

EC6302 ELECTRONIC DEVICES AND CIRCUITS

UNIT-I - PN JUNCTION DEVICES

1. What is depletion region in PN junction?

The region around the junction from which the mobile charge carriers (electrons and holes) are depleted is called as depletion region. Since this region has immobile ions, which are electrically charged, the depletion region is also known as space charge region.

2. Give the other names of depletion region?

- i. Space charge region
- ii. Transition region

3. What is barrier potential?

The oppositely charged ions present on both sides of PN junction an electric potential is established across the junction even without any external voltage source which is termed as barrier potential.

4. What is meant by biasing a PN junction?

Connecting a PN junction to an external voltage source is biasing a PN junction.

5. What are the types of biasing a PN junction?

- 1. Forward bias
- 2. Reverse bias

6. What is forward bias and reverse bias in a PN junction?

When positive terminal of the external supply is connected to P region and negative terminal to N region, the PN junction is said to be forward biased. Under forward biased condition the PN region offers a very low resistance and a large amount of current flows through it.

7. What is reverse bias in a PN junction?

When positive terminal of the external supply is connected to N type and negative terminal to P type then the PN junction is said to be in reverse bias. Under reverse biased condition the PN region offers a very high resistance and a small amount of current flows through it.

8. What is Reverse saturation current?

The current due to the minority carriers in reverse bias is said to be reverse saturation current. This current is independent of the value of the reverse bias voltage.

9. What is an amplifier?

An amplifier is a device which produces a large electrical output of similar characteristics to that of the input parameters.

10. Why contact differences of potential exist in PN junction?

When a PN junction is formed by placing a p-type and n-type material in intimate contact, the Fermi level throughout the newly formed specimen is not constant at equilibrium. There will be transfer of electron and energy until Fermi levels in the two sides did line up. But the valence and conduction band in p side cannot be at the same level as in n side .this shift in energy level results in contact difference of potential.

11. What is the static resistance of a diode?

Static resistance R of a diode can be defined as the ratio of voltage V across the diode to the current flowing through the diode.

$$R = V / I$$

Where

R - Static resistance of a diode

V - Voltage across the diode

I - current across the diode

12. Define dynamic resistance.

Dynamic resistance of a diode can be defined as the ratio of change in voltage across the diode to the change in current through the diode.

$$r = V / I$$

Where

r - Dynamic resistance of a diode

V - Change in voltage across the diode

I - Change in current through the diode

13. Why do we choose Q point at the center of the load line?

The operating point of a transistor is kept fixed usually at the center of the active region in order that the input signal is well amplified. If the point is fixed in the saturation region or the cut off region the positive and negative half cycle gets clipped off respectively.

14. When does a transistor act as a switch?

The transistor acts as a switch when it is operated at either cutoff region or saturation region.

15. What is biasing?

To use the transistor in any application it is necessary to provide sufficient voltage and current to operate the transistor. This is called biasing.

16. What is operating point?

For the proper operation of the transistor a fixed level of current and voltages are required. This values of currents and voltages defined at a point at which the transistor operate is called operating point.

17. Define injection laser diode.

When the emitted light is coherent, (ie) essentially monochromatic, then such a diode is referred to as an injection laser diode

PART-B

1. Explain forward bias and reverse bias in a PN junction and also VI characteristics.
2. Explain the VI characteristics of Zener diode.
3. Explain about diffusion and transient capacitance.
4. How does the Zener diode act as a voltage regulator? Explain.
5. Explain the half wave and full wave rectifiers with relevant diagram.

UNIT II TRANSISTORS**1. What are the advantages of FET?**

- * Input impedance is very high. This allow high degree of Isolation between the input & output circuit.
- *Current carriers are not crossing the junctions hence noise is highly reduced.
- * It has a negative temperature Co-efficient of resistance. This avoids the thermal runaway.

2. What are the advantages of MOSFET compared to JFET?

The input impedance of MOSFET is higher than that of JFET.

3. What are the two modes of MOSFET?

- (a) Depletion mode
- (b) Enhancement mode

4. Why UJT is called so?

UJT has only one PN junction so it is called as uni-junction transistor.

5. Define turn - on time.

It is the time taken by the SCR to reach to its full conduction from the time the trigger is applied.

6. Define breakdown voltage.

The applied voltage at which the thyristors conducts heavily without gate voltage.

7. Define latching current.

It is the minimum current required to latch the device from OFF to ON state.

8. Define holding current.

It is defined as the minimum current required holding the device into conduction.

9. What is Reverse saturation current?

The current due to the minority carriers in reverse bias is said to be reverse saturation current. This current is independent of the value of the reverse bias voltage.

10. Define turn - off time.

It is the finite time taken by the SCR after application of the reverse voltage to switch the device off.

11. What is the advantage of SCR?

Switching speed is high No moving parts. So it gives noiseless operation at high frequency it controls large current in the load by means of small gate current occupies less space.

12. Give some applications of Thyristor?

Used for power control Used for speed control of a d.c shunt motor.

13. Define finger voltage.

It is defined as the minimum voltage which is required between anode and the cathode of thyristor to trigger into conduction.

14. Define drain resistance.

It is the ratio of change in drain source voltage to change in drain current at constant gate source voltage.

15. Define inter-base resistance.

It is the resistance offered by the silicon bar.

16. Define pinch-off voltage.

It is the drain source voltage above which the drain current becomes constant.

17. What is amplification factor?

It is the product of drain resistance and transconductance $m = R_d \times g_m$

R_d =Drain resistance, g_m =Transconductance.

PART B

1. Explain about the operation, characteristics and their applications of MOSFET.
2. Explain about characteristics of JFET and their applications.
3. Explain the biasing technique for enhancement MOSFET?
4. Explain the biasing technique for D-MOSFET?
5. Describe UJT and Thyristor.

UNIT III AMPLIFIERS

1. Define Transistor.

Transistor consists of two junctions formed by sandwiching either P-type or N-type semiconductor between a pair of opposite types.

2. Write the current amplification factor for a CB transistor.

$a = \text{Change in Collector Current at constant } V_{CB} / \text{Change in emitter current.}$

3. Write the formula for input resistance in a CB transistor.

$\text{Input resistance} = \text{Change in base - emitter voltage} / \text{Change in emitter current at constant } V_{CB}.$

4. Write the current amplification factor for a CE transistor.

$b = \text{Change in Collector Current} / \text{Change in base current at constant } V_{CE}.$

5. Define transistor action.

A transistor consists of 2 coupled PN junctions. The base is a common region to both junctions and makes a coupling between them. Since the base regions are smaller, a significant interaction between junctions will be available. This is called transistor actions.

6. Define delay time.

It is defined as the time required for the current to rise from 0 to 10% of its maximum value.

7. Define rise time.

It is the time required for the current to rise from 0 to 90 percentage of the maximum value.

8. Define turn-on time.

It is the time required for the current to rise from 0 to 90 percentage of the maximum value $t_{on} = t_d + t_r$.

9. Define fall time.

It is the time required for the Collector current to fall from 90 to 10 percentages of I_{cs} .

10. Define Storage time.

It is the time required to fall from 100 to 90 percent of I_{cs} .

11. Define turn-off time.

It is the time required to fall from 100 to 90 percent of I_{cs} . $T_{off} = t_s + t_r$.

12. Define hybrid parameters.

Any linear circuit having input and output terminals can be analysed by four parameters (one measured on ohm, one in mho and two dimensionless) called hybrid or h parameters.

13. Define power transistors.

Power transistors are those which handle a large amount of current and also dissipates large amount of power across collector base junction.

15. Define current amplification factor in CC transistor.

$\beta = \text{Change in emitter current} / \text{Change in base current at constant VCE}$

16. What are the values of input resistance in CB, CE & CC Configuration

CB - Low about 75 Ω CE - Medium About 750 Ω CC - Very high about 750 Ω .

17. Which is the most commonly used transistor configuration? Why?

The CE Configuration is most commonly used.

The reasons are

- * High Current gain
- * High voltage gain
- * High power
- * Moderate input to output ratio.

PART B

1. Explain the input & output Characteristic of CB configuration of a transistor?
2. Explain the input & output Characteristic of CC configuration of a transistor?
3. Explain the input & output Characteristic of CE configuration of a transistor?
4. Describe about BJT small signal model.
5. Explain about High frequency analysis.

UNIT IV MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER

1. What is an amplifier?

An amplifier is a device which produces a large electrical output of similar characteristics to that of the input parameters.

2. Why do we choose Q point at the center of the load line?

The operating point of a transistor is kept fixed usually at the center of the active region in order that the input signal is well amplified. If the point is fixed in the saturation region or the cut off region the positive and negative half cycle gets clipped off respectively.

3. When does a transistor act as a switch?

The transistor acts as a switch when it is operated at either cutoff region or saturation region.

4. What is biasing?

To use the transistor in any application it is necessary to provide sufficient voltage and current to operate the transistor. This is called biasing.

5. What is operating point?

For the proper operation of the transistor a fixed level of current and voltages are required. This values of currents and voltages defined at a point at which the transistor operate is called operating point.

6. What is d.c load line?

The d.c load line is defined as a line on the output characteristics of the transistor which gives the value of I_c & V_{CE} corresponding to zero signal condition.

7. What is the necessary of the coupling capacitor?

It is used to block the DC signal to the transistor amplifier. It allows a c & blocks the d c.

8. Why is the operating point selected at the Centre of the active region?

The operating point is selected at the Centre of the active region to get to perfect amplification. Moreover there is no distortion.

9. Define an operational amplifier.

An operational amplifier is a direct-coupled, high gain amplifier consisting of one or more differential amplifier. By properly selecting the external components, it can be used to perform a variety of mathematical operations.

10. Mention the characteristics of an ideal op-amp.

- * Open loop voltage gain is infinity.
- * Input impedance is infinity.
- * Output impedance is zero.
- * Bandwidth is infinity.
- * Zero offset.

11. Define input offset voltage.

A small voltage applied to the input terminals to make the output voltage as zero when the two input terminals are grounded is called input offset voltage.

12. Define slew rate.

The slew rate is defined as the maximum rate of change of output voltage caused by a step input voltage. An ideal slew rate is infinite which means that op-amp's output voltage should change instantaneously in response to input step voltage.

PART B

1. Explain the types of differential amplifiers.
2. What is meant by Neutralization? Discuss their methods.
3. Describe about Single tuned amplifiers.
4. Explain BIMOS cascade amplifier.
5. What is meant by power amplifier? Explain their types?

UNIT V FEEDBACK AMPLIFIERS AND OSCILLATORS

1. Mention any two audio frequency oscillators.

- RC phase shift oscillator
- Wein bridge oscillator

2. What is meant by feedback?

The process of combining a fraction or part of output energy back to the input is known as feedback.

3. What is meant by negative feedback? (Or) Define degenerative feedback.

If the feedback signal applied to the input is out of phase with the input signal and thus signal decrease, it is called negative feedback. It is also known as degenerative feedback.

4. What are the types of feedback?

The different types of feedback are:

1. Positive feedback,
2. Negative feedback.

5. What is meant by positive feedback?

If feedback signal applied is in phase with the input signal and thus increases the input, it is called as positive feedback. It is also known as regenerative feedback.

6. How are the amplifiers classified based on the input and output.

The amplifier is basically classified into four types based on the input given and output obtained. They are

- 1). Voltage amplifier.
- 2). Current amplifier.
- 3). Transconductance amplifier.
- 4). Transresistance amplifier.

7. What are the effects of negative feedback?

1. It improves the stability of the circuit.
2. It improves the frequency response of the amplifier.
3. It improves the percentage of harmonic distortion.
4. It improves the signal to noise ratio (SNR).
5. It reduces the gain of the circuit.

8. What are the classifications of feedback amplifiers?

1. Current series feedback.
2. Current shunt feedback.

3. Voltage series feedback.

4. Voltage shunt feedback.

9. Define the feedback factor β .

It is the ratio between the feedback voltages to the output voltage of the amplifier.

$$\beta = V_f / V_o$$

Where, β is a feedback factor, V_f is the feedback voltage, V_o is the output voltage.

10. What is current-series feedback amplifier? (or) What is transconductance amplifier?

In a current series feedback amplifier the sampled signal is a current and the feedback signal (Which is fed in series) is a voltage.

$$G_m = I_o / V_i$$

Where, G_m = Amplifier gain.

I_o = Output current.

I_i = Input current.

11. Name two low frequency Oscillators.

1. RC phase shift. 2. Wein Bridge Oscillator.

12. Name two high frequency Oscillators.

i. Hartley Oscillator.

ii. Colpitts Oscillator.

iii. Crystal Oscillator.

13. What is voltage series feedback amplifier? (Or) What is voltage amplifier?

In a voltage series feedback amplifier the sampled signal is a voltage and feedback signal (Which is fed in series) is also a voltage.

$$A = V_o / V_i$$

Where, A = Amplifier gain.

V_o = Output voltage.

V_i = Input voltage.

14. What is Voltage shunt feedback? (Or) What is transresistance amplifier?

In voltage shunt feedback amplifier the sampled signal is a voltage and the feedback signal (Which is fed in shunt) is a current.

$$R_m = V_o / I_i \quad (\text{or}) \quad V_o = R_m \cdot I_i$$

Where, R_m = Amplifier gain.

V_o = Output voltage.

I_i = Input current.

15. What is current -shunt feedback amplifier? (Or) What is current amplifier?

In a current shunt feedback amplifier, the sampled signal is a current and the feedback signal (Which is fed in shunt) is a current.

$$A = I_o / I_i \quad (\text{or}) \quad I_o = A I_i$$

Where, A = Amplifier gain.

I_o = Output current.

I_i = Input current.

16. What is piezo electric effect?

The piezo electric Crystals exhibit a property that if a mechanical stress is applied across one face the electric potential is developed across opposite face. The inverse is also live. This phenomenon is called piezo electric effect.

17. What are the types of sinusoidal oscillator?

1. Wein Bridge Oscillator.
2. Hartley Oscillator.
3. Colpitts Oscillator.
4. Crystal Oscillator.

18. What is an Oscillator?

An Oscillator is a Circuit, which generates an alternating voltage of any desired frequency. It can generate an a.c output signal without requiring any externally applied input signal.

19. What are the advantages of Rc phase shift Oscillator?

- i. It is best suited for generating fixed frequency signals in the audio frequency range.
- ii. Simple Circuit.
- iii. Pure sine wave output is possible.

20. List the disadvantages of Rc phase shift Oscillator.

- i. It is ideal for frequency adjustment over a wide range.
- ii. It requires a high β transistor to overcome losses in the network.

21. List the disadvantages of crystal Oscillator.

1. It is suitable for only low power circuits
2. Large amplitude of vibrations may crack the crystal.
3. It large in frequency is only possible replacing the crystal with another one by different frequency.

PART B

1. What are the advantages of negative feedback amplifier.
2. Explain RC-Phase shift with neat diagram
3. What is meant by Wien bridge and explain the frequency of oscillation.
4. Explain about their characteristics of Hartley and Colpitts oscillator.
5. Discuss about Crystal oscillators and their types.

EE6303 - LINEAR INTEGRATED CIRCUITS AND APPLICATIONS

UNIT-I CIRCUIT CONFIGURATION FOR LINEAR ICs

1. Mention the advantages of integrated circuits.

- *Miniaturization and hence increased equipment density.
- *Cost reduction due to batch processing.
- *Increased system reliability due to the elimination of soldered joints.
- *Improved functional performance.
- *Matched devices.
- *Increased operating speeds.
- *Reduction in power consumption.

2. Write down the various processes used to fabricate IC's using silicon planar technology.

- *Silicon wafer preparation.
- * Epitaxial growth
- *Oxidation.
- *Photolithography.
- *Diffusion.
- *Ion implantation.
- *Isolation.
- *Metallization.
- *Assembly processing and packaging.

3. What is the purpose of oxidation?

- *SiO₂ is an extremely hard protective coating and is unaffected by almost all reagents.
- *By selective etching of SiO₂, diffusion of impurities through carefully defined windows can be accomplished to fabricate various components.

4. Why aluminium is preferred for metallization?

- *It is a good conductor.
- *it is easy to deposit aluminium films using vacuum deposition.
- *It makes good mechanical bonds with silicon.
- *It forms a low resistance contact.

5. What are the popular IC packages available?

Metal can package.
Dual-in-line package.
Ceramic flat package.

6. Define an operational amplifier.

An operational amplifier is a direct-coupled, high gain amplifier consisting of one or more differential amplifier. By properly selecting the external components, it can be used to perform a variety of mathematical operations.

7. Mention the characteristics of an ideal op-amp.

- * Open loop voltage gain is infinity.
- *Input impedance is infinity.
- *Output impedance is zero.
- *Bandwidth is infinity.
- *Zero offset.

8. What happens when the common terminal of V+ and V- sources is not grounded?

If the common point of the two supplies is not grounded, twice the supply voltage will get applied and it may damage the op-amp.

9. Define input offset voltage.

A small voltage applied to the input terminals to make the output voltage as zero when the two input terminals are grounded is called input offset voltage.

10. Define input offset current. State the reasons for the offset currents at the input of the op-amp.

The difference between the bias currents at the input terminals of the op-amp is called as input offset current. The input terminals conduct a small value of dc current to bias the input transistors. Since the input transistors cannot be made identical, there exists a difference in bias currents.

11. Define CMRR of an op-amp.

The relative sensitivity of an op-amp to a difference signal as compared to a common mode signal is called the common –mode rejection ratio. It is expressed in decibels.

$$CMRR = A_d/A_c$$

12. What are the applications of current sources?

Transistor current sources are widely used in analog ICs both as biasing elements and as load devices for amplifier stages.

13. Justify the reasons for using current sources in integrated circuits.

- *superior insensitivity of circuit performance to power supply variations and temperature.
- *more economical than resistors in terms of die area required to provide bias currents of small value.
- *When used as load element, the high incremental resistance of current source results in high voltage gain at low supply voltages.

14. What is the advantage of widlar current source over constant current source?

Using constant current source output current of small magnitude (microamp range) is not attainable due to the limitations in chip area. Widlar current source is useful for obtaining small output currents. Sensitivity of widlar current source is less compared to constant current source.

15. Mention the advantages of Wilson current source.

- *provides high output resistance.
- *offers low sensitivity to transistor base currents.

16. Define sensitivity.

Sensitivity is defined as the percentage or fractional change in output current per percentage or fractional change in power-supply voltage.

17. What are the limitations in a temperature compensated zener-reference source?

A power supply voltage of at least 7 to 10 V is required to place the diode in the breakdown region and that substantial noise is introduced in the circuit by the avalanching diode.

18. What do you mean by a band-gap referenced biasing circuit?

The biasing sources referenced to V_{BE} has a negative temperature co-efficient and V_T has a positive temperature co-efficient. Band gap reference circuit is one in which the output current is referenced to a composite voltage that is a weighted sum of V_{BE} and V_T so that by proper weighting, zero temperature co-efficient can be achieved.

19. In practical op-amps, what is the effect of high frequency on its performance?

The open-loop gain of op-amp decreases at higher frequencies due to the presence of parasitic capacitance. The closed-loop gain increases at higher frequencies and leads to instability.

20. What is the need for frequency compensation in practical op-amps?

Frequency compensation is needed when large bandwidth and lower closed loop gain is desired. Compensating networks are used to control the phase shift and hence to improve the stability.

21. Mention the frequency compensation methods.

- *Dominant-pole compensation
- *Pole-zero compensation.

22. What are the merits and demerits of Dominant-pole compensation?

- *Noise immunity of the system is improved.

*Open-loop bandwidth is reduced.

23. Define slew rate.

The slew rate is defined as the maximum rate of change of output voltage caused by a step input voltage. An ideal slew rate is infinite which means that op-amp's output voltage should change instantaneously in response to input step voltage.

24. Why IC 741 is not used for high frequency applications?

IC741 has a low slew rate because of the predominance of capacitance present in the circuit at higher frequencies. As frequency increases the output gets distorted due to limited slew rate.

25. What causes slew rate?

There is a capacitor with-in or outside of an op-amp to prevent oscillation. It is this capacitor which prevents the output voltage from responding immediately to a fast changing input.

16 MARKS QUESTIONS

1. Explain in detail the fabrication of ICs using silicon planar technology.

- *Silicon wafer preparation.
- * Epitaxial growth
- *Oxidation.
- *Photolithography.
- *Diffusion.
- *Ion implantation.
- *Isolation.
- *Metallisation.
- *Assembly processing and packaging.

2. Design an active load for an emitter-coupled pair(differential amplifier) and perform a detailed analysis to find its differential mode gain and the output resistance.

Output voltage, $V_o = V_{cc} - V_{BE(on)} + 2V_{A(eff)} \tanh(V_{id} / 2V_T)$

Gain , $A_{vd} = 1 / (V_T/V_{AN} + V_T/V_{AP})$

Output resistance, $R_o = r_{onp} \parallel r_{opn}$

3. Design a Widlar current source and obtain the expression for output current. Also prove that widlar current source has better sensitivity than constant current source.

For Widlar current source, $V_T \ln(I_{c1} / I_{c2}) = I_{c2} R_2$

Sensitivity is defined as the percentage or fractional change in output current per percentage or fractional change in power-supply voltage. For constant current source sensitivity is unity because the output current is directly proportional to supply voltage. The sensitivity of a widlar current source is better compared to constant current source because the output current has a logarithmic dependence on power supply voltage.

4. Explain the supply independent biasing technique using VBE as the reference voltage. Also, find the dependence of its output current on temperature.

The output current is given by, $I_{out} = V_{BE1} / R_2 = (V_T / R_2) \ln (I_{ref} / I_{s1})$ (Circuit diagram, self-biasing VBE reference circuit, start-up circuit to avoid zero-current state) Temperature coefficient, $TCF = -V_{BE1} / V_{BE1} \approx -5.5 \times 10^{-5}$

5. Explain supply independent biasing using zener-referenced bias circuit. Also, design a temperature compensated zener-reference source.

The output current is given by, $I_{out} = V_Z / R_2$ (Circuit diagram, self-biasing zener bias reference circuit, temperature compensated zener reference source)

6. Obtain the frequency response of an open-loop op-amp and discuss about the methods of frequency compensation.

The open-loop gain of op-amp decreases at higher frequencies due to the presence of parasitic capacitance. The closed-loop gain increases at higher frequencies and leads to instability. Frequency compensation is needed when large bandwidth and lower closed loop gain is desired. Compensating networks are used to control the phase shift and hence to improve the stability.

Frequency compensation methods:

- *Dominant-pole compensation
- *Pole-zero compensation.

UNIT II : APPLICATIONS OF OP – AMPS

1. Mention some of the linear applications of op – amps :

Adder, Subtractor, voltage-to-current converter, current-to-voltage converters, instrumentation amplifier, analog computation, power amplifier, etc are some of the linear op-amp circuits.

2. Mention some of the non – linear applications of op-amps:-

Rectifier, peak detector, clipper, clamper, sample and hold circuit, log amplifier, anti-log amplifier, multiplier are some of the non – linear op-amp circuits.

3. What are the areas of application of non-linear op- amp circuits?

Industrial instrumentation
Communication
Signal processing

4. What is the need for an instrumentation amplifier?

In a number of industrial and consumer applications, the measurement of physical quantities is usually done with the help of transducers. The output of transducer has to be amplified so that it can drive the indicator or display system. This function is performed by an instrumentation amplifier.

5. List the features of instrumentation amplifier:

High gain accuracy

Time marker generator

Phase detector

14. What is a Schmitt trigger?

Schmitt trigger is a regenerative comparator. It converts sinusoidal input into a square wave output. The output of Schmitt trigger swings between upper and lower threshold voltages, which are the reference voltages of the input waveform.

15. What is a multivibrator?

Multivibrators are a group of regenerative circuits that are used extensively in timing applications. It is a wave shaping circuit which gives symmetric or asymmetric square output. It has two states stable or quasi-stable depending on the type of multivibrator.

16. What do you mean by monostable multivibrator?

Monostable multivibrator is one which generates a single pulse of specified duration in response to each external trigger signal. It has only one stable state. Application of a trigger causes a change to the quasi-stable state. An external trigger signal generated due to charging and discharging of the capacitor produces the transition to the original stable state.

17. What is an astable multivibrator?

Astable multivibrator is a free running oscillator having two quasi-stable states. Thus, there is oscillations between these two states and no external signal are required to produce the change in state.

18. What is a bistable multivibrator?

Bistable multivibrator is one that maintains a given output voltage level unless an external trigger is applied. Application of an external trigger signal causes a change of state, and this output level is maintained indefinitely until a second trigger is applied. Thus, it requires two external triggers before it returns to its initial state

19. What are the requirements for producing sustained oscillations in feedback circuits?

For sustained oscillations, " The total phase shift around the loop must be zero at the desired frequency of oscillation, f_o . ie, $\angle \beta A = 0^\circ$ " At f_o , the magnitude of the loop gain $|\beta A|$ should be equal to unity

20. Mention any two audio frequency oscillators:

RC phase shift oscillator
Wein bridge oscillator

21. What are the characteristics of a comparator?

Speed of operation
Accuracy
Compatibility of the output

22. What is a filter?

Filter is a frequency selective circuit that passes signal of specified band of frequencies and attenuates the signals of frequencies outside the band

23. What are the demerits of passive filters?

Passive filters work well for high frequencies. But at audio frequencies, the inductors become problematic, as they become large, heavy and expensive. For low frequency applications, more number of turns of wire must be used which in turn adds to the series resistance degrading inductor's performance i.e., low Q, resulting in high power dissipation.

24. What are the advantages of active filters?

Active filters use op-amp as the active element and resistors and capacitors as passive elements. "By enclosing a capacitor in the feedback loop, inductor less active filters can be obtained" Op-amp used in non – inverting configuration offers high input impedance and low output impedance, thus improving the load drive capacity.

25. Mention some commonly used active filters :

- Low pass filter
- High pass filter
- Band pass filter
- Band reject filter.

16 MARKS QUESTIONS

1. Discuss the need for an instrumentation amplifier? Give a detailed analysis for the same.

In a number of industrial and consumer applications, the measurement of physical quantities is usually done with the help of transducers. The output of transducer has to be amplified so that it can drive the indicator or display system. This function is performed by an instrumentation amplifier. Circuit diagram, instrumentation amplifier with transducer bridge, Analysis, Expression for output voltage.

2. Explain the operation of the Schmitt trigger.

Schmitt trigger is a regenerative comparator. It converts sinusoidal input into a square wave output. The output of Schmitt trigger swings between upper and lower threshold voltages, which are the reference voltages of the input waveform. Circuit diagram, Analysis. Expression for upper and lower threshold voltages with and without V_{ref} . Hysteresis width. Waveforms.

3. Discuss in detail the operation of Astable multivibrator.

Astable multivibrator is a free running oscillator having two quasi-stable states. Thus, there is oscillation between these two states and no external signal is required to produce the change in state. Circuit diagram, Analysis. Expression for time period, Waveforms. Circuit for asymmetric square wave generator.

4. Discuss in detail the operation of Monostable multivibrator.

Monostable multivibrator is one which generates a single pulse of specified duration in response to each external trigger signal. It has only one stable state. Application of a trigger causes a change to the quasi-stable state. An external trigger signal generated due to charging and discharging of the capacitor produces the transition to the original stable state. Circuit diagram, Analysis.

5. What are the requirements for producing sustained oscillations in feedback circuits? Discuss any two audio frequency oscillators.

For sustained oscillations, The total phase shift around the loop must be zero at the desired frequency of oscillation, f_o . ie, $\angle \beta A = 0^\circ$. At f_o , the magnitude of the loop gain $|\beta A|$ should be equal to unity.

RC phase shift oscillator: Circuit diagram, Derive the condition for frequency of oscillation.

Gain, $A_v \gg 29$

Wein bridge oscillator : Circuit diagram, Derive the condition for frequency of oscillation.

Gain, $A_v = 3$

UNIT – 3: ANALOG MULTIPLIER AND PLL

1. Mention some areas where PLL is widely used:

- *Radar synchronization
- *satellite communication systems
- *air borne navigational systems
- *FM communication systems
- *Computers.

2. List the basic building blocks of PLL:

- *Phase detector/comparator
- *Low pass filter
- *Error amplifier
- *Voltage controlled oscillator

3. What are the three stages through which PLL operates?

- *Free running
- *Capture
- *Locked/ tracking

4. Define lock-in range of a PLL:

The range of frequencies over which the PLL can maintain lock with the incoming signal is called the lock-in range or tracking range. It is expressed as a percentage of the VCO free running frequency.

5. Define capture range of PLL:

The range of frequencies over which the PLL can acquire lock with an input signal is called the capture range. It is expressed as a percentage of the VCO free running frequency.

6. Define Pull-in time.

The total time taken by the PLL to establish lock is called pull-in time. It depends on the initial phase and frequency difference between the two signals as well as on the overall loop gain and loop filter characteristics.

7. For perfect lock, what should be the phase relation between the incoming signal and VCO output signal?

The VCO output should be 90 degrees out of phase with respect to the input signal.

8. Give the classification of phase detector:

- *Analog phase detector
- *Digital phase detector

9. What is a switch type phase detector?

An electronic switch is opened and closed by signal coming from VCO and the input signal is chopped at a repetition rate determined by the VCO frequency. This type of phase detector is called a half wave detector since the phase information for only one half of the input signal is detected and averaged.

10. What are the problems associated with switch type phase detector?

*The output voltage V_e is proportional to the input signal amplitude. This is undesirable because it makes phase detector gain and loop gain dependent on the input signal amplitude.

11. What is a voltage controlled oscillator?

Voltage controlled oscillator is a free running multivibrator operating at a set frequency called the free running frequency. This frequency can be shifted to either side by applying a dc control voltage and the frequency deviation is proportional to the dc control voltage.

12. On what parameters does the free running frequency of VCO depend on?

- *External timing resistor, R_T
- *External timing capacitor, C_T
- *The dc control voltage V_c .

13. Give the expression for the VCO free running frequency.

$$f_o = 0.25 / R_T C_T$$

14. Define Voltage to Frequency conversion factor.

Voltage to Frequency conversion factor is defined as,

$$K_{VCO} = \Delta f_o / \Delta V_c$$

ΔV_c is the modulation voltage required to produce the frequency shift Δf_o

15. What is the purpose of having a low pass filter in PLL?

- *It removes the high frequency components and noise.
- *Controls the dynamic characteristics of the PLL such as capture range, lock-in range, bandwidth and transient response.

*The charge on the filter capacitor gives a short- time memory to the PLL.

16. Discuss the effect of having large capture range.

The PLL cannot acquire a signal outside the capture range, but once captured, it will hold on till the frequency goes beyond the lock-in range. Thus , to increase the ability of lock range, large capture range is required. But, a large capture range will make the PLL more susceptible to noise and undesirable signal.

17. Mention some typical applications of PLL:

- Frequency multiplication/division
- Frequency translation
- AM detection
- FM demodulation
- FSK demodulation.

18. What is a compander IC? Give some examples.

The term companding means compressing and expanding. In a communication system, the audio signal is compressed in the transmitter and expanded in the receiver.

Examples: LM 2704- LM 2707; NE 570/571.

19. What are the merits of companding?

- *The compression process reduces the dynamic range of the signal before it is transmitted.
- *Companding preserves the signal to noise ratio of the original signal and avoids non linear distortion of the signal when the input amplitude is large.
- *It also reduces buzz, bias and low level audio tones caused by mild interference.

20. List the applications of OTA:

OTA can be used in

- Programmable gain voltage amplifier
- sample and hold circuits
- Voltage controlled state variable filter
- Current controlled relaxation oscillator.

16 MARKS

1. Briefly explain the block diagram of PLL and derive the expression for Lock range and capture range.

Block diagram of PLL

Explanation for each block.

Derivation for capture range and lock range.

2. With a neat functional diagram, explain the operation of VCO. Also derive an expression for f_o .

Internal diagram for VCO IC.

Explanation

Derivation for fo.

3. Analyse the Gilbert's four quadrant multiplier cell with a neat circuit diagram. Discuss its applications.

Circuit diagram
Analysis
Expression for output current
Applications.

4. In detail discuss the applications of PLL:

AM detection
FM demodulation
FSK demodulation
Frequency multiplication/division.

UNIT IV – A/D AND D/CONVERTERS

2 marks questions

1. List the broad classification of ADCs.

1. Direct type ADC.
2. Integrating type ADC.

2. List out the direct type ADCs.

- | | |
|--------------------------------------|--|
| 1. Flash (comparator) type converter | 2. Counter type converter |
| 3. Tracking or servo converter | 4. Successive approximation type converter |

3. List out some integrating type converters.

- | | |
|-------------------------|-------------------|
| 1. Charge balancing ADC | 2. Dual slope ADC |
|-------------------------|-------------------|

4. What is integrating type converter?

An ADC converter that perform conversion in an indirect manner by first changing the analog I/P signal to a linear function of time or frequency and then to a digital code is known as integrating type A/D converter.

5. Explain in brief the principle of operation of successive Approximation ADC.

The circuit of successive approximation ADC consists of a successive approximation register (SAR), to find the required value of each bit by trial & error. With the arrival of START command, SAR sets the MSB bit to 1. The O/P is converted into an analog signal & it is compared with I/P signal. This O/P is low or High. This process continues until all bits are checked.

6. What are the main advantages of integrating type ADCs?

- i. The integrating type of ADC's do not need a sample/hold circuit at the input.
- ii. It is possible to transmit frequency even in noisy environment or in an isolated form.

7. Where is the successive approximation type ADC's used?

The Successive approximation ADCs are used in applications such as data loggers & instrumentation where conversion speed is important.

8. What is the main drawback of a dual-slop ADC?

The dual slope ADC has long conversion time. This is the main drawback of dual slope ADC.

9. State the advantages of dual slope ADC:

It provides excellent noise rejection of ac signals whose periods are integral multiples of the integration time T.

10. Define conversion time.

It is defined as the total time required converting an analog signal into its digital output. It depends on the conversion technique used & the propagation delay of circuit components. The conversion time of a successive approximation type ADC is given by

$$T(n+1)$$

Where, T---clock period; Tc---conversion time ; n----no. of bits

11. Define resolution of a data converter.

The resolution of a converter is the smallest change in voltage which may be produced at the output or input of the converter.

Resolution (in volts)= $V_{FS}/2^n - 1 = 1 \text{ LSB increment}$. The resolution of an ADC is defined as the smallest change in analog input for a one bit change at the output.

12. Define accuracy of converter.

Absolute accuracy:

It is the maximum deviation between the actual converter output & the ideal converter output.

Relative accuracy:

It is the maximum deviation after gain & offset errors have been removed. The accuracy of a converter is also specified in form of LSB increments or % of full scale voltage.

13. What is settling time?

It represents the time it takes for the output to settle within a specified band $\pm 1/2 \text{ LSB}$ of its final value following a code change at the input (usually a full scale change). It depends upon the switching time of the logic circuitry due to internal parasitic capacitance & inductances. Settling time ranges from 100ns. 10 μ s depending on word length & type circuit used.

14. Explain in brief stability of a converter:

The performance of converter changes with temperature age & power supply variation. So all the relevant parameters such as offset, gain, linearity error & monotonicity must be specified over the full temperature & power supply ranges to have better stability performances.

15. What is meant by linearity?

The linearity of an ADC/DAC is an important measure of its accuracy & tells us how close the converter output is to its ideal transfer characteristics. The linearity error is usually expressed as a fraction of LSB increment or percentage of full-scale voltage. A good converter exhibits a linearity error of less than $\pm\frac{1}{2}\text{LSB}$.

16. What is monotonic DAC?

A monotonic DAC is one whose analog output increases for an increase in digital input.

17. What is multiplying DAC?

A digital to analog converter which uses a varying reference voltage V_R is called a multiplying DAC(MDAC). If the reference voltage of a DAC, V_R is a sine wave give by $V(t)=V_m \sin \omega t$ Then, $V_o(t)=V_m \sin \omega t$

18. What is a sample and hold circuit? Where it is used?

A sample and hold circuit is one which samples an input signal and holds on to its last sampled value until the input is sampled again. This circuit is mainly used in digital interfacing, analog to digital systems, and pulse code modulation systems.

19. Define sample period and hold period.

The time during which the voltage across the capacitor in sample and hold circuit is equal to the input voltage is called sample period. The time period during which the voltage across the capacitor is held constant is called hold period.

16 MARKS QUESTIONS

1. What is integrating type converter? Explain the operation of dual slope ADC:

An ADC converter that perform conversion in an indirect manner by first changing the analog I/P signal to a linear function of time or frequency and then to a digital code is known as integrating type A/D converter. Functional diagram of Dual slope ADC. Explanation, Derivation.

2. Explain the principle of operation of successive Approximation ADC.

The circuit of successive approximation ADC consists of a successive approximation register (SAR), to find the required value of each bit by trial & error. With the arrival of START command, SAR sets the MSB bit to 1. The O/P is converted into an analog signal & it is compared with I/P signal. This O/P is low or High. This process continues until all bits are checked.

Functional diagram Operation Truth table, Output graph.

3. Explain the operation of sample and hold circuit .

Circuit diagram

Operation

Output waveforms.

4. Explain the various types of digital to analog converters:

Weighted resistor DAC
R-2R ladder DAC
Inverted R-2R ladder DAC
Circuit diagram & operation for each

5. What is delta sigma modulation? Explain the A/D conversion using Delta modulator.

Delta modulation is a technique capable of performing analog signal quantisation with smaller bandwidth requirements. Here, the binary output representing the most recent sampled amplitude will be determined on the basis of previous sampled amplitude levels.
Functional diagram, Operation.

UNIT V – SPECIAL FUNCTION ICs

1. Mention some applications of 555 timer:

- *Oscillator
- *pulse generator
- *ramp and square wave generator
- *mono-shot multivibrator
- *burglar alarm
- *traffic light control.

2. List the applications of 555 timer in monostable mode of operation:

- *missing pulse detector
- *Linear ramp generator
- *Frequency divider
- *Pulse width modulation.

3. List the applications of 555 timer in Astable mode of operation:

- *FSK generator
- *Pulse-position modulator

4. What is a voltage regulator?

A voltage regulator is an electronic circuit that provides a stable dc voltage independent of the load current, temperature, and ac line voltage variations.

5. Give the classification of voltage regulators:

- *Series / Linear regulators
- *Switching regulators.

6. What is a linear voltage regulator?

Series or linear regulator uses a power transistor connected in series between the unregulated dc input and the load and it conducts in the linear region. The output voltage is controlled by the continuous voltage drop taking place across the series pass transistor.

7. What is a switching regulator?

Switching regulators are those which operate the power transistor as a high frequency on/off switch, so that the power transistor does not conduct current continuously. This gives improved efficiency over series regulators.

8. What are the advantages of IC voltage regulators?

- *low cost
- *high reliability
- *reduction in size
- *excellent performance

9. Give some examples of monolithic IC voltage regulators:

78XX series fixed output, positive voltage regulators
79XX series fixed output, negative voltage regulators
723 general purpose regulators.

10. What is the purpose of having input and output capacitors in three terminal IC regulators?

A capacitor connected between the input terminal and ground cancels the inductive effects due to long distribution leads. The output capacitor improves the transient response.

11. Define line regulation.

Line regulation is defined as the percentage change in the output voltage for a change in the input voltage. It is expressed in millivolts or as a percentage of the output voltage.

12. Define load regulation.

Load regulation is defined as the change in output voltage for a change in load current. It is expressed in millivolts or as a percentage of the output voltage.

13. What is meant by current limiting?

Current limiting refers to the ability of a regulator to prevent the load current from increasing above a preset value.

14. Give the drawbacks of linear regulators:

- *The input step down transformer is bulky and expensive because of low line frequency.
- *Because of low line frequency, large values of filter capacitors are required to decrease the ripple.
- *Efficiency is reduced due to the continuous power dissipation by the transistor as it operates in the linear region.

15. What is the advantage of switching regulators?

- *Greater efficiency is achieved as the power transistor is made to operate as low impedance switch. Power transmitted across the transistor is in discrete pulses rather than as a steady current flow.
- *By using suitable switching loss reduction technique, the switching frequency can be increased so as to reduce the size and weight of the inductors and capacitors.

16. What is an opto-coupler IC? Give examples.

Opto-coupler IC is a combined package of a photo-emitting device and a photo-sensing device. Examples for opto-coupler circuit : LED and a photo diode, LED and photo transistor, LED and Darlington. Examples for opto-coupler IC : MCT 2F , MCT 2E .

17. Mention the advantages of opto-couplers:

- *Better isolation between the two stages.
- *Impedance problem between the stages is eliminated.
- *Wide frequency response.
- *Easily interfaced with digital circuit.
- *Compact and light weight.
- *Problems such as noise, transients, contact bounce,.. are eliminated.

18. What is an isolation amplifier?

An isolation amplifier is an amplifier that offers electrical isolation between its input and output terminals.

19. What is the need for a tuned amplifier?

In radio or TV receivers, it is necessary to select a particular channel among all other available channels. Hence some sorts of frequency selective circuit is needed that will allow us to amplify the frequency band required and reject all the other unwanted signals and this function is provided by a tuned amplifier.

20. Give the classification of tuned amplifier:

- (i) Small signal tuned amplifier
 - *Single tuned
 - *Double tuned
 - *Stagger tuned
- (ii) Large signal tuned amplifier.

16 MARKS

1. What is 555 timer? What are the features of 555 timer? Explain the monostable mode in detail?

Features of 555
Description about 555
Circuit diagram
Derivation for frequency.

2. Explain the Astable mode of operation using 555 timer.

Description about 555
Circuit diagram
Derivation for frequency.

3. In detail discuss the 723 IC general purpose voltage regulator.

Functional diagram

Low and high voltage regulation using 723

Features of 723.

4. Explain the operation of switching regulators. Give its advantages.

Functional diagram

Operation

Output waveforms.

Advantages.

5. Explain the functional diagram of LM 380 power amplifier.

Introduction

Internal diagram

Operation

Features.