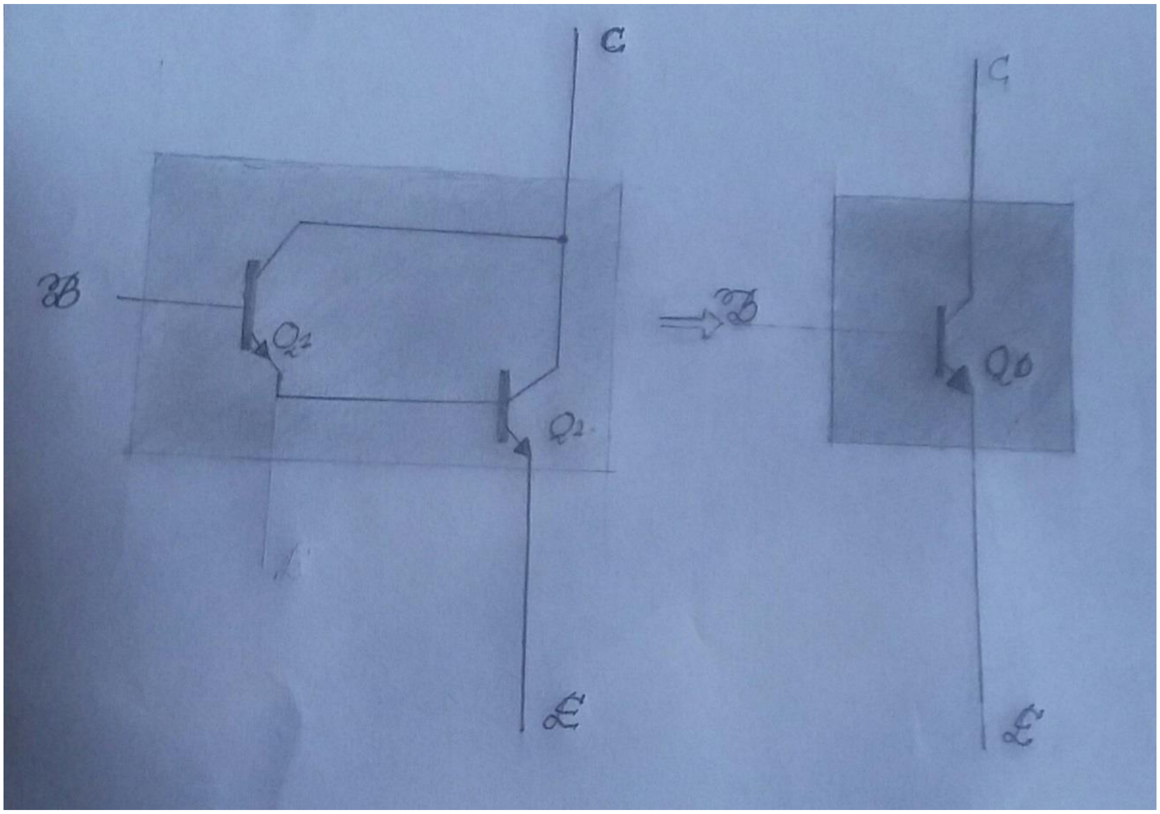
Application:

Safety:

A Darlington pair can be sensitive enough to respond to the current passed by skin contact even at safe zone voltages. Thus it can form a new input stage of a touch-sensitive switch.

Amplification:

Darlington transistors can be used in high-current[clarification needed] circuits, such as those involving computer control of motors or relays. The current is amplified from the normal low level of the computer output line to the amount needed by the connected device.



Part(B):

The input of a certain regulator increases by 4.5 V. As a result, the output voltage increases by 0.062 V. The nominal output is 40 V. Evaluate the line regulation in both % and in %/V

Answer:

We know that.

Line Reg.=0.062/4.5*100%=1.3777%

And line Reg.=0.062/40*100%=1.555%/v

Q2. Explain Colpitts and Hartley oscillators.

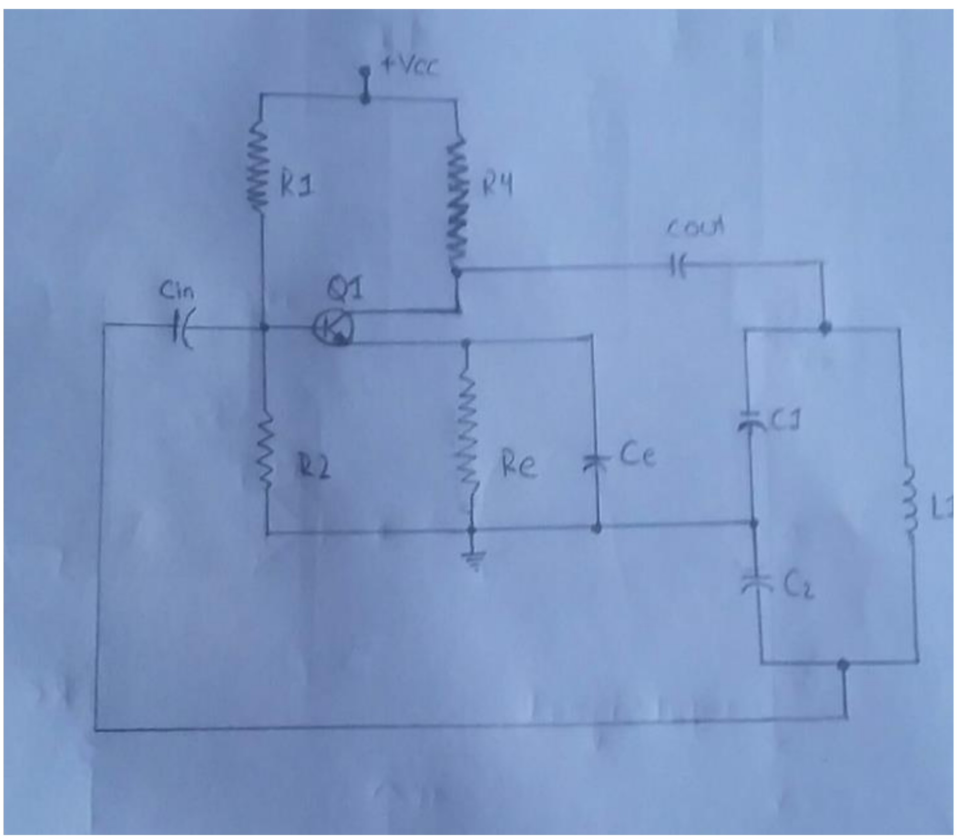
Answer:

Colpitts Oscillator:

Oscillator is an amplifier with the positive feedback and it converts DC input signal into AC output waveform with certain variable frequency drive and certain shape of output waveform (like sine wave or square wave, etc) by using the positive feedback instead of input signal. Oscillators which utilizes the inductor L and capacitor C in their circuit are called as LC oscillator which is a type of linear oscillator.

Colpitts Oscillator Circuit:

Every other oscillator circuit which generates sinusoidal waveforms utilizes the LC resonant circuit except a few electronic circuits such RC oscillators, Wien-Robinson oscillator and a few crystal oscillators which don't require additional inductances for this purpose.



Circuit Diagram of Colpitts Oscillator:

It can be realized by using gain device such as Bipolar Junction Transistor(BJT), operational amplifier and field effect transistor(FET) as similar in other LC oscillators also. The capacitors C1 & C2 forms potential divider and this tapped capacitance in the tank circuit can be used as the source for feedback and this setup can be used to provide better frequency stability compared to the Hartley oscillator in which tapped inductance is used for feedback setup

Applications of Colpitts Oscillator:

It is used for generation of sinusoidal output signals with very high frequencies.

The Colpitts oscillator using SAW device can be used as the different type of sensors such as temperature sensor. As the device used in this circuit is highly sensitive to perturbations, it senses directly from its surface.

It is frequently used for the applications in which very wide range of frequencies are involved.

Used for applications in which undamped and continuous oscillations are desired for functioning.

This oscillator is preferred in situations where it is intended to withstand high and low temperatures frequently.

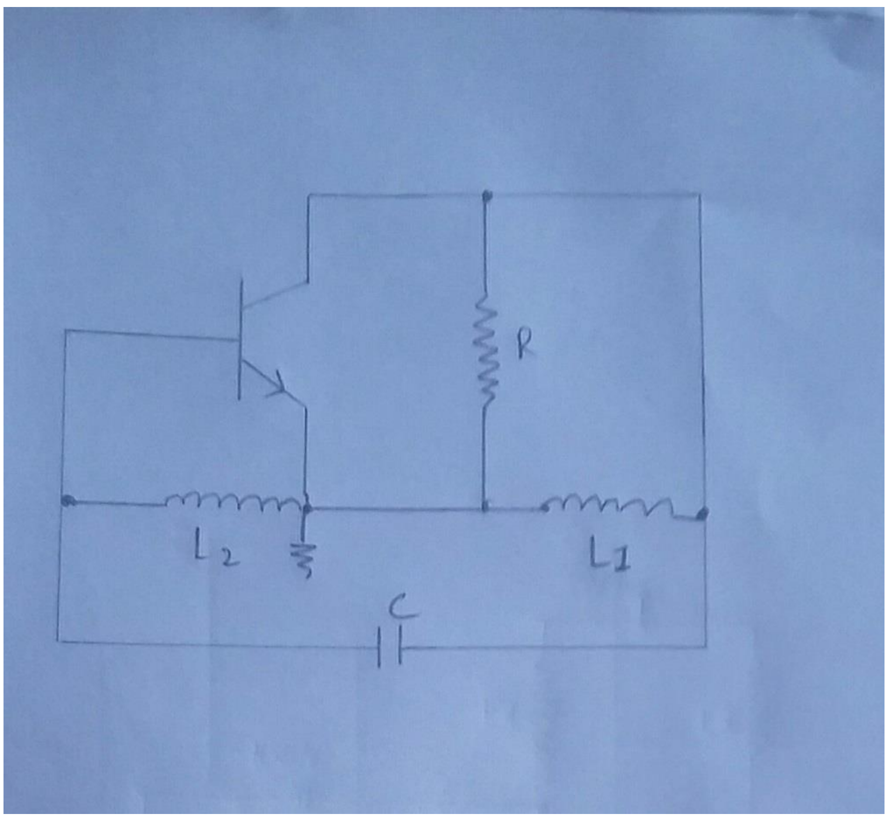
The combination of this oscillator with some devices (instead of tank circuit) can be used to achieve great temperature stability and high frequency.

It is used for the development of mobile and radio communications.

It has many applications used for the commercial purposes.

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) and a single capacitor C.



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

Advantages:

Instead of two separate coils L1 and L2, a single coil of bare wire can be used and the coil grounded at any desired point along with it.

By using a variable capacitor or by making core movable (varying the inductance), the frequency of oscillations can be varied.

Very few components are needed, including either two fixed inductors or a tapped coil.

The amplitude of the output remains constant over the working frequency range.

Disadvantages:

It cannot be used as a low-frequency oscillator since the value of inductors becomes large and the size of the inductors becomes large.

The harmonic content in the output of this oscillator is very high and hence it is not suitable for the applications which require a pure sine wave.

Applications:

The Hartley oscillator is to produce a sine wave with the desired frequency

Hartley oscillators are mainly used as radio receivers. Also note that due to its wide range of frequencies, it is the most popular oscillator

The Hartley oscillator is Suitable for oscillations in RF (Radio-Frequency) range, up to 30MHZ.

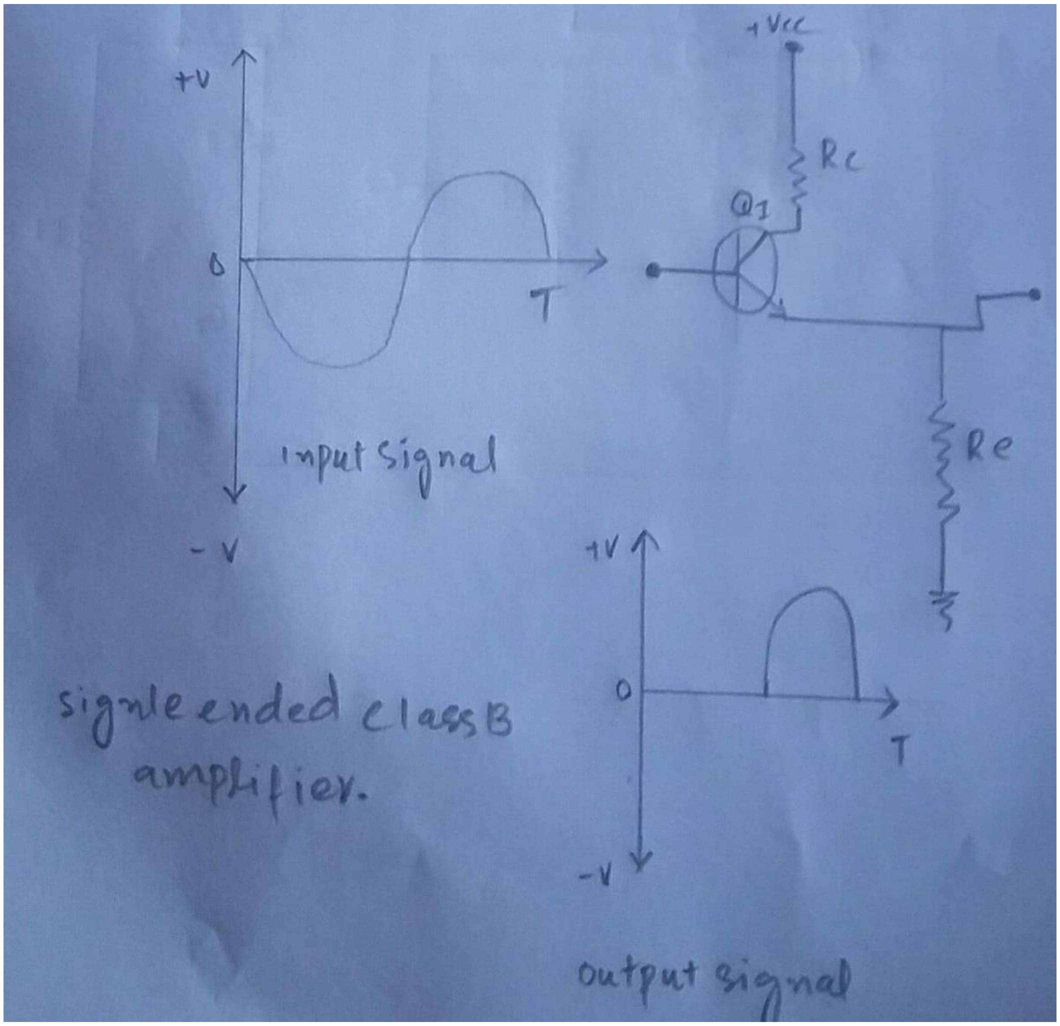
Question 3(A).

Describe the idea behind class B amplifiers.

Answer:

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



Class B benefits:

The first is circuit simplicity.

The signal is subjected to comparatively little amplification, resulting in an open loop gain which is generally fairly low.

This means that very little overall feedback is used, so stability and phase should be excellent over the audio frequencies.

Class B output stage:

Do not require any frequency compensation.

Q1 and Q2 form two unbiased emitter followers

Q1 only conducts when the input is positive

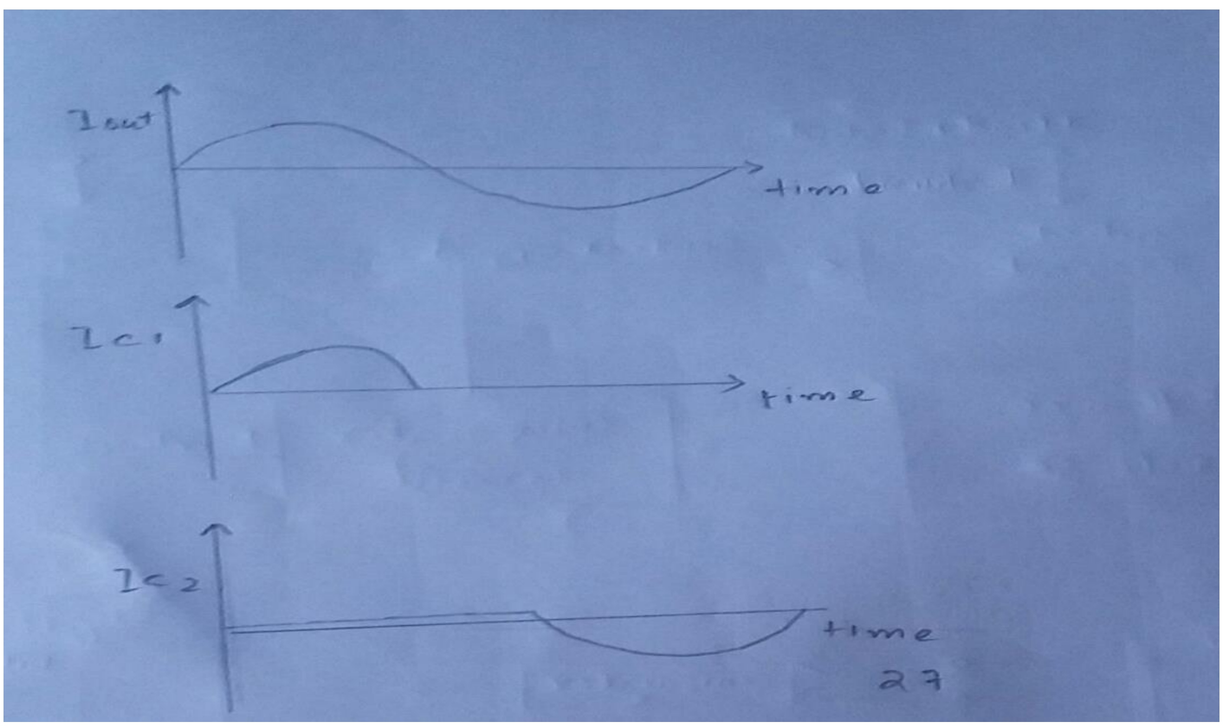
Q2 only conducts when the input is negative

Conduction angle is, therefore, 180°

When the input is zero, neither conducts

i.e. the quiescent power dissipation is zero.

Class B Current Waveforms



Class B amplifiers are used in low cost designs or designs where sound quality is not that important.

Class B amplifiers are significantly more efficient than class A amplifiers.

They suffer from bad distortion when the signal level is low (the distortion in this region of operation is called "crossover distortion").

Class B is used most often where economy of design is needed.

Before the advent of IC amplifiers, class B amplifiers were common in clock radio circuits, pocket transistor radios, or other applications where quality of sound is not that critical.

Part(B):

Explain the types of voltage regulators and their purposes.

Answer:

Types of Voltage Regulators and Their Working Principle

Basically, there are two types of Voltage regulators: Linear voltage regulator and Switching voltage regulator.

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

There are three types of Switching voltage regulators: Step up, Step down and Inverter voltage regulators.

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 of a linear voltage regulator:

Gives a low output ripple voltage

Fast response time to load or line changes

Low electromagnetic interference and less noise

Disadvantages of the linear voltage regulator:

Efficiency is very low

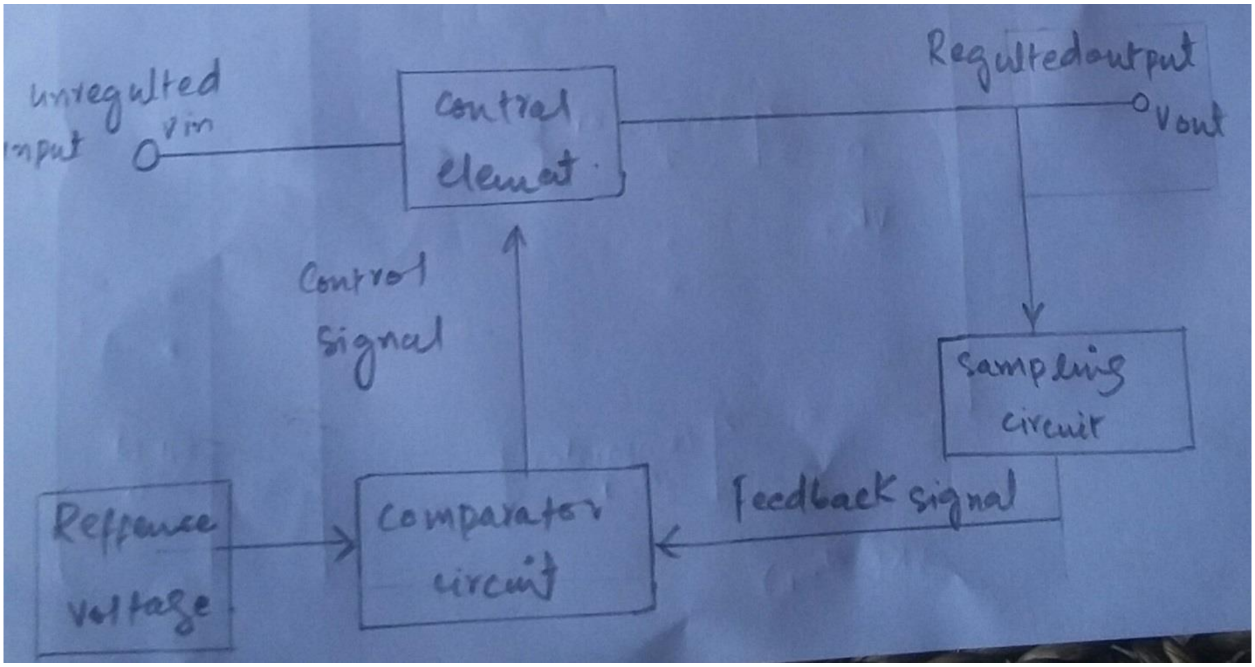
Requires large space – heatsink is needed

Voltage above the input cannot be increased

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. The amount of current drawn is effectively used by the load; this is the main advantage of the series voltage regulator. Even when the load does not require any current, the series regulator does not draw full current. Therefore, a series regulator is considerably more efficient than shunt voltage regulator.

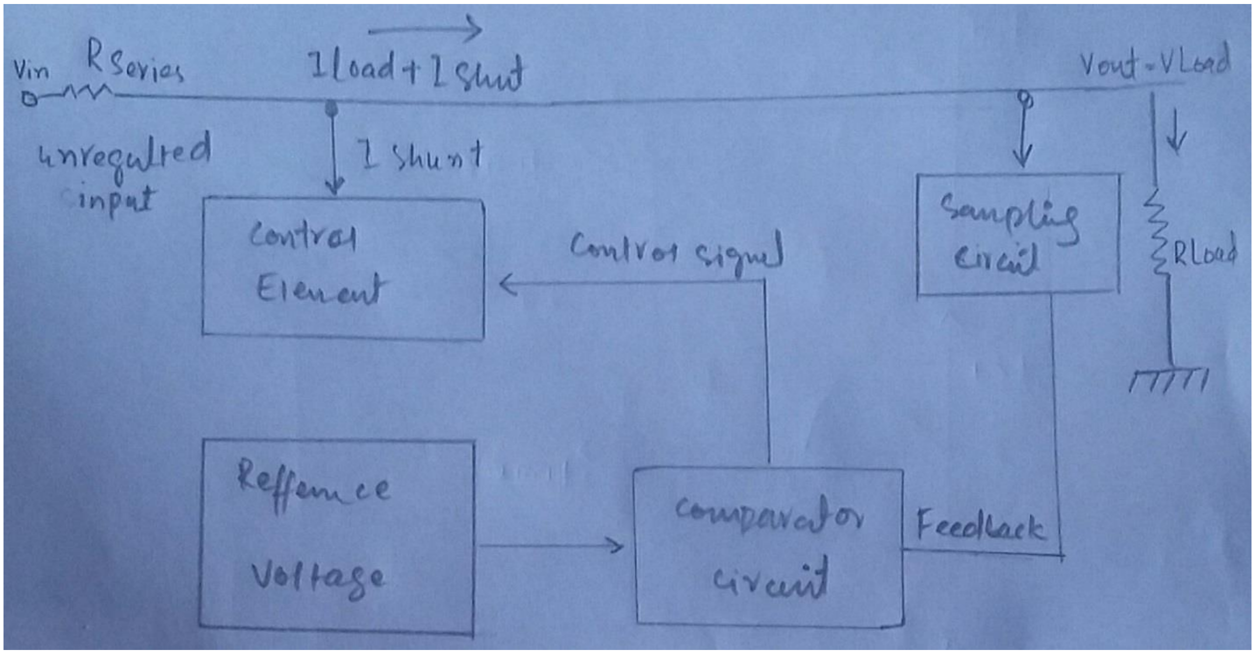
Series Voltage Regulator Circuit Series Voltage Regulator Circuit



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 from the load and flows uselessly to the ground, making this form usually less efficient than the series regulator. It is, however, simpler, sometimes consisting of just a voltage-reference diode, and is used in very low-powered circuits wherein the wasted current is too small to be of concern. This form is very common for voltage reference circuits. A shunt regulator can usually only sink (absorb) current.

Shunt Voltage Regulator



Applications of Shunt Regulators:

Shunt regulators are used in:

Low Output Voltage Switching Power Supplies

Current Source and Sink Circuits

Error Amplifiers

Adjustable Voltage or Current Linear and Switching Power Supplies

Voltage Monitoring

Analog and Digital Circuits that require precision references .Precision current limiters

Switching Voltage Regulator:

A switching regulator rapidly switches a series device on and off. The switch’s duty cycle sets 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. Switching regulators are able to generate output voltages that are higher than the input voltage or of opposite polarity, unlike linear regulators

Switching Voltage Regulator

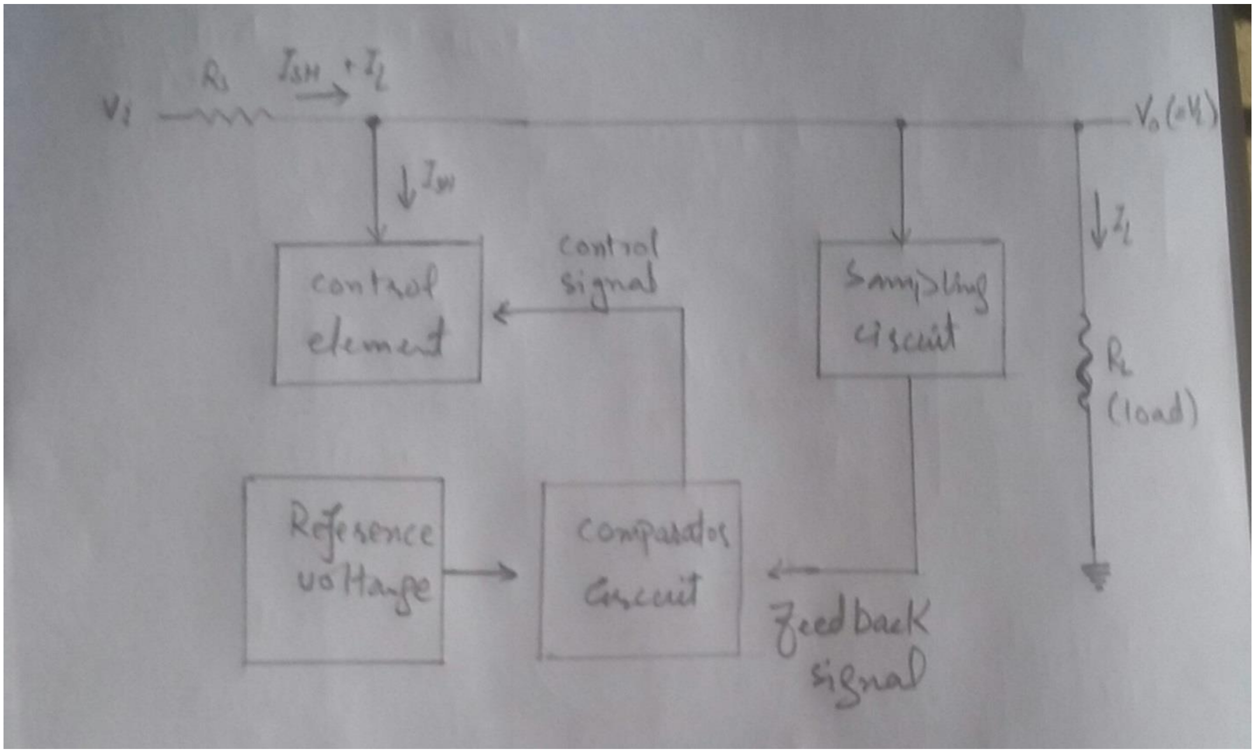
The switching voltage regulator switches on and off rapidly to alter the output. It requires a control oscillator and also charges storage components.

In a switching regulator with Pulse Rate Modulation varying frequency, constant duty cycle and noise spectrum imposed by PRM vary; it is more difficult to filter out that noise.

A switching regulator with Pulse Width Modulation, constant frequency, varying duty cycle, is efficient and easy to filter out noise.

In a switching regulator, continuous mode current through an inductor never drops to zero. It allows the highest output power. It gives better performance.

In a switching regulator, discontinuous mode current through the inductor drops to zero. It gives better performance when the output current is low.



Switching Topologies:

It has two types of topologies: Dielectric isolation and Non- isolation.

Non –Isolation: It is based on small changes in Vout/ Vin. Examples are Step Up voltage regulator (Boost) – Raises input voltage; Step Down (Buck) – lowers input voltage; Step up/ Step Down (boost/ buck) Voltage regulator – Lowers or raises or inverts the input voltage depending on the controller; Charge pump – It provides multiples of input without using inductor.

Dielectric – Isolation: It is based on radiation and intense environments.

Advantages of Switching Topologies:

The main advantages of a switching power supply are efficiency, size, and weight. It is also a more complex design, which is capable of handling higher power efficiency. Switching voltage regulator can provide output, which is greater than or less than or that inverts the input voltage.

<u>Disadvantages of Switching Topologies:</u>

Higher output ripple voltage

Slower transient recovery time

EMI produces very noisy output

Very expensive

Question(4).

Explain the working of Flash ADC.

<u>Answer:</u>

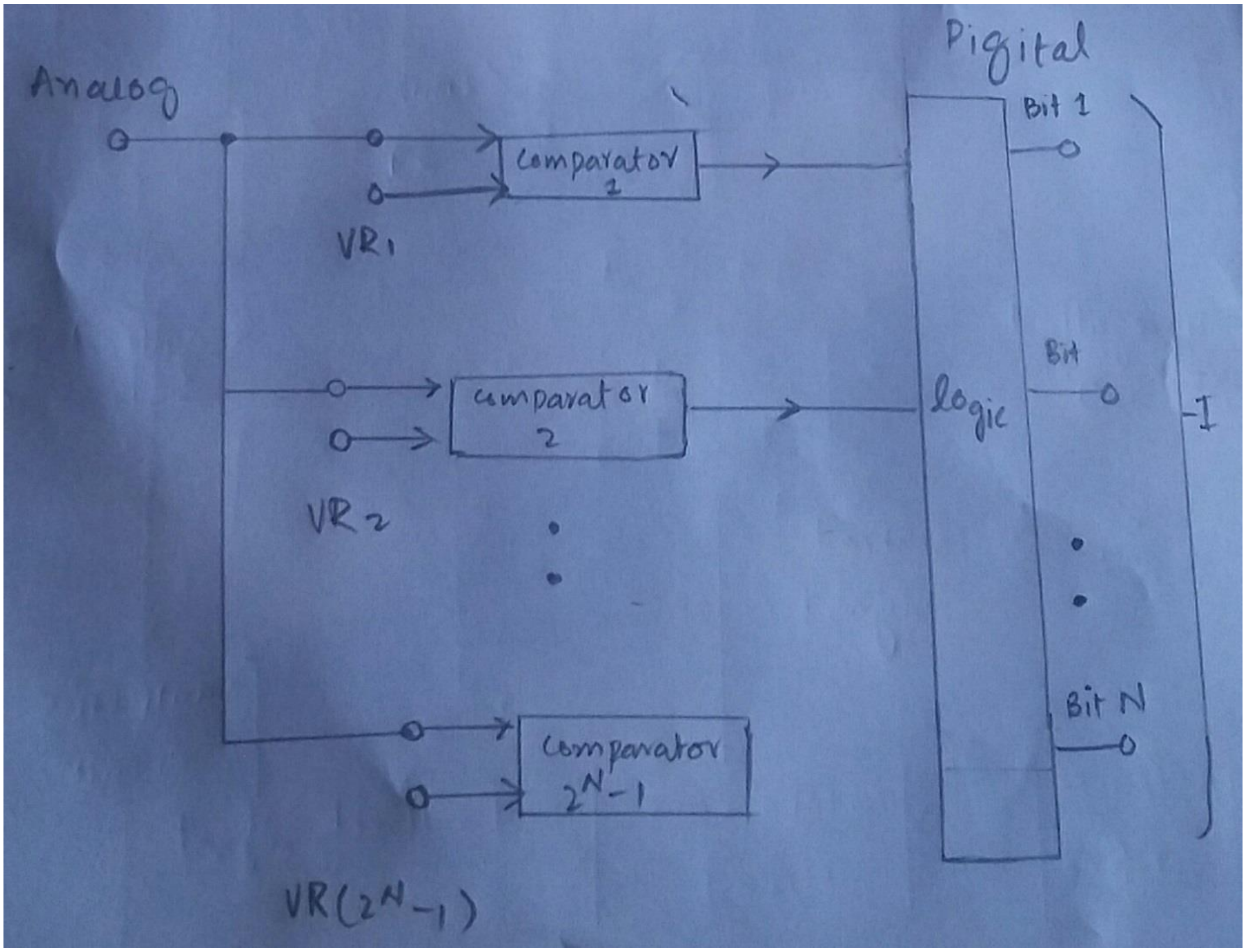
<u>Flash ADC:</u>

Also called the parallel A/D converter, this circuit is the simplest to understand. It is formed of a series of comparators, each one comparing the input signal to a unique reference voltage. The comparator outputs connect to the inputs of a priority encoder circuit, which then produces a binary output. The following illustration shows a 3-bit flash ADC circuit.

2N-1 comparators for N-bits

Each reference voltage equivalent to a quantization level

Encoding logic produces word.



Flash Working:

- As the analog input voltage exceeds the reference voltage at each comparator, the comparator outputs will sequentially saturate to a high state.

The priority encoder generates a binary number based on the highest-order active input, ignoring all other active inputs.

Advantages:

Simplest in terms of operational theory

Most efficient in terms of speed, very fast

limited only in terms of comparator and gate propagation delays.

Disadvantages:

Lower resolution

Expensive

For each additional output bit, the number of comparators is doubled

Example:

for 8 bits, 256 comparators needed.

Question (5).

Differentiate between the following:

(a) Low pass & high pass filters.

Answer:

(a) Low pass & high pass filters.

High Pass Filter:

A high pass filter attenuates the low-frequency signal and allows only high-frequency signal to pass through it. Although it offers attenuation to high-frequency signal too but the attenuation factor is so small that it can be neglected.

You must be thinking what is the designing process of High Pass filter, what makes it allow signals of high frequency to pass through it and blocking the signals of low frequency. This is possible by utilizing the characteristics of capacitor and resistor.

The input signals are applied to the capacitor, and then the voltage across the resistor is obtained as the output voltage. The combined term for the resistance of resistor and resistance of the capacitor is termed as reactance.

In the above circuit, it is evident that a capacitor is connected to the resistor.

It is quite clear from the above equation that the reactance is inversely proportional to the cut off frequency. If the frequency of the input signal is high, then the reactance will assume lower value. But if the frequency of the signal is low, the reactance will be high.

I hope now you understood that why a high pass filter allows the high frequency to pass through it while blocking the low frequency.

Low Pass Filter:

In a low pass filter, the position of capacitor and resistor is interchanged so that the desired output can be obtained. When the input is applied to low pass filter circuit, then the resistance will offer the constant obstruction, but the position of capacitor affects the output signal.

If the high-frequency signal is introduced in the low pass circuit, so it will pass from resistance which will offer it the usual resistance, but the resistance offered by capacitor will be zero. This is because the resistance offered by the capacitor to high-frequency signal is zero while to the low-frequency signal is infinite.

It is clear from the circuit diagram that if high-frequency signal enters low pass filter circuit than the capacitor will allow it to pass and it will be passed to ground. In this condition, the output voltage obtained is zero as the entire voltage is passed to ground.

But if low-frequency signal enters the low pass filter circuit then it will generate the output, because the resistance will offer the same obstruction as in the case of high-frequency signal bt the capacitor will provide infinite resistance.

Thus, in this condition, the signal cannot pass through the capacitor path. Thus he entire low-frequency signal is passed to the output terminal.

Comparison Chart:

PARAMETERS	HIGH PASS FILTER	LOW PASS FILTER
Definition:	It is a circuit which allows the frequencies above cut off frequency to pass through it.	It is a circuit which allows the frequency below cut off frequency pass to it.
Circuit Architecture:	It consists of Capacitor followed by a resistor.	It consists of resistor followed by Capacitor.
Significance:	it is significant when the distortion due to low frequency signal such as noise is to be removed .	It is significant in removing aliasing effect.
Operating Frequency:	Higher than the cut off frequency.	Lower than the cut off frequency.
Applications :	In audio amplifiers, low noise amplifiers etc.	In communications circuit as anti-aliasing filter.

Part (b).

Active and passive filters:

Passive filters:

contains passive components (R,L,C), they do not depend upon an external power supply and/or they do not contain active components such as transistors or battery. The simplest passive filters, RC and RL filters, include only one reactive element, except HYBRIED LC Filter which is characterized by inductance and capacitance integrated in one element.

Active filters:

are implemented using a combination of passive and active (amplifying) components, and require an outside power source. operational filters are frequently used in active filter designs. These can have high Q Factor, and can achieve resonance without the use of inductors. However, their upper frequency limit is limited by the bandwidth of the amplifiers. The most common types of active filters are classified into four such as 1.Butterworth 2.Chebyshev 3.Bessel 4.Elliptical

The difference between Active and Passive Filters:

1. Passive filters consume the energy of the signal, but no power gain is available; while active filters have a power gain.

2. Active filters require an external power supply, while passive filters operate only on the signal input.

3. Only passive filters use inductors.

4. Only active filters use elements kike op-amps and transistors, which are active elements.

5. Theoretically, passive filters have no frequency limitations while, active filters have limitations due to active elements.

6. Passive filters have a better stability and can withstand large currents.

7. Passive filters are relatively cheaper than active filters.

Applications of Active filters:

Active filters are used in communication system for suppressing noise to isolate a communication of signal from various channels to improve the unique message signal from a modulated signal.

These filters are used in instrumentation systems by the designers to choose a required frequency apparatus and detach unwanted ones.

These filters can be used to limit the analog signals bandwidth before altering them to digital signals.

audio systems by engineers to send various frequencies to various speakers. For example, in the music industry, record & playback applications are needed to control the frequency components.

Active filters are used in biomedical instruments to interface psychological Sensors with diagnostic equipments & data logging.

Applications of Passive filters:

low pass filters Woofers for low frequency, and Tweeters for high frequency reproduction). In this application the combination of high and low pass filters is called a "crossover filter".

high pass filters especially audio amplifiers

band pass filters while rejecting signals at all frequencies above and below this band

band stop filters older radio and TV receivers

I.F Transformers found in older in radio and TV equipment to pass a band of radio frequencies from one stage of the intermediate frequency (IF) amplifiers.