



U23ECT42 - LINEAR INTEGRATED CIRCUITS

PART A

UNIT 1 BASICS OF OPERATIONAL AMPLIFIERS

1. Define an Integrated circuit.

An integrated circuit(IC) is a miniature, 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.

- 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.

3. Define sheet resistance.

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

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-film capacitor

6. 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 differential amplifier makes it possible to achieve high voltage gain without requiring large power supply voltage.

7. 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.

8. Define virtual ground of a OP-Amp?

A virtual ground is a ground which acts like a ground. It is a point that is at the fixed ground potential (0v), though it is not practically connected to the actual ground or common terminal of the circuit.

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

Using constant current source output current of small magnitude (micro amp 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.

14. Mention the advantages of Wilson current source.

- (i) Provides high output resistance.
- (ii) Offers low sensitivity to transistor base current

15. Define sensitivity

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

16. 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

17. 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.

18. 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.

19. 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.

20. 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.

UNIT 2 APPLICATIONS OF OPERATIONAL AMPLIFIERS

PART-A

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?

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. LED
3. Zener diode tester

8. Define Band pass filter.

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

9. Write transfer function of op amp as an integer.

The transfer function of the integer is $|A| = 1/WR1cf$

10. What do you mean by a precision rectifier?

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.

11. Write down the applications of precision diode.

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

12. Define Logarithmic and antilogarithmic amplifier.

When a logarithmic PN junction is used in the feedback network of op-amp, the circuit exhibits log or antilog response. The logarithmic amplifier is a current to voltage converter with the transfer characteristics $v_0 = v_i \ln(I_f/I_i)$ Antilog amplifier is a decoding circuit which converts the logarithmically encoded signal back to the original signal levels as given by $v_l = vR10^{-kvi}$

13. Differentiate Schmitt trigger and comparator.

Comparator.

1. It compares the input signal with references voltage then yields the output voltage . comparator output need not to be square wave

2. It need not consist of feedback

Schmitt trigger

1. It operates between two reference points namely UTP<P.

2. It employs positive feedback

3. Its output is square wave.

14. List the applications of Log amplifiers:

1. Analog computation may require functions such as $\ln x$, $\log x$, $\sin hx$ 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. Write down the condition for good differentiation.

1. For good differentiation, the time period of the input signal must be greater than or equal to $R_f C_f$
2. $T > R_f C_f$ Where, R_f is the feedback resistance
3. C_f is the input capacitance

16. What is a comparator?

A comparator is a circuit which compares a signal voltage applied at one input of an op amp with a known reference voltage at the other input. It is an open loop op - amp with output $+V_{sat}$.

17. What are the applications of comparator?

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

18. 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.

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20. Which are the reference voltages of the input waveform?

- i. RC phase shift oscillator
- ii. Wein bridge oscillator

UNIT 3 TIMER CIRCUITS , VCO AND PLL

PART-A

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 frequencies namely mark (logic 1) and space frequency (logic 0).

3. What is analog multiplier?

A multiplier produces an output v_0 , which is proportional to the product of two inputs v_x and v_y $V_0 = k v_x v_y$

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

- Logarithmic summing technique
- Pulse height /width modulation technique
- Variable Tran's conductance 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 the VCO 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 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.

10. Write the expression for FSK modulation.

$$\Delta v_f = f_2 - f_1 / k_0$$

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 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.

16. Define Voltage to Frequency conversion factor.

Voltage to Frequency conversion factor is defined as,

$$K_v = f_o / V_c = 8f_o / V_{cc}$$

V_c is the modulation voltage f_o -frequency shift

17. 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

18. 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.

19. Mention some typical applications of PLL:

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

20. 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.

UNIT 4 ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS

PART-A

1. Name the essential parts of a DAC.

- Drive motors
- Analog devices
- Deglitcher
- Filter

2. Write down the drawback of weighted D/A converter.

The main disadvantage of binary weighted D/A converter is the requirement of wide range of resistor values. As the length of the binary word is increased, the range of resistor values needed also increases.

3. List the broad classification of ADCs.

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

4. 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

5. List out some integrating type converters.

1. Charge balancing ADC
2. Dual slope ADC

6. What is integrating type converter?

An ADC converter that performs 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 an integrating type A/D converter.

7. 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.

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

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

9. Where are the successive approximation type ADCs used?

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

10. What is the main drawback of a dual-slope ADC?

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

11. 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.

12. 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 $T(n+1)$ where T---clock period Tc---conversion time n-- --no. of bits

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n----no.of bits

17. 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 LSB increment. The resolution of an ADC is defined as the smallest change in analog input for a one bit change at the output.

18. 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.

19. What is settling time?

It represents the time it takes for the output to settle within a specified band $\pm\frac{1}{2}$ 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. 10Ws depending on word length & type circuit used.

20. 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.

UNIT 5 WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS

PART-A

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 monolithic switching regulators?

- *Greater efficiency is achieved as the power transistor is made to operate as a 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, and contact bounce are eliminated.

18. What is an isolation amplifier? Mention it's application.

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 sort 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.