DHANALAKSHMI SRINIVASAN INSTITUTE O TECHNOLOGY,
SAMAYAPURAM -621112
ACADEMIC YEAR 2018-2019
DEPARTMENT OF BIOMEDICAL ENGINEERING
IV SEMESTER BME
EC8453 – LINEAR INTEGRATED CIRCUITS
QUESTION BANK

UNIT-I BASICS OF OPERATIONAL AMPLIFIERS
PART-A

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

The biasing sources referenced to VBE has a negative temperature coefficient and VT 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 VBE and VT so that by proper weighting, zero temperature coefficient can be achieved.

2. Define thermal drift.

The bias current, offset current & offset voltage change with temperature. A circuit carefully nulled at 25^{o}C may not remain so when the temperature raises to 35^{o}C.This is called thermal drift. Often, offset current drift is expressed in nA/ ^{o}C and offset voltage drift in mV/ ^{0}C.

3. Define supply voltage rejection ratio (SVRR)

The change in OPAMP's input offset voltage due to variations in supply voltage is called the supply voltage rejection ratio. It is also called Power Supply Rejection Ratio (PSRR) or Power Supply Sensitivity (PSS).

4. 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.

5. 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.

6. 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.

7. 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

8. What is frequency response of Op-amp?

The plot showing the variations in magnitude and phase angle of the gain due to change in frequency is called frequency response of Op-amp. The plot is used to find the bandwidth and cut-off frequencies of Op-amp.

9. Define Unity Gain Bandwidth of Op-amp.

For a certain frequency of the input signal, the gain of the Op-amp reduces to 0 dB. This means 20 log |AOL (f) | is 0dB i.e. |AOL (f) | = 1. Such a frequency is called gain cross over frequency or unity gain bandwidth (UGB).

10. 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 opamp's output voltage should change instantaneously in response to input step voltage.

11. Define P.S.R.R of an op-amp.

Power Supply Rejection Ratio (PSRR) is the ability of an amplifier to maintain its output voltage as its DC power-supply voltage is varied.

PSRR = (change in Vcc)/(change in Vout)

12. Define Input bias current of an op-amp.

Input bias current IB is the average of the currents that flow into the inverting and non-inverting input terminals of the op-amp.

i.e. IB = (IB1+IB2)/2

13. Define Input offset current of an op-amp.

The algebraic difference between the current into the inverting and non-inverting terminals is referred to as input offset current Iio. Mathematically it is represented as Iio = |IB - IB |

Where

I B+is the current into the non-inverting input terminals.

IB- is the current into the inverting input terminals.

14. Define Input offset current of an op-amp.

This is the voltage required to be amplified at the input for making output voltage to zero volts.

15. Define Virtual ground property of an OP-AMP

A virtual ground is a ground which acts like a ground. It may not have physical connection to ground. This property of an ideal op-amp indicates that the inverting and non-inverting terminals of op-amp are at the same potentials. The non-inverting input is grounded for the inverting amplifier circuit. This means that the inverting input of the op-amp is also at ground potential

PART-B

1. Wilson current source circuit and widlar current source circuit.
2. Explain Block diagram of op-amp (8) Internal Stages of Op-amp.
3. Explain the operation of differential amplifier, DC analysis of differential amplifier,

Differential amplifier with constant current source, Differential amplifier active load.

4. Elaborate on AC & DC characteristics of Op-amp.
5. Analyse the open loop and closed loop characteristics of Op am.

UNIT II - APPLICATION OF OP – AMPS

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. Define virtual ground property of Op-amp.

Concept of virtual ground says that the two input terminals of the Op-amp are always at the same potential. Thus if one terminal is grounded the other can be assumed to be at ground potential, which is called virtual ground.

4. What is Voltage follower?

- A circuit in which the output voltage follows the input voltage is called voltage follower Circuit.
- In Op-amp if the inverting input and the output terminals are shorted and if any signal is Applied at the non-inverting terminal, it appears at the output without any change.
- It is also called as source follower, unity gain amplifier, buffer amplifier or isolation amplifier.

5. List the features of instrumentation amplifier.

- High gain accuracy
- High CMRR
- High gain stability with low temperature co-efficient
- Low dc offset
- Low output impedance

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

- Low voltage dc and ac voltmeter
- LED
- Zener diode tester

7. 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 milli volt.

8.What are the limitations of the basic differentiator circuit?

At high frequency, a differentiator may become unstable and break into oscillations. The input impedance decreases with increase in frequency , thereby making the circuit sensitive to high frequency noise.

9. Write down the condition for good differentiation.

For good differentiation, the time period of the input signal must be greater than or equal to R_f C_1

$T > R_f C_1$ Where, R_f is the feedback resistance C_f is the input capacitance

10. What are the applications of comparator?

- Zero crossing detector
- Window detector
- Time marker generator
- Phase detector

11. 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.

12. Define logarithmic and antilogarithmic amplifier.

The Op-amp circuit in which the output is proportional to the logarithmic of the input is called logarithmic amplifier. It employs a diode or a transistor in the negative feedback path.

The Op-amp circuit in which the output is proportional to the antilogarithmic of the input is called logarithmic amplifier. It employs a diode or a transistor in the input stage.

13. List the applications of Log amplifiers.

- Analog computation may require functions such as ln x, log x, sin h x etc.

These functions can be performed by log amplifiers

- Log amplifier can perform direct dB display on digital voltmeter and spectrum analyzer
- Log amplifier can be used to compress the dynamic range of a signal

14. What are the advantages of active filters?

- Active filters used 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.

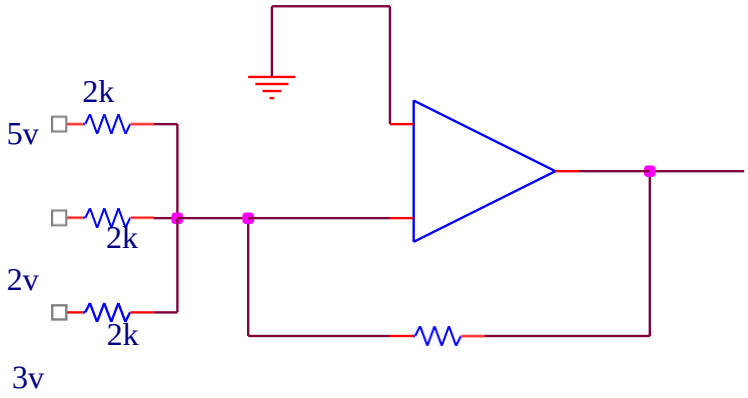
15.What are the requirements for producing sustained oscillations in feedback circuits?

For sustained oscillations,

- The total phase shift around the loop must be zero at the desired frequency of oscillation, fo. ie, AB =0 (or) 360°
- At fo, the magnitude of the loop gain | A β | should be equal to unity

PART-B

1. What is meant by voltage follower?
2. Determine the output voltage v_o for the following circuit.



3. Explain the operation of the Schmitt trigger.
4. Describe Logarithmic and anti-logarithmic amplifier
5. Explain Precision rectifier and its applications -Clipper and clamper circuits
6. Analyse of low pass Butterworth filters.
7. Elaborate on I to V and V to I converters and applications
8. Explain application of op-amp as integrator and differentiator
9. Discuss the need for an instrumentation amplifier? Explain three op-amp instrumentation amplifier with diagram (16)

UNIT –III ANALOG MULTIPLIER AND PLL

PART-A

1. What is a four quadrant multiplier?

In a multiplier circuit, if both the inputs are allowed to swing in both positive and negative directions the multiplier is called as a four quadrant multiplier.

2. Mention some areas where PLL is widely used.

- Radar synchronization
- Satellite communication systems
- Air borne navigational systems
- FM communication systems
- Computers.

3. List the basic building blocks of PLL

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

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

- Free running
- Capture
- Locked/ tracking

5. 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.

6. 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.

7. 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.

8. Mention some typical applications of PLL:

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

FSK demodulation.

9. 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.

10. Define VCO.

A voltage controlled oscillator is an oscillator circuit in which the frequency of oscillations can be controlled by an externally applied voltage.

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

- External timing resistor, RT
- External timing capacitor, CT

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

fo = 0.25 / RT CT

13. Define Voltage to Frequency conversion factor.

Voltage to Frequency conversion factor is defined as,

Ky = f**o** / V**c= 8fo /Vcc**

where, Vc is the modulation voltage required to produce the frequency shift fo

14. Define FSK modulation.

In digital data communication, binary data is transmitted by means of a carrier frequency. FSK employs two different carrier frequencies one for logic 1 and other for logic 0 states ofbinary data signal. This process is called FSK modulation.

15. Define free running mode.

In a PLL if the error control voltage is zero then the PLL is said to be operated in free running mode and its output frequency is called its center frequency f0.

PART-B

1. Elaborate on Gilbert multiplier cell/ Four quadrant multiplier.
2. Explain Analog multiplier using emitter coupled transistor.
3. Analyze the analog multiplier IC with a neat circuit diagram. Discuss its applications.
4. Discuss the Operation of PLL & applications of PLL.
5. With a neat functional diagram, explain the operation of VCO. Also derive an expression for fo.

UNIT IV - ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS

PART-A

1. 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.

2. 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.

3. What is the main drawback & advantages of a dual-slop ADC?

The dual slope ADC has long conversion time. This is the main drawback of dual slope ADC.
Adv:It provides excellent noise rejection of ac signals whose periods are integral multiples of the integration time T.

4. Define conversion time.

It is defined as the total time required to convert an analog signal into its digital output. It dependson the conversion technique used & the propagation delay of circuit components. The conversion time of a successive approximationtype ADC is given by
T(n+1) where T---clock period
Tc---conversion time n no. of bits

5.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)= VFS/2n-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.

6. 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.

7. What is settling time?

It represents the time it takes for the output to settle within a specified band }.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. 10μ s depending on word length & type circuit used.

8. 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.

9. 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 LSB.

10. Find the resolution of an 8-bit DAC.

Resolution =1/(2^8 -1) =1/ 255

11. Which is the fastest A/D converter and why?

`Flash type A/D converter is the fastest ADC, because the fast conversion speed is accomplished by providing 2n-1 comparators and simultaneously comparing the input signal with unique reference levels spaced 1 LSB apart.

12. What are limitations of Flash type ADC?

Flash type ADC employs 2n-1 comparators for conversion which makes it costlier which trade offs in the speed of conversion.

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

Adv:-

- Easier to build accurately as only two precision metal film r istors are required

can be expanded by adding more sections of same R/2R values.

- In inverted R/2R ladder DAC, node voltages remain constant with changing input binary wo

This avoids any slowdown effects by stray capacitances.

Disadv:-

- With increasing output bits the circuit becomes larger
- The switches used are noted for the sources of errors.

14. 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 la st 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.

15.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.

PART-B

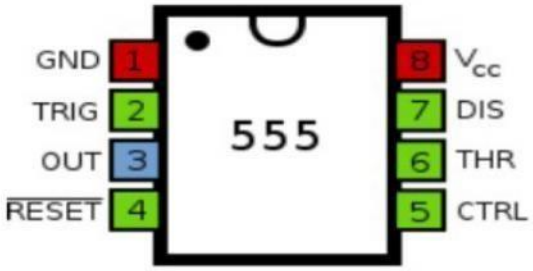
1. Explain the operation of sample and hold circuit.
2. Explain the operation of FLASH type ADC.
3. Weighted resistor type D/A converter, R-2R ladder type D/A converter – Voltage mode and current mode
4. Dual Slope type A/D converter , Single slope type A/D converter
5. Sample and Hold circuits for A/D converter
6. Explain A/D convertors using any two methods - successive Approximation A

UNIT V – WAVEFORM GENERATORS & SPECIAL FUNCTION ICs

PART-A

1. Define 555 IC & its Pin diagram ?

The 555 timer is an integrated circuit specifically designed to perform signal generation and timing functions.



Pin	Name	Purpose
1	GND	Ground, low level (0 V)
2	TRIG	OUT rises, and interval starts, when this input falls below 1/3 V_{CC}.
3	OUT	This output is driven to +V_{CC} or GND.
4	$\overline{\text{RESET}}$	A timing interval may be interrupted by driving this input to GND.
5	CTRL	"Control" access to the internal voltage divider (by default, 2/3 V_{CC}).
6	THR	The interval ends when the voltage at THR is greater than at CTRL.
7	DIS	Open collector output; may discharge a capacitor between intervals.
8	$V+$, V_{CC}	Positive supply voltage is usually between 3 and 15 V.

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

- Monostable:
- Missing pulse detector
- Linear ramp generator
- Frequency divider

Pulse width modulation.

Astable:

FSK generator

Pulse-position modulator

3. 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.

4.What do you mean by monostable multivibrator & astable 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.
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

5. What is a linear voltage & switching 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.

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.

6. 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.

7. Define line regulation & load regulation.
Line regulation is defined as the percentage change in the output voltage for a change in the input voltage. It is expressed in milli volts or as a percentage of the output voltage.
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.

8. 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.

9. 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.

10. Define drop-out voltage of a fixed voltage regulator.
It is the minimum voltage that must exist between input and output terminals. It is defined as the ratio of the r.m.s input ripple voltage to the r.m.s output ripple voltage. It is expressed in decibels (dB).

11. Define video amplifier.

A video amplifier has to amplify signals over a wideband of frequencies, say upto 20MHz. It is a RC coupled amplifier with bandwidth from d.c. to high frequency upto few megahertz.

12. What is opto coupler?

An opto-isolator, also called an optocoupler, photocoupler, or optical isolator, is "an electronic device designed to transfer electrical signals by utilizing light waves to provide coupling with electrical isolation between its input and output". The main purpose of an opto-isolator is "to prevent high voltages or rapidly changing voltages on one side of the circuit from damaging components or distorting transmissions on the other side eg:

LED and photo transistor,

- LED and Darlington

13. 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.

14. What is an isolation amplifier?

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

15. List the applications of Isolation amplifier.

- Floating pulse amplifier output voltage and current interface
- Instrumentation in high-noise environments.
- Analogue front-end processing.
- Medical instrumentation.

PART-B

1. Wien Bridge and RC phase oscillator using IC741
2. Triangular and saw tooth wave generator
3. Working of ICL 8038 function generator
4. Discuss in detail the operation of Astable multivibrator, Monostable multivibrator.
5. Explain functional block diagram of IC 555 timer.(8)
6. In detail discuss the 723 IC general purpose voltage regulators.
7. Explain the operation of switching regulators. Give its advantages.
8. Explain the functional diagram of LM 380 power amplifier.
9. Explain the operation of ICL 8038 function generator. Give its advantages.
10. Explain the operation of(1) opto electronic ICs, (2) audio amplifier (3) video amplifier (4) Opto-couplers and fiber optic ICs