1 a) What is the need of a difference amplifier?

A difference amplifier is a type of electronic amplifier that amplifies the difference between two input voltages but suppresses any voltage common to the two inputs.

→ It is an analog circuit with two inputs V_{in}^- and V_{in}^+ and one output V_{out} in which the output is ideally proportional to the difference between the two voltages.

$$V_{out} = A(V_{in}^+ - V_{in}^-)$$

where,

A - gain of the amplifier.

b) What is the Effect of -ve feedback on gain?

The negative feedback improves the gain stability

Proof:

The gain of negative feedback amplifier,

$$A_f = \frac{A}{1 + A\beta}$$

differentiate w.r.t 'A' on both sides

$$\frac{dA_f}{dA} = \frac{(1+A\beta) - A\beta}{(1+A\beta)^2} = \frac{1}{1+A\beta} - \frac{A\beta}{(1+A\beta)^2}$$

$$\frac{dA_f}{dA} = \frac{1 + A\beta - A\beta}{(1+A\beta)^2} = \frac{1}{(1+A\beta)^2}$$

$$dA_f = \frac{dA}{(1+A\beta)^2}$$

divide with A_f on both sides

$$\frac{dA_f}{A_f} = \frac{dA}{A_f (1+A\beta)^2}$$

$$\frac{dA_f}{A_f} = \frac{dA}{\frac{A}{1+A\beta}(1+A\beta)^2}$$

$$\frac{dA_f}{A_f} = \frac{dA}{A} \cdot \frac{1}{(1+A\beta)}$$

→ An $(1+A\beta) >> 1$, the percentage change in A_f is less than the percentage change in A.

→ Hence it proves that the stability gain with feedback.

→ Sensitivity factor, $S_f = \frac{1}{1+A\beta}$

→ Desensitivity factor, $S_{df} = (1+A\beta)$

c) Write the advantages of crystal oscillators.

→ The Q-factor of a crystal is very high of the order of 10^6 compared to that of an LC circuit and as such the frequency of crystal oscillator is highly stable, the circuit frequency depends upon the crystal resonance frequency alone and nothing else.

→ By changing the crystal with another crystal different oscillator frequencies can easily be achieve.

→ The frequency drift can be made less than one part in 10^6.

→ Crystal oscillator doesn't need a separate tuned circuit.

d) What are the advantages of push-pull amplifier?

Advantages of push-pull amplifier :—

→ Even harmonics are Eliminated

→ It gives more output for an allowed distortion.

→ It consists of less distortion for a specified

output.

→ It Eliminates the saturation of transformer core due to out of phase collector currents.

→ The Effects of ripple voltage due to inadequate filtering is restricted.

e) What is the need of heat sinks in power amplifiers?

The power transistors are required to operate over a temperature range of 100° – 200°C.

To protect them from damage, maximum ratings are provided by the manufacture. Silicon power amplifier has an operating temperature range of 150° – 200°C and Germanium has 100° – 110°C. The average power dissipated is approximately given by, $P_D = V_{CE} I_C$

In order to dissipate the heat generated by the power transistor junctions into air, heat sinks are used. That is heat sink is one who holds the case temperature at a lower value.

8) List the ideal characteristics of OP-AMP.

The various characteristics of a ideal OP-AMP are:

(a) Infinite voltage gain
(b) Infinite input resistance
(c) Zero output resistance
(d) Zero offset voltage
(e) Infinite Bandwidth
(f) Infinite CMRR
(g) Infinite slew rate
(h) No effect of temperature.

9) What is CMRR ? Define.

→ The ability of a differential amplifier to reject a common mode signal is expressed by a ratio called Common mode rejection ratio. Denoted as CMRR.

→ CMRR is defined as the ratio of the differential voltage gain A_d to common mode voltage gain A_c.

$$\therefore \text{CMRR} = \frac{A_d}{A_c}$$

→ CMRR in decibels $= 20 \log \left(\frac{A_d}{A_c}\right)_{dB}$.

1 a) Write about Barkhausen Criteria.

* When the loop gain $A\beta$ is made Equal to unity in the above Expression, then A_f becomes '∞'. Then the circuit oscillator on this condition ($A\beta = 1$) is known as Barkhausen condition for oscillation.

* The content of magnitude of attentivation β produced by the feedback network is compensated by the gain ($A = 1/\beta$), contributed by the internal amplifier so that $A\beta = 1$.

* Oscillator o/p signal undergoes a total phase shift of 360° or 0°. The signal undergoes a phase shift of 180° in the internal amplifier and 180° phase shift in feedback network.

b) Compare class A, B and C amplifiers.

* Class A Power amplifier: When the collector current flows at all time during the full cycle of signal, the power amplifier is known as class A power amplifier.

→ It is defined as an amplifier in which the

output current flows for the full cycle of 360° of input signal.

* Class B Power amplifier: When the collector flows only during the positive half cycle of the input signal, the power amplifier is known as class B power amplifier.

→ It is defined as an amplifier in which the output current I_o flows for half cycle of 180° of input signals.

* Class C Power amplifier: When the collector current flows for less than half cycle of the input signal the amplifier is known as Class-C power amplifier.

→ The flow of current is for above 120° of output current I_o during the +ve half cycle of the input.

→ It has high efficiency, is used in tuned RF Power amplifiers.

c) What is harmonic distortion?

The harmonic distortion means the presence of the frequency components in the output wave form, which are not present in the input signal.

→ The component frequency same as the input

signal is called fundamental frequency component

→ The additional frequency components present in the output signal are having frequencies which are integral multiples of the fundamental frequency are called harmonic components / harmonics.

d) Write about different types of Heat sinks.

e) Write about frequency stability in oscillations.

→ The frequency stability of the oscillator is defined as the ability of an oscillator to maintain the required frequency over along time interval as possible.

→ In transistor oscillator, the frequency of oscillations doesnot remain stable during a long time because the circuit gestures like circuit components, transistor parameters, supply voltage and stray capacitances etc; On which the oscillator frequency depends, do not remain constant in time.

f) Explain how an operational amplifier acts like differentiator.

→ An operational amplifier is a direct coupled high gain amplifier usually consisting of

one or more differential amplifiers and followed by a level translator and an output stage.

→ This operational amplifier circuit performs the mathematical operation of differentiator, that is it produces a voltage output which is directly proportional to the input voltages rate of change with respect to time.

→ As with the integrator circuit, we have a resistor and capacitor forming an RC network across the operational amplifier and the reactance (X_C) of the capacitor plays a major role in the performance of an OP-AMP differentiator.

9) Explain in brief types of feedback amplifier.

→ The feedback amplifier are classified into four types. They are:

(1) Voltage series feedback Amplifier.

(2) Voltage shunt " "

(3) Current series " "

(4) Current shunt " "

Voltage Series feedback Amplifier :—

→ Here the part of the output voltage is feedback in series with the input signal.

→ The input connection is given by series and the output in shunt type.

Voltage shunt feedback Amplifier :— .

→ The feedback connection at the input part is shunt type. So, the feedback parameter is converted to current.

→ Where the feedback connection at output is also shunt type.

Current series feedback Amplifier :—

→ Current can be sampled by breaking the circuit at the output part and adding to the feedback network in series.

→ By adding the f/b n/w, automatically couple the output into the input port.

Current shunt feedback Amplifier :—

→ The output current is sampled and applied in shunt to the input of the amplifier.

→ Where the feedback connection at output port is series type.

AEC Previous Questions

2012 (2 Marks)

1. Discuss about push-pull amplifier.

A push pull amplifier is an amplifier which has an output stage that can drive a current in either direction through the load. It consists of two identical pair of transistors PNP and NPN.

* As the collector currents are flowing in opposite direction in the primary transformer core DC saturation of the Core is eliminated.

2. what are the merits of RC oscillators

* RC phase shift oscillator provides good frequency stability
* It can even produce very low frequencies (5Hz)
* The h_{fe} of amplifier used in phase shift oscillator is $h_{fe} > 44.5$

3. what are the values of R_i and R_o for ideal voltage and current amplifiers?

Voltage amplifier	Current amplifier
i, Very large input resist-ance $R_{in} >> R_s$	i, Very small input resistance $R_{in} << R_s$
ii, Very small o/p resistance $R_o << R_L$	ii, Very large o/p resistance $R_o >> R_L$

4. In what respects small signal amplifiers differ from large signal amplifier?

In large signal amplifiers, the input voltages are high are as comparable to that of D.C voltages (supply voltages) whereas, the input voltages are very small compared to D.C voltages in small signal amplifiers.

5. what are the four possible topologies of feedback networks?

a. voltage series feedback
b. voltage shunt feedback
c. Current series feedback
d. Current shunt feedback

6. list out the classification of oscillators

i, Audio frequency oscillators (below 20Hz)
   * RC oscillators
ii, Radio frequency oscillators (above 20Hz)
   * LC oscillators
iii, Crystal oscillators

7. Define i, slew rate ii, CMRR of op-Amp.

Slew Rate:- Slew rate is defined as the rate of change of output voltage with time.

CMRR :- It is defined as the ratio of differential voltage gain A_d to common mode voltage gain A_c

$$CMRR = \frac{A_d}{A_c}$$

2013

1. what is meant by positive and negative feedback?

Positive feedback :- It is defined as the feedback in which the feedback signal is in phase with the input signal. It is also called regenerative feedback.

Negative feedback :- It is defined as the feedback in which the feedback signal is phase opposition to the input signal. It is also called degenerative feedback

2. what are the conditions for sustained oscillations?

An oscillator can produce sustained oscillations only if it satisfies Barkhausen's criteria.

i) The phase shift of the circuit must be 0° or 360°

ii) Loop gain ($A\beta$) must be equal to 1 ($A\beta = 1$)

3. what is cross-over distortion? How it can be elimina-ted?

crossover distortion is the term given to a type of distor-tion that occurs in push-pull class AB or class B

amplifiers. This can be reduced considerably by applying a slight forward bias base voltage of the two transistors via centre-tapped input transformer

4. what are the advantages of double tuned over single tuned amplifiers.

(i) The Bandwidth obtained from the double tuned amplifier is $\sqrt{2}$ time the bandwidth obtained from that of single tuned amplifier

(ii) Double tuned amplifiers provide flattal response for all pass band frequencies.

5. state applications of op-amp.

Op amps can be used as

(i) Summer (ii) Buffer (iii) Inverter (iv) Integrator

(v) Differentiator (vi) Multi-Vibrator (vii) Pulse generator

6. Explain the different regions in frequency response of an amplifier.

The different regions in frequency response of an amplifier are

(i) low frequency range

(ii) Medium frequency range

(iii) High frequency range

2011 PAPER

1a) State the advantages and disadvantages of cascaded Amplifiers.

Ans Advantages:

1. Signal, load and the amplifier bias are separate.
2. No dc current flows through the load or through the signal source.
3. Stages can easily be cascaded.
4. Gain and Bandwidth increases.

Disadvantages:

1. At low frequencies, capacitors fail to act like short circuit.

Therefore, cascaded Amplifiers behaves like a high pass filter and becomes useful only above a certain cut-off frequency.

2. Three capacitors are needed for each amplifier stage. Capacitors are bulky and costly and cannot be integrated on a silicon chip.

b) Name the four feedback amplifier topologies.

Ans The four feedback Amplifier topologies are:-

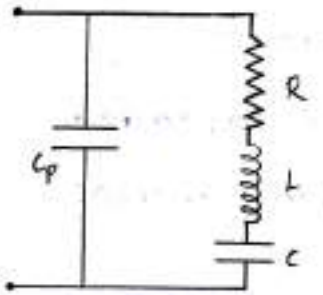
1) Voltage Series feedback Amplifier.
2) Voltage Shunt feedback Amplifier.

3.) Current Series feedback Amplifier.

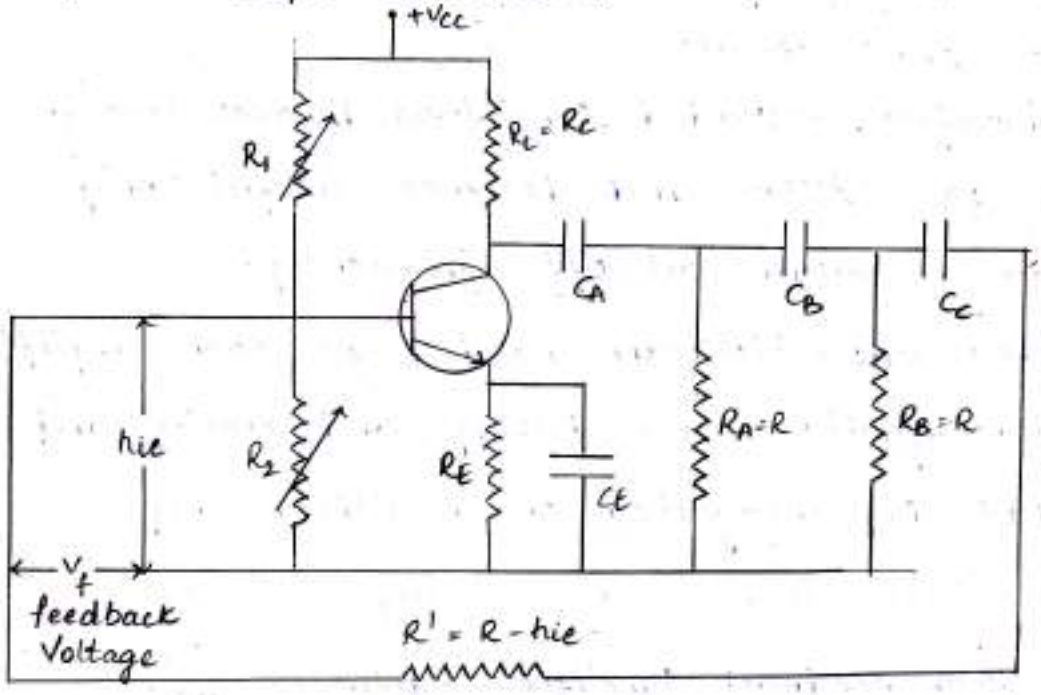
4.) Current shunt feedback amplifier.

c) Draw the electrical equivalent of Crystal oscillator. Draw the circuit for RC phase shift oscillator.

Ans Electrical equivalent of Crystal Oscillator.



RC phase shift Oscillator:



d) Why are power Amplifiers called large signal Amplifiers?

Ans The main aim of large signal amplifier is to deliver a substantial amount of power to a load. Hence they are called power amplifiers.

e) Differentiate between synchronous tuning and Stagger tuning.

Ans

Synchronously tuned Amp.		Stagger tuned Amp.
Each tuned circuit is tuned to the same frequency.	1.	Each tuned ckt is tuned to slightly different frequency.
The overall B.W is less than that of single tuned amp.	2.	B.W is increased.
B.W shrinks by a factor of $\sqrt{2^{1/n}-1}$ in terms of B.W of single stage.	3.	B.W is $\sqrt{2}$ times that of individual single tuned circuit.
Gain is more.	4.	Gain is less when compared to synchronously tuned amp.
Narrower B.W	5.	Maximally flat wide B.W with steeper slopes.

f.) Define the following terms as applied to OP-Amp.
i.) CMRR ii.) Slew rate.
What is the physical significance of each?

Ans i.) CMRR:

It is defined as the ratio of differential voltage gain (A_d) to common mode voltage gain (A_c).

$$CMRR = \frac{A_d}{A_c}$$

The ability of differential amp to reject a common mode signal is expressed by a ratio called CMRR. (Common Mode Rejection Ratio).

ii.) Slew rate:

It is defined as the max. rate of change of o/p voltage per unit change in time and is expressed in V/μ.sec.

$$\text{i.e., } SR = \frac{dV_o}{dt}\Big|_{\text{max. value}} \quad V/\mu s.$$

Slew rate indicates how rapidly the o/p of OP-Amp can change in response to change in the i/p frequency.

g.) Give the ideal characteristics of an ideal OP-Amp.

Ans
1. Infinite input resistance
2.) Zero o/p resistance.
3. Infinite Voltage gain.
4. Infinite B.W.
5. Infinite CMRR.
6.) Infinite Slewrate
7.) Zero offset.

2010 Paper

1a) What are the limitations of single stage amplification and how do they overcome in multistage amplifiers?

Ans If the voltage or power gain obtained from a single stage small signal amp is not sufficient for a practical application, one have to use more than one stage of amplification to achieve necessary voltage and power gain. Hence multistage amp's overcome the limitation of single stage amp.

b) What is the max. efficiency of the push pull configuration of class B and where is the Q-point for a class B amplifiers?

Ans Max. Efficiency - 25π % = 78.5 % for a class B system compared with 50% for class A operation.

In class-B amp., the dissipation at the collector is zero (ie, on the X-axis) in the quiescent state.

c) What is a tuned amplifier? In which range of frequencies are tuned amplifiers used.

Ans To amplify the selective range of frequencies, the resistive load R_L is replaced by a tuned

circuit. The tune ckt is capable of amplifying a signal over a narrow band of frequencies centered at f_r (resonant freq.). The amplifier with such a tuned ckt are known as Tuned voltage amplifier (Tuned amplifier).

d) List five characteristics of an amplifier which are modified by negative feedback.

Ans (i) Gain of the amplifier $A_f = \frac{A}{1+A\beta}$.

(ii) Stability is high.

(iii) Noise is less.

(iv) Distortion is less.

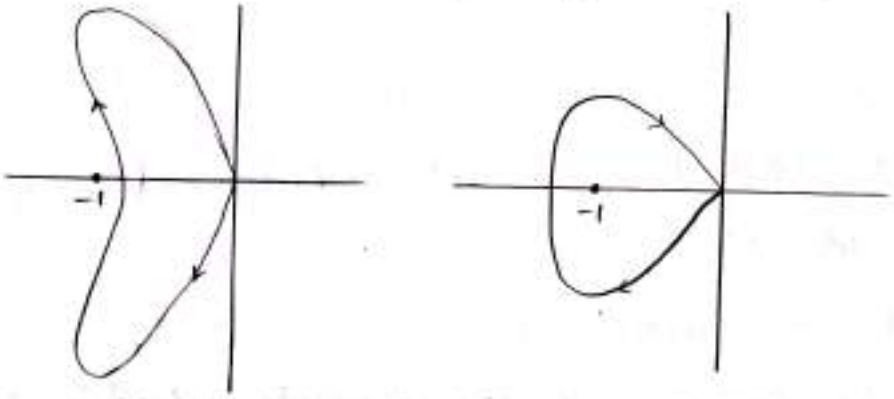
(v) Input and output impedances are modified

e) State the Nyquist Criterion for stability.

Ans In order to investigate stability, Nyquist method, a popular technique is used. Nyquist diagram is used to plot gain and phase shift as a function of frequency on a complex plane. Since the product $A\beta$ is a complex number and function of frequency, points in the complex plane are obtained for the values of $A\beta$. corresponding to values of f from $-\infty$ to ∞.

The locus of all these points form a closed curve.

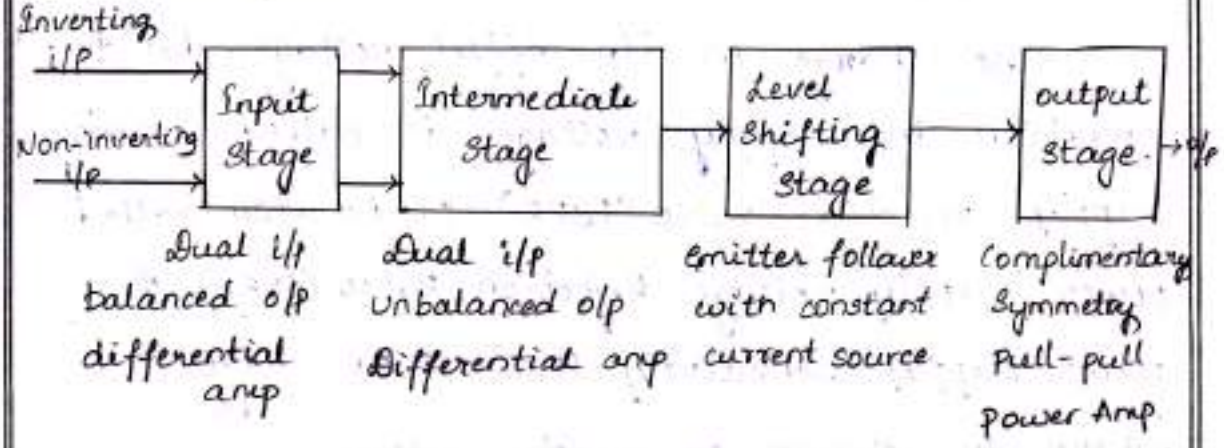
Nyquist criterion for stability states that an amp. is unstable if the Nyquist curve encloses the $-1 + j0$ point, and the amp is stable if the curve does not encloses this point.



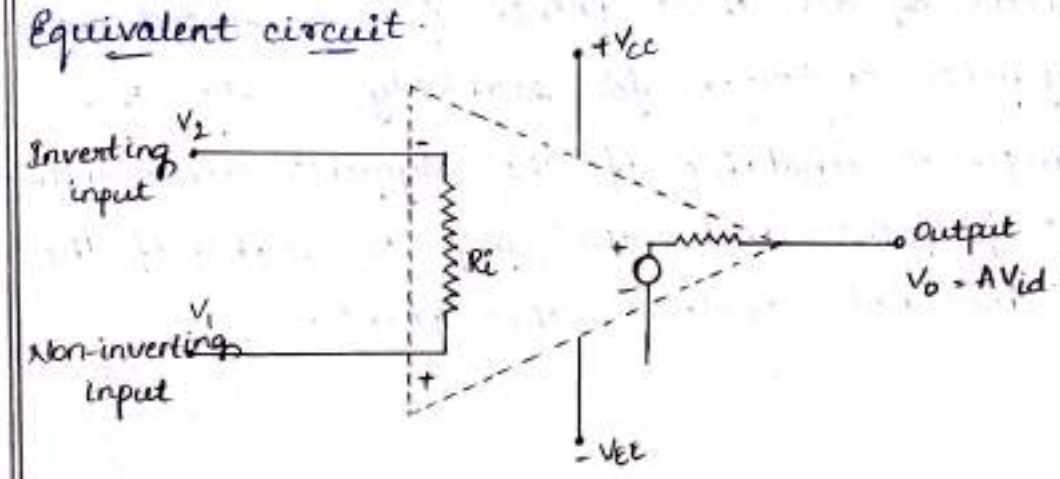
a) Stable b) Unstable.

f.) Draw the schematic block diagram of basic OP-Amp with inverting and Non-inverting inputs. Indicate its equivalent circuit.

Ans Block Diagram:



Equivalent circuit.



9.) Define input bias current and power supply rejection ratio for OP-AMP.

Sol) Input Bias Current.

The average of the currents entering into the inverting & Non-inverting input terminals of an Op-Amp is called Input Bias current.

$$I_B = \frac{I_{B_1} + I_{B_2}}{2}.$$

For OP-AMP 741C, the max. value of I_B is 500 nA.

Power supply Rejection Ration:

The change in i/p offset voltage due to variation in supply voltage is called power supply rejection ratio (PSRR). It is also called power supply voltage Rejection Ratio (SVRR) & power supply sensitivity (PSS). $PSRR = \frac{dV_{io}}{dV}$.

where dV - change in supply voltage.

dV_{io} - Corresponding change in i/p offset voltage.

For 741C, SVRR = 150 μV/V.

Heat sinks are used for power transistors as the power dissipated at their collector junction is large. If heat dissipation is not done, this will cause large increases in junction temperature. It is possible to increase the power handling capacity of the transistor by using heat sink.

e) Explain Band width calculation

Sol:- Normally, Bandwidth refers to the range of frequencies used to transmit data. It is measured in Hertz

To calculate bandwidth, we have the to consider the frequency response curve which consists of 'gain in dB' on y-axis and 'frequency' on x-axis. In that curve, we have to subtract 3dB from the maximum gain and we have to draw one horizontal line at that value. This line touches the frequency response curve at two points. The frequencies corresponding to two points are called lower cut-off and upper cut-off frequencies 'f_L' and 'f_H'.

Bandwidth = $f_H - f_H$

= Upper cut-off frequency - Lower cut-off frequency

f) Explain calculation of CMRR } Related to operational-

g) Write about Logarithmic amplifier } amplifiers (out of syllabus according to new syllabus)

2016

1) a) What is gain band width product.

Sol:- The gain bandwidth product for an amplifier is the product of the amplifier's bandwidth and the gain at which the bandwidth is measured.

The "gain bandwidth product" remains same for an amplifier with and without feedback. Since after applying feedback, the gain decreases but the bandwidth increases. So overall product remains same

(b) What is the difference between series feedback and shunt feedback amplifiers

Sol:- In series feedback, the feedback signal is connected in series with the input voltage signal. In shunt feedback, the feedback signal is connected in parallel with an input current source.

In case of series feedback, the input resistance will be increased. Incase of shunt feedback, the input resistance will be decreased.

(c) List out applications of sinusoidal oscillation?

Sol:- Sinusoidal oscillators have a wide range of applications including usage in radios, televisions, communication systems, computers, industrial controlled applications, and laboratories. They work as a function or signal generator.

(d) what is a heat sink?

Sol:- A heat sink is a mechanical device. It is connected to the case of the semiconductor device. So it is providing a path for the heat transfer.

signal is called fundamental frequency component

→ The additional frequency components present in the output signal are having frequencies which are integral multiples of the fundamental frequency are called harmonic components / harmonics.

d) Write about different types of Heat sinks.

Sol:- 1) Active Heat sinks :- These are generally fan type and utilize power for cooling purpose. They can also be termed as Heat sink or fans. The performance of these kinds of heat sink is excellent but not for long term applications.

2) Passive Heat sinks :- These do not possess any mechanical components and are made of aluminium finned radiators. These dissipate thermal energy or heat by using the convection process.

3) Aluminum Heat sink :- Heat sinks are generally made of metals and aluminum is the most common metal used in heat sink. The thermal conductivity of metal is proportional to the heat transfer in heat sink.

In addition to the above heat sinks, we have many heat sinks like stamped heat sinks, conventim cooler type etc.,