EC 2254-LINEAR INTEGRATED CIRCUITS

2 MARKS QUESTIONS & ANSWERS

UNIT I

IC FABRICATION AND CIRCUIT CONFIGURATION FOR LINEAR ICS

1. Define an Integrated circuit.

An integrated circuit(IC) is a low cost electronic circuit consisting of active and passive components fabricated together on a single crystal of silicon. The active components are transistors and diodes and passive components are resistors and capacitors.

2. Mention the advantages of integrated circuits over discrete components.

*Miniaturisation 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.

3. Define sheet resistance.

Sheet resistance is defined as the resistance in ohms /square offered by the diffused area.

4. What is the use of buried n+ layer in monolithic IC transistor?

The buried n+ layer provides a low resistance path in the active collector region for the flow of current

5. What are the two common methods for obtaining integrated capacitors?

• Monolithic junction capacitor

• Thin-flim capacitor

6.What are the basic processes involved in fabricating ICs using planar technology?

1. Silicon wafer (substrate) preparation
2. Epitaxial growth
3. Oxidation
4. Photolithography

5. Diffusion

6. Ion implantation

7. Isolation technique

8. Metallization

9. Assembly processing & packaging

7. What is active load? Where it is used and why?

The active load realized using current source in place of the passive load in the collector arm of differencial amplifier makes it possible to achieve high voltage gain without requiring large power supply voltage.

8. Why open loop OP-AMP configurations are not used in linear applications?

The open loop gain of the op-amp is not a constant and it varies with changing the temperature and variations in power supply.Also the bandwidth of the open loop op-amp is negligibly small.For this reasons open loop OP-AMP configurations are not used in linear applications.

9.List out the steps used in the preparation of Si – wafers.

1. Crystal growth &doping

2. Ingot trimming & grinding

3. Ingot slicing

4. Wafer policing & etching

5 .Wafer cleaning

10. What are the two important properties of SiO2?

1.SiO2 is an extremely hard protective coatng & is unaffected by almost all reagents except by hydrochloric acid. Thus it stands against any contamination.

2.By selective etching of SiO2 , diffusion of impurities through carefully defined windows in the SiO2 can be accomplished to fabricate various components.

11. Explain the process of oxidation.

The silicon wafers are stacked up in a quartz boat & then inserted into quartz furnace tube. The Si wafers are raised to a high temperature in the range of 950 to 1150oC & at the same time, exposed to a gas containing O2 or H2O or both. The chemical action is

$$Si + 2H2O > Si O2+ 2H2$$

12. What are the advantages and limitations implantation of ion implantation?

Advantages:

- Accurate control over doping
- Very good reproducibility
- Precise resistance value
- A room temperature process

Limitations:

- Annealing at higher temperature is required for avoiding the crystal damage
- The possibility of dopant implanting through various layers of wafer.

13. 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.

14. 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.

$$CMRR = Ad/Ac$$

15.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.

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

(i) Superior insensitivity of circuit performance to power supply variations and temperature.

(ii) More economical than resistors in terms of die area required to provide bias currents of small value.

(iii) When used as load element, the high incremental resistance of current source results in high voltage gain at low supply voltages.

17. 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.

18.Mention the advantages of Wilson current source.

(i) Provides high output resistance.

(ii) Offers low sensitivity to transistor base currents.

19. 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.

20.Define slew rate. What causes 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.

Causes:

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

UNIT-II

APPLICATION OF OPERATIONAL AMPLIFIERS

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 opamp 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?

1. Industrial instrumentation
2. Communication
3. Signal processing

4. What is voltage follower?

A circuit in which output follows the input is called voltage follower.

5. 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.

6. List the features of instrumentation amplifier.

1. High gain accuracy
2. High CMRR
3. High gain stability with low temperature co-efficient
4. Low dc offset
5. Low output impedance

7. What are the applications of V-I converter?

1. Low voltage dc and ac voltmeter
2. L E D
3. Zener diode tester

8. Define Bandpass filter.

The bandpass filter is the combination of high and low pass filters, and this allows a specified range of frequencies to pass through.

9. What do you mean by a precision diode?

The major limitation of ordinary diode is that it cannot rectify voltages below the cut – in voltage of the diode. A circuit designed by placing a diode in the feedback loop of an op – amp is called the precision diode and it is capable of rectifying input signals of the order of millivolt.

10. Write down the applications of precision diode.

1. Half - wave rectifier
2. Full - Wave rectifier
3. Peak – value detector
4. Clipper
5. Clamper

11. Differentiate Schmitt trigger and comparator.

Schmitt trigger	**comparator**
1. It operates between two reference points namely UTP&LTP.	1. It compares the input signal with references voltage then yields the output voltage
2. It employs positive feedback	2. It need not consist of feedback
3. Its output is square wave.	3. comparator output need not to be square wave

14. List the applications of Log amplifiers.

1. Analog computation may require functions such as lnx, log x, sin hx etc. These functions can be performed by log amplifiers
2. Log amplifier can perform direct dB display on digital voltmeter and spectrum analyzer

3.Log amplifier can be used to compress the dynamic range of a signal

15. What are the applications of comparator?

1. Zero crossing detector
2. Window detector
3. Time marker generator
4. Phase detector

16. 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.

17. 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 either stable or quasi- stable depending on the type of multivibrator.

18. 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.

19. 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.

20. Mention any two audio frequency oscillators .

i. RC phase shift oscillator

ii. Wein bridge oscillator

UNIT- III

ANALOG MULTIPLIER AND PLL

1. List the basic building blocks of PLL:

1. Phase detector/comparator
2. Low pass filter
3. Error amplifier
4. Voltage controlled oscillator

2. Define FSK modulation.

FSK is a type of frequency modulation ,in which the binary data or code is transmitted by means of a carrier frequency that is shifted between two fixed frequency namely mark(logic1) and space frequency(logic 0).

3. What is analog multiplier?

A multiplier produces an output v0, which is proportional to the product of two inputs vx and vy

$$V0= kvxvy$$

4. List out the various methods available for performing for analog multiplier.

- Logarithmic summing technique
- Pulse height /width modulation technique
- Variable transconductance technique
- Multiplication using gilbert cell
- Multiplication technique using transconductance technique

5. Mention some areas where PLL is widely used.

1.Radar synchronizations
2. Satellite communication systems
3. Air borne navigational systems
4. FM communication systems
5.Computers.

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

1. Free running
2. Capture
3. Locked/ tracking

7. 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 theVCO free running frequency.

8. 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.

9. Define Pull-in time.

The total time taken by the PLL to establish lok 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

10. Write the expression for FSK modulation.

Pvf=f2-f1/k0

11. Define free running mode.

An interactive computer mode that allows more than one user to have simultaneous use of a program.

12. 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.

13. Give the classification of phase detector:

1. Analog phase detector .
2. Digital phase detector

14. 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.

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

1. The output voltage Ve 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.

2. The output is proportional to cosQ making it non linear.

16.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.

17. Define Voltage to Frequency conversion factor.

Voltage to Frequency conversion factor is defined as,

$$\mathbf{Kv = fo / Vc = 8fo / Vcc}$$

Vc is the modulation voltage

fo frequency shift

18.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,band-width and transient response.

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

19.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.

20.Mention some typical applications of PLL.

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

UNIT- IV

ANALOG TO DIGITAL CONVERTERS AND DIGITAL TO ANALAG CONVERTERS

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?

a. The integrating type of ADC's do not need a sample/Hold circuit at the input.

b. It is possible to transmit frequency even in noisy environment or in an isolated form.

7. Where are 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

19. 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 to convert 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

$$\mathbf{Tc = T(n+1)}$$

Where, T→clock period

Tc→conversion time

n→no. of bits

11. 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.

12. What is settling time?

It represents the time it takes for the output to settle within a specified band ±½LSB 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. 10Ws depending on word length & type circuit used.

13. 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.

14. 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 ±½LSB.

15. What are the specifications of D/A converter?

The specifications are accuracy, offset voltage, monotonicity, resolution, and settling time.

16. 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.

17 .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.

18. Which is the fastest ADC and why?

Simultaneous type A/D converter(flash type A/D converter) is the fastest because A/D conversion is performed simultaneously through a set of comparators .

19. What are the advantages and disadvantages of R-2R ladder DAC?

Advantage:

- Easier to build
- Number of bits can be expanded by adding more sections.

Disadvantage:

- More power dissipation makes heating, which in turns develops

non-linearties in DAC.

20. Give the disadvantages of flash type A/D converter.

The simultaneous type A/D converter is not suitable for A/D conversion with more than 3 or 4 digital output bits. Then (2n-1)comparators are required for an n-bit A/D converter and the number of comparators required doubles for each added bit.

UNIT- V

WAVEFORM GENERATORS AND SPECIAL FUNCTION IC'S

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 continous 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 continously.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 regulator.

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.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.

12.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 continous power dissipation by the transistor as it operates in the linear region

13.What is the advantage of monolithic 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

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

Opto-coupler IC is a combined package of a photo-emitting device and a photosensing 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 .

15. 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.

16.What is an isolation amplifier?

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

17. Write the frequency of oscillation (f0) equation for triangular wave Generator.

f0=R3/4R1C1R2

18. How frequency to voltage converted on OP-AMPS.

A Frequency to voltage converter produces an output voltage, whose amplitude is a function of frequency of the input signal. The input signal may be a sinewave, a square wave or a pulse train. The F/V converter is essentially an FM detector or discriminator.

19. What is video amplifier?

The video or wideband amplifiers are designed to provide a relatively flat gain versus frequency response characteristics for the range of frequencies required to transmit video information.

20. What is audio amplifier?

The amplifier receives an input from signal source or from a transducer and gives out an amplified signal to the output device is called an audio amplifier.