Chettinad College of Engineering & Technology
Approved by AICTE-New Delhi and Affiliated to Anna University-Chennai

Academic Year 2024- 2025

Question Bank

Year/Semester: II/ IV	Department: ECE	Unit: I
Date: 12 /03/2024	Subject Code/Title :EC3451/LINEAR INTEGRATED CIRCUITS	Section: Part A/B/C
	Faculty Name: Mrs.P.Nagarani alias sobana	

UNIT I

Part A:

UNIT I- BASICS OF OPERATIONAL AMPLIFIERS

1. **Mention any four characteristics of an ideal operational amplifier. [April 2017, Nov 17]**

The Characteristics of an ideal operational amplifier are

(i) Open loop voltage gain $A_{OL} = \infty$ (infinity)
(ii) Input impedance $R_i = \infty$ (infinity)
(iii) Output impedance R_o=0 (zero)
(iv) Zero offset V_o =0 (zero) when V_1=V_2=0
(v) Bandwidth BW=∞ (infinity)

2. **Define slew rate and what causes slew rate. (April 2015)**

Slew rate is defined as the maximum rate of change of output voltage caused by a step input voltage.
Unit is V/µs.

$$s = \frac{2\pi f v_m}{10^6} V/\mu S$$

V_m is amplitude of input signal
f is frequency of input signal
Slew rate of 741 IC is 0.5V/µS.

Cause of slew rate: A capacitor present in an op-amp is used to prevent oscillation. This capacitor prevents the output voltage from responding immediately to a fast changing input.

3. **In what way is IC741S is better than IC741?**

(i) IC741S is military grade of amplifier
(ii) It has higher slew rate
(iii) It has Lower temperature than IC741.

4. **Define CMRR.**

Common Mode Rejection Ratio (CMRR) is defined as the "ratio of difference mode gain to common mode gain". Its ideal value is infinity.

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

Where A_d is difference mode gain and A_c is common mode gain.

5. **Define PSRR.**

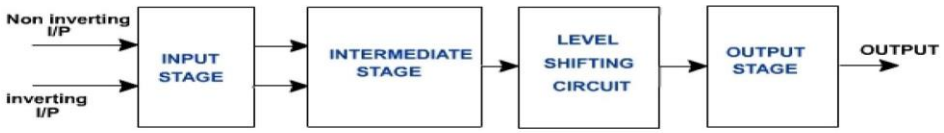
Power Supply Rejection Ratio (PSRR) is defined as the "change in op-amp's input offset voltage due to variations in supply voltage". It is expressed in micro volt per volt or measured in dB.

6. **Define Tail current.**

Tail current is defined as the "current which is flowing through the common emitter resistor of the differential amplifier".

7. **Draw and explain the internal block diagram of typical op-amp circuit. [Nov 2016, June 2018]**

The internal block diagram of typical op-amp circuit is given below:



(i) Differential amplifiers are used to provide high gain.
(ii) The buffer is an emitter follower circuit whose input impedance is
(iii) Very high. It prevents loading of high gain stage.
(iv) The output driver stage provides low output impedance.

8. List the basic types of differential amplifier configurations.

The Four basic types of differential amplifier configurations are

(i) Dual input and balanced output.
(ii) Dual input and unbalanced output.
(iii) Single input and balanced output.
(iv) Single input and unbalanced output.

9. Mention the draw backs of using large RC in differential amplifiers.

The main drawbacks of using a large RC are

(i) A large value of resistance requires a large chip area.
(ii) For large RC quiescent drop, a large power supply will be required to maintain a given quiescent collector current.

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

DC characteristics of op-amp are

(i) Input bias current.
(ii) Input offset current.
(iii) Input offset voltage.
(iv) Thermal drift.

11. Why do we use R_{comp} resistor?

In a bipolar op-amp circuit, even when the input is zero, the output will not be zero. This is due to the effect of bias current. This effect can be compensated using R_{comp} resistor and it is given by

$R_{comp}=(R_1R_f)/(R_1+R_f)$

Where R_1 is input resistance and R_f is feedback resistance.

12. Define thermal drift.

Thermal drift is defined as the change in offset current and offset voltage due to change in temperature.

13. List various ac characteristics of an op-amp.

The AC characteristics of an op-amp are

(i) Frequency response
(ii) Slew rate
(iii) Frequency compensation

14. Define magnitude plot and phase angle plot.

Magnitude plot is drawn between "changes in gain of an op-amp along y-axis with respect to the changes in frequency along x-axis".

Phase angle plot is drawn between "phase angle changes along y-axis with respect to the changes in frequency along y-axis".

15. Define compensating network.

The compensating network is formed by passive components such as resistor and capacitor to obtain

(i) Larger bandwidth and

(ii) Lower closed loop gain.

16. Mention the two types of external compensation techniques.

The two types of external compensation techniques are

(i) Dominant-pole compensation

(ii) Pole-zero (lag) compensation

17. Define large signal voltage gain. Why it is referred so?

Large signal Voltage gain is defined as "the ratio of the output voltage to differential input voltage".

Since the amplitude of the output signal is much larger than the input signal, the voltage gain is commonly referred to as large signal voltage gain.

18. What does the output voltage swing indicate?

The output voltage swing indicates the maximum value of positive and negative voltage of an op-amp.

It should never exceed the supply voltage V^+ and V^-.

19. Define output resistance.

Output resistance R_o is defined as the resistance measured between the output terminal of the op-amp and the ground. The typical value is 75 for 741 ICs.

20. Define input resistance.

The resistance offered by a differential amplifier to the differential input signal (V_1-V_2) is called differential input resistance R_{id}.

21. List the different types of op-amp.

Different types of op-amp are:

(i) Bipolar op-amp

(ii) FET op-amp

(iii) MOSFETop-amp

22. Define input offset voltage. [Nov 2013]

Input offset voltage is defined as the voltage that must be applied between the input terminals of an op-amp to nullify the output, when no input is given.

For IC741, the maximum value is 6mV.

23. Define supply current.

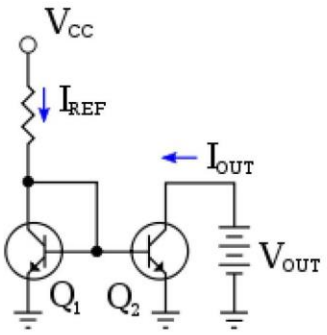
Supply current I_S is defined as the current drawn by the op-amp from the power supply.

It is 2.8mA for 741 IC.

24. What is current mirror?

Current mirror is a circuit which produces a copy of current through one active device by controlling current in another active device of the circuit. Here output current is constant regardless of load. An ideal current mirror is an ideal current amplifier.

[Note: this provides bias current and act as an active load to other circuit.]



25. Why is the current mirror circuit used in differential amplifier stage? [April 2017]

The current mirror circuit is used in differential amplifier to get

(i) high gain

(ii) an improved output swing differential amplifier.

26. What is an integrated circuit?

Integrated circuit is a miniature low cost circuit in which all the active and passive components are fabricated on the same silicon chip. It is classified as analog IC and digital IC.

27. State the advantages of IC over discrete components. [May 2013, Nov 2014]

(i) Miniaturization and hence increased equipment density.

(ii) Cost reduction due to batch processing

(iii) Improved functional performance

(iv) Matched devices

(v) Increased operating speed

(vi) Reduction in power consumption

(vii) Increased system reliability due to elimination of solder joints.

28. What is meant by monolithic IC? [Nov 2014]

All the active, passive components and their interconnections are manufactured into or on top of single chip of silicon.

Lowest per unit cost and higher order of reliability can be obtained when identical circuits are very large in quantities.

29. **What is the maximum undistorted amplitude that a sine wave input of 10 kHz can produce at the output of an op-amp whose slew rate is 0.5V/ µs.**

$$s = \frac{2\pi f v_m}{10^6} V/\mu s$$

$$0.5 = \frac{2*3.14*10*10^3*V_m}{10^6}$$

V_m=7.95V or $V_{m(PP)}$=15.91V

30. **A differential amplifier has a differential voltage gain of 2000 and a common voltage gain of 0.2. Determine the CMRR in dB. (April 2015)**

CMRR=Differential mode gain/Common mode gain

CMRR=2000/0.2=10000

CMRR in dB=20log10000=80dB.

31. **Mention the advantages of active load over passive load in an op-amp. [Nov 2015, Nov2010]**

The active load circuit provides high ac resistance which in turn produces high differential gain.

The quiescent voltage required across a current mirror is very less and hence low biasing supply voltage is required for an active load.

[Note: passive load requires high RC and high supply voltage.]

32. **Define input bias current and input offset current of an op-amp. [Nov 2015]**

Input Bias current I_B is defined as the average value of the base currents entering into the inverting and non inverting terminals of an op-amp.

$$I_B = \frac{I_{B+} + I_{B-}}{2}$$

For 741IC the bias current is 500nA.

Input offset current is defined as the algebraic difference between the currents into the non inverting input terminal (I_B^+) and inverting input terminal (I_B^-). For 741IC the offset current is 200nA.

$$|I_{os}| = (I_B^+) - (I_B^-)$$

33. **Find maximum frequency of sine wave output voltage $10V_{(pp)}$ with an op-amp whose slew rate is 1V/µs. [May 2016]**

Given s=1V/ µs=1x10^6 V/ s

V_m=10V

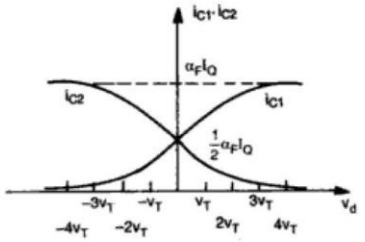
$f_{max} = \frac{s}{2\pi Vm}$ Hz$= \frac{1*10^6}{2*\pi*10}$=15.9kHz.

34. **Draw the dc transfer characteristics of a BJT differential amplifier and define differential mode input voltages. [Nov 2017]**

The difference in input voltage V1 and V2 between the inverting and non inverting input terminals respectively is called difference or differential mode input voltages.

i.e., $V_d = V_1 \sim V_2$

Transfer characteristics



35. The power supply rejection ratio of an op-amp is 80dB for a 1V change in supply voltage. Calculate the change in offset voltage. [Nov 2017]

Given: PSRR=80dB

dB to voltage gain conversion is done using the formula $V=10^{\frac{\text{dB value}}{20}}$

$PSRR=10^{\frac{80}{20}}=10^{4=}10{,}000$

$\Delta V=1V$

$PSRR=\frac{\Delta V_{ios}}{\Delta V}$

Therefore $\Delta V_{ios}=10000*1=10000V$.

36. State the limitations of discrete circuits. [May 2013]

(i) Power consumption is more due to discrete components.
(ii) Cost is high.
(iii) Complex circuits.
(iv) Cost is more and weight is more.
(v) More supply voltage is required.

37. Differentiate ideal and practical characteristics of op-amp. [May 2016]

IDEAL CHARACTERISTICS	PRACTICAL CHARACTERISTICS
Bias current is zero	Bias current is nearly 500nA for IC 741
Infinite input resistance	Input resistance is 2MΩ
Output resistance is zero	Output resistance is 75Ω
Output offset voltage is zero	Offset depends on bias current, offset current, input offset voltage

38. Define Bandwidth of filter. [Nov 2014]

Bandwidth is defined as the difference between higher cut-off and lower cut-off frequency (f_H-f_L).

It is the range of frequencies within the given band for effective transmission of the signal.

It is measured in Hz.

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS

1. List out the important features of an Instrumentation amplifier.

The important features of an Instrumentation amplifier:

(i) High gain accuracy

(ii) High CMRR

(iii) High gain stability with low temperature coefficient

(iv) Low dc offset

(v) Low output impedance

2. Mention the disadvantages of passive filters.

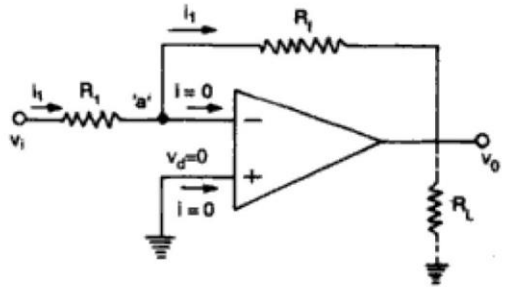
The disadvantages of passive filter are

(i) Inductors used in passive filters are large, heavy and expensive for low frequency applications.

(ii) More number of turns of wire needs to be used. This adds to the series resistanceΔ degrading inductor's performance. (i.e.) low Q, resulting in high power dissipation.

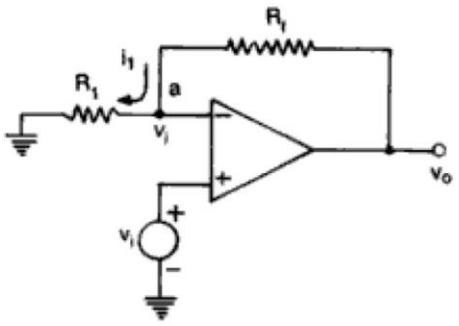
3. What is an inverting amplifier?

Inverting amplifier is a type of op-amp in which the input signal is applied to the inverting input terminal. The output voltage is feedback to the inverting input terminal through feedback resistance (R_f). The output signal obtained is the amplified form of input signal with a phase shift of 180^0. The circuit diagram of inverting op-amp is given below:

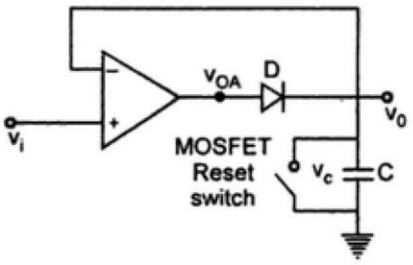


4. What is a non inverting amplifier?

Non inverting amplifier a type of amplifier in which the input signal is applied to the non-inverting input terminal and the output is feedback to the inverting input terminal through the feedback resistor R_f. The output signal is the amplified form and is in phase with the input signal. The circuit diagram of non-inverting amplifier is given below:



5. **Draw the circuit diagram of peak detector.** (June 2014)



6. **Give an application of voltage follower, peak detector, Schmitt trigger and clamper. (Nov 2013)**

Voltage follower is used as

(i) Buffers for logic circuits.
(ii) To prevent loading effect in Active filters.

Peak detector is used

(iii) As detector in AM circuit.
(iv) In Measurement and Instrumentation applications.

Schmitt trigger used in

(v) Wave shaping circuit to convert any input to square wave output (as square wave converter).

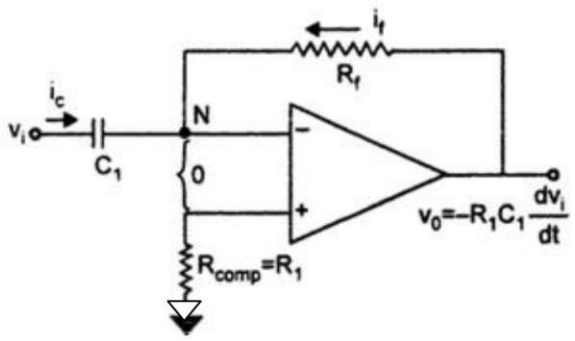
Clamper circuit is used

(vi) To add dc signal to ac output both in positive sides and negative sides.
(vii) Used in Television.

7. **Give an application of inverting amplifier.**

(i) As a sign changer i.e., Vo=Vin
(ii) Acts as an unity gain inverter when R_f=R_1

8. Draw the circuit diagram of op-amp differentiator.



9. What is linear op-amp circuit?

An op-amp circuit which has the output signal with the same shape as that of the input signal is called linear op-amp circuit. The op-amp does not go to saturation during its cycle.

10. List some of the linear op-amp circuits.

Some of the linear op-amp circuits are

(i) Inverting amplifiers

(ii) Non-inverting amplifiers

(iii) Differential amplifiers

(iv) Instrumentation amplifiers

(v) Current boosters

11. What is non-linear op-amp circuit?

An op-amp circuit which has the output signal with a different shape from the input signal is called nonlinear op-amp circuit. The op-amp saturates during part of its input cycle.

12. List some non-linear op-amp circuits.

Nonlinear op-amp circuits:

(i) Comparators

(ii) Wave shapers

(iii) Active diode circuits.

(iv) Log and Antilog amplifiers

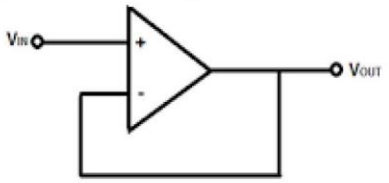
13. How is the gain stabilized by negative feedback?

Negative feedback is used mainly to stabilize the overall voltage gain. If the open loop voltage gain A_{OL} increases, the output voltage will increase and feeds back more voltage to the inverting input. This opposing feedback voltage reduces inverting input voltage V_2 and hence the final output increases much less. Thus stability is maintained with negative feedback.

14. What is voltage follower? [May 2014]

Voltage follower is the circuit in which the output voltage follows the input voltage both in magnitude as well as in phase. The circuit diagram of

voltage follower is given below:



15. Mention the main applications of differentiator.

Main applications of differentiator:

(i) Used in wave shaping circuits to detect high frequency components in an input signal.

(ii) Used as rate of change detector in FM modulations.

16. List the drawbacks of ideal integrator.

Drawbacks of ideal integrator:

(i) At low frequencies (dc), gain becomes infinity.

(ii) When the op-amp saturates, ideal integrator behaves like an open circuit.

17. What is a differentiator?

A differentiator is the circuit which perform the mathematical operation of differentiation, i.e., the output wave form is the derivative of the input waveform. The output voltage is given by

$$\mathbf{V_0 = -R_f C_1 \frac{dV_i}{dt}}$$

Where R_f is the feedback resistor,

C_1 is the input capacitance and

V_i is the input voltage.

18. Mention the main applications of differentiator.

Main applications of differentiator:

(i) Used in waveshaping circuits to detect high frequency components in an input signal.

(ii) Used as rate of change detector in FM modulations.

19. List the drawbacks of ideal integrator.

Drawbacks of ideal integrator:

(i) At low frequencies (dc), gain becomes infinity.

(ii) When the op-amp saturates, ideal integrator behaves like an open circuit.

20. Why is the practical integrator called as lossy integrator?

The gain of the integrator at lower frequencies can be limited to avoid the saturation problem, if the feedback capacitor Cf is shunted by a resistor Rf.The parallel combination of Rf and Cf behaves like practical capacitor, which dissipates power, unlike an ideal capacitor. For this reason, the circuit is called as lossy integrator.

Part B:

1.(i)With a suitable circuit diagram, explain the operating principle of an instrumentation amplifier and derive its gain.

(ii)Design a second order Butterworth low-pass filter having upper cut-off frequency of 2.1961 kHz

2.Compare and contrast Adder, Subtractor, and Averaging circuit using op-amp with equations.

3.Illustrate the operation of current to voltage and Voltage to current Converter circuits.

4.(i)Draw and explain the operation of Triangular wave generator.

(ii)Write short notes on second order Low Pass Butterworth filter (Sallen-key filter).

5.Derive the expression for log computation using op-amp and explain necessary circuit diagram.

6.With neat figures describe the circuit using op-amps on the following of

(i)Integrator and double integrator circuit

(ii)First order High pass filter

7.Draw and explain the circuit of a voltage to current converter if the load is

i) Floating

ii) Grounded

8.(i)Design an OP-AMP based first order active low pass filter.

(ii)Creating a second order Butterworth LPF having upper cut-off frequency 1 kHz. Determine the frequency response.

PART-C

1.Evaluate Inverting adder and Non-inverting adder with neat circuit diagram and mathematical expressions.

2.Create any of three op-amp based mathematical function circuits

3. i)Design a Butterworth low pass filter circuit using operational amplifier.

ii) Design a wide band filter having FL=400Hz, FH=2kHz and pass band gain of 4.Find the value of Q of filter.

4. Justify that how the circuit using Op-amps on the operation of.

(i)Zerocross Detector, Clipper and Clamper circuit

(ii)Schmitt Trigger.

2021 - CNCET

UNIT III ANALOG MULTIPLIER AND PLL

1. **What is an analog multiplier?**

   An analog multiplier is a multiplier circuit which produces an output voltage (V_o) proportional to the product of two input voltages V_X and V_Y.The output voltage is given by,

   $V_{O=}KV_XV_Y$.

   Where K is a scale factor, usually its value is $1/(10)V^{-1}$.

2. **What is a two quadrant multiplier?**

   One of the two inputs V_1 or V_2 of a multiplier circuit is held positive and other input is allowed to swing in both positive and negative polarity.

   It uses any 2 quadrants at a time in four quadrants.

3. **What is a four quadrant multiplier?**

   A multiplier that accepts inputs of both polarity (both positive and negative) and produce the correct polarity relationship at the output is referred to as a four quadrant multiplier.

4. **Give the applications of analog multipliers.**

   Applications of analog multipliers are

   (i) Frequency doubling

   (ii) Frequency shifting

   (iii) Phase angle detection

   (iv) Real power computation

   (v) Multiplying two signal, dividing and squaring of signals

5. **What is the unique feature of Operational Transconductance Amplifier (OTA)?**

   The unique feature of OTA is that, it is possible to vary transconductance 'g_m' over a wide range, by means of an external control current. OTA is an inherently fast device.

6. **Give the typical applications of Operational Transconductance Amplifier (OTA)**

   The applications of Operational Transconductance Amplifier (OTA) are

   (i) To implement programmable amplifiers and integrators in audio processing and electronic music synthesis.

   (ii) As current switches in sample and hold applications.

   (iii) Using VLSI techniques in neural networks.

7. **List the basic limitations of Operational Transconductance Amplifier (OTA).**

   The basic limitations of Operational Transconductance Amplifier are

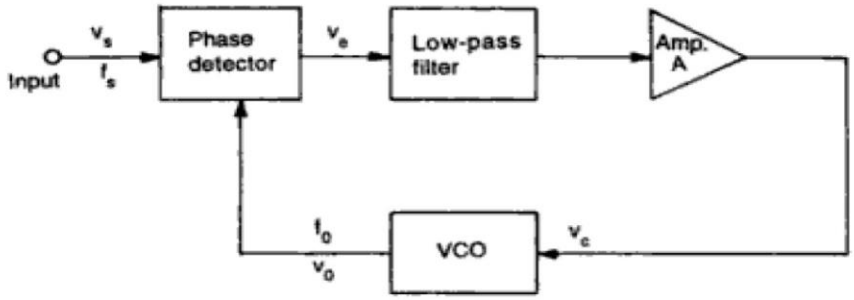
   (i) Output current is non-linear when the input voltage exceeds 20mV.

   (ii) As the control current IC is varied to adjust gain or resistance, all the

offset voltage, input bias current and slew rate are also affected.

(iii) Temperature affects the performance of OTA

8. Draw the general block diagram of phase locked loop.



Where V_s and f_s are the signal voltage and signal frequency respectively, V_c and f_c are the control voltage and frequency of the control signal respectively. V_e is the error voltage, V_o is the output voltage.

9. Define lock-in range. [Nov 2013]

Lock-in range is defined as the range of input frequencies over which the PLL can maintain lock with the incoming signal. It is also called as tracking range. The lock-in range is expressed as a percentage of VCO frequency f_o.

10. What is the significance of lock-in range of PLL?

When the output frequency of VCO and input signal frequency are same, PLL is said to be locked. The significance of lock-in range explains the range of input frequency over which PLL can maintain lock condition. The lock-in condition is taken until PLL loses lock for specific input frequency.

11. Define capture range.

Capture range is defined as the range of frequencies over which the PLL can acquire lock with an input signal. This parameter is expressed as a percentage of VCO frequency f_o. Capture range is always smaller than lock range.

12. Define Pull-in time. [Nov 2013]

Pull-in time is defined as the total time taken by the PLL to establish lock with the input signal.

This depends on the initial phase and frequency difference between the two signals as well as on the overall loop gain and loop filter characteristics.

13. What is the basic function of phase detector? [Nov 14]

The basic function of the phase detector is to compare the phase and frequency of the incoming signal with the output of VCO in PLL. If the two signals differ in frequency and/or phase, an error signal is generated.

14. What are the two types of phase detectors available?

Two types of phase detectors:

(i) Analog phase detector

(ii) Digital phase detector

15. List some examples of digital phase detectors.

Examples of digital phase detectors are

(i) Exclusive OR phase detector.

(ii) Edge-triggered phase detector.

(iii) Monolithic phase detector.

16. What is voltage controlled oscillator?

The voltage controlled oscillator is a free running multivibrator and operates at a set frequency f_o called the free running frequency. This frequency f_o is determined by the externally connected resistor and capacitor.

17. What is the function of VCO in PLL?

The error voltage in the phase detector is amplified and applied as a control voltage (V_c) to VCO. The signal V_c Shifts the VCO frequency in a direction to reduce the frequency difference between f_s and f_o. The VCO continues to change frequency, till its output frequency f_o is exactly the same as the input signal frequency f_s.

18. List the typical applications of Phase-Locked Loop.

Applications of Phase Locked Loop are

(i) Frequency multiplication/division

(ii) Frequency translation

(iii) AM detection.

(iv) FM demodulation and

(v) FSK demodulation.

19. How can FM signal demodulated using PLL?

If PLL is locked to a FM signal, the VCO tracks the instantaneous frequency of the input signal. The filtered error voltage which controls VCO and maintains lock with the input signal is the demodulated FM output. The VCO transfer characteristics determine the linearity of the demodulated output.

20. What is frequency shift keying technique?

Frequency Shift Keying (FSK) technique is a type of the data transmission in which, binary data is transmitted by means of a carrier frequency which is shifted between two preset frequencies (mark and space frequency).

21. What is frequency shift?

The difference between the two preset input frequencies of Frequency Shift Keying (FSK) demodulator is called frequency shift.

22. What is frequency shift keying demodulation?

The binary data which is shifted by a carrier frequency between two preset frequencies are retrieved by using Frequency Shift Keying (FSK) demodulator.

23. What will be the output frequency if a Phase Locked Loop (PLL) frequency translator has a center frequency of 'f' and input frequency of 'f1'?

The output frequency is $f+f_1$.

24. What are the main advantages of using low pass filter in PLL circuits?

Main advantages of using lowpass filter:

(i) The lowpass filter used in PLL not only removes the high frequency components and noise, but also controls the dynamic characteristics of PLL.

(ii) The charge on the filter capacitor gives a short time memory to the PLL. Thus, even if the signal becomes less than the noise for a few cycles, the dc voltage on the capacitor continues to shift the frequency of the VCO till it picks up the signal again.

25. Define voltage to frequency conversion factor in VCO.

Voltage to frequency conversion factor K_v is given by

$$K_v=\frac{\Delta f_o}{\Delta v_c}$$

Where Δv_c is the modulating voltage required to produce the frequency shift Δf_o for a VCO.

Note: VCO is also called as voltage to frequency converter since for every change in control voltage, corresponding change in output frequency is observed.

26. Why is the capture range of PLL dependent upon low pass filter (LPF) characteristics?

The capture range of PLL depends on low pass filter characteristics because the LPF will remove the high frequency components and noise. The difference frequency (low frequency signal) is the control voltage for VCO which further reduces the difference between f_s and f_o to reach the capture range.

27. What are the advantages of emitter coupled transistor pair?

(i) High current gain

(ii) More stability

(iii) Compact and easily in IC

28. What are the advantages of variable Transconductance technique?

(i) It is simple and easy to fabricate inside the chip

(ii) Produce accurate output

(iii) Low cost and economical

(iv) Provide 4 quadrant multiplication mode

(v) Speed of operation is high.

29. What is frequency synthesizing? [Nov 13, 14]

Frequency synthesizer is used to produce large number of precise frequencies which are derived from single reference source of frequency. The reference source is crystal oscillator.

30. A PLL frequency multiplier has input frequency of 'f' and a decade counter is included in the loop. What will be the frequency of PLL output? [May 13]

Given:

Input frequency is f;

N=10 (decade counter)

Counter in feedback loop:

We know that under locked condition $f= f_o/N$

Output frequency of PLL $f_o=Nf$

$f_o=10f$

Counter in forward path:

$f_o=f/N-f/10$

31. Define modulation index. [Nov 14]

Modulation index of AM is ratio of modulation voltage to carrier voltage.

$$m=\frac{E_m}{E_c}$$

Modulation index of FM is twice the value of sum of frequency deviation and peak modulating signal frequency.

$m=2(\Delta f+f_m)$

32. Mention the applications of PLL [Nov 13, May 13,15]

(i) Frequency synthesizer.

(ii) Frequency multiplication/division

(iii) Frequency translation

(iv) AM, FM, FSK detection

33. What is the basic operation of PLL? [May 14]

Phase detector compares input signal with the feedback signal and generation error as output signal. It is then filtered in LPF to remove high frequency noise from dc output. This acts as a control voltage for VCO and this process repeats until the VCO output frequency and input signal at phase detector found to be same.

34. Mention the significance of Gilbert Multiplier Cell. [Nov 2018]

(i) The output current is an accurate multiplication of the base currents of both inputs.

Part B:

1.How would you describe the block diagram of PLL and derive the expression for Lock range and capture range.
2.Illustrate the operation of VCO with neat block diagram. Also derive an expression for
3.(i)Analyze the Gilbert's four quadrant multiplier cell with a neat circuit diagram.
(ii)Identify how a frequency doubler can be realized using this cell.
4.Discuss any three applications of PLL in detail.
5.Explain the purpose and functioning of
(i)Frequency division circuit using PLL IC565
(ii)Frequency synthesizer
6.(i)Estimate the working principle of operational Tran conductance Amplifier (OTA).
(ii)Explain the application of VCO for FM generation.
7.(i)Define capture range and lock range.
(ii)Explain the process of capturing the lock and also derive for capture range and lock range.

8.(i)How would you explain the working of a VCO?
(ii)Derive the expression for voltage to frequency conversion factor.

PART-C

1. (i)Discuss the basic analog multiplication techniques.
(ii)Develop the expression for free running frequency of voltage controlled oscillator.
2. Explain the operation of a variable trans conductance multiplier circuit. Derive the expression for its output voltage.
3. Measure the closed loop analysis of PLL with necessary diagrams.
4.Construct the block diagram and explain principle of working, characteristics and applications of:
(i)Frequency synthesizer.
(ii)Frequency shift keying (FSK) Demodulator

8262 - CNCET

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS

1. What is the need of sample and hold circuit? [Nov 2018]

A sample and hold circuit samples an input signal and holds onto its last sampled value, until the input is sampled again. The circuit is used to take voltage of constantly varying analog signal and lock its value at a stable state for particular period of time.

2. Mention few applications of sample and hold circuit.

Applications of sample and hold circuits:

(i) Analog to digital systems

(ii) Pulse code modulation systems.

3. What is sample period?

The time period during which the voltage across the capacitor is equal to input voltage is called sample period.

4. What is hold period?

The time period during which the voltage across the capacitor is held constant is called hold period.

5. List various resistive DAC techniques available.

Various resistive DAC techniques available:

(i) Weighted resistor DAC

(ii) R-2Rladder

(iii) Inverted R-2R ladder

6. What is the resolution for a DAC?

The resolution of the analog to digital converter is the smallest change in voltage, which may be produced at the output (or input) of the converter.

7. List the different direct type ADCs.

Direct type ADCs:

(i) Flash (comparator) typeconverter

(ii) Counter type converter

(iii) Tracking or servo converter

(iv) Successive approximate type converter

8. List some integrating type converters.

Most widely used integrating type converters:

(i) Charge balancing ADC

(ii) Dualslope ADC

9. What is integrating type converter?

An ADC Performs conversion in an indirect manner by first changing the analog input signal to a linear function of time or frequency and then to a digital code is known as integrating type converter.

10. Where is the successive approximation type ADCs used?

The successive approximation ADCs are used in applications such as, data loggers and instrumentation where conversion speed is important.

11. Name the various types of electronic switches used in DAC.

Various types of electronic switches used in DAC

(i) Single pole double throw switch
(ii) Totempole MOSFET switch
(iii)CMOS inverter switch

12. Mention the main disadvantage of flashtype ADC?

The main disadvantage of flashtype A/D converter is that, the number of comparators required almost doubles for each added bit.

For example: A 2-bit ADC requires 3 comparators, 3-bit ADC requires 7 comparators.

13. How many total number of clock pulses required for 8-bit successive-approximation type A/D converter?

The total number of clock pulses required for 8-bit successive approximation A/D converter is 8.

14. Mention the main advantages of integrating type ADCs?

Main advantages of integrating type ADCs:

(i) The integrating type of ADCs do not require a S/H circuit at the input
(ii) It is possible to transmit frequency even in noisy environment

15. Define absolute accuracy.

Absolute accuracy is the maximum deviation between the actual converter output and ideal converter output.

16. Define relative accuracy.

Relative accuracy is the maximum deviation between the actual converter output and ideal converter output after gain and offset errors have been removed.

17. What is monotonic DAC?

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

18. What is settling time?

Settling time is the time taken for the output to settle within a specified band $\pm$(1/2)LSB of its final value following a code change at the input. It ranges from 100ns to10 s depending on word length and type of circuit used.

19. Write the main logic involved in Deltamodulation.

Delta modulation (DM) is the single bit version of PCM. In this modulation the difference between original sample and previous sample of error signal is encoded into a single bit. If the current sample is smaller than the previous sample, logic0 is transmitted. If the current sample is larger than

the previous sample, logic1 is transmitted.

20. Mention the main function of comparator in delta modulation transmitter.

The comparator compares the pulse analog signal and the previous signal and gives output as logic1 (+V) or logic 0 (-V).

21. Write the two problems associated with DM.

Problems associated with DM:

(i) Slope overload

(ii) Granular noise

22. Where are analog switches used?

Analog switches are used in chopper amplifiers, D/A converters, function generators, S/M amplifiers and switching power supplies.

23. What is slope overload?

When the analog input signal changes at a faster rate than DAC can maintain, the analog signal is greater than the delta modular can maintain, and this is called as the slope overload.

24. What is granular noise?

When the original analog input signal has relatively constant amplitude, the reconstructed signal has variations that were not present in the original signal. This is called as granular noise.

25. What is adaptive delta modulation?

Adaptive delta modulation is a delta modulation system where the step size of the DAC is automatically varied depending on the amplitude characteristics of analog input signal.

26. Differentiate between direct type and integrator type ADC's.[NOV 2018]

Direct type ADCs compares a given analog signal with the internally generated equivalent signal. Example,

(i) Flash type

(ii) Successive approximation type converter

Integrating type ADCs perform conversion in an indirect manner by first changing the analog input signal to a linear function of time or frequency. Then it is converted to digital code.

(i) Charge balancing ADC

(ii) Dual slope ADC

27. Define sampling. [June 2018]

Sampling is the reduction of continuous-time signal to a discrete time signal.

28. Write the names of switches used in MOS transistor. [June 2018]

(i) P- Channel MOSFET

(ii) N- Channel MOSFET.

Part B:

1.(i)How would you categorize A/D converters?
(ii)Discuss the working principle of successive approximation type ADC.
2.(i)Estimate the working of R-2R ladder type DAC.
ii.)Compare binary weighted DAC with R-2R ladder network DAC.
3.(i)With circuit schematic explain analog switches using FET.
ii.)What is meant by resolution, offset error in ADC.
4.(i)Explain in detail on the operational features of 4-bit weighted resistor type D/A converter.
ii.)Differentiate between current mode and voltage mode R-2R ladder D/A converters.

5. Show the operation of any two direct type of ADCs and Explain.
6. Summarize the following Digital to Analog & Analog to Digital conversion techniques.
(i)Flash type ADC
(ii)Weighted resistor DAC

7. (i)Draw the diagram of sample and hold circuit.
(ii)State how you will reduce its hold mode droop.

8. Design a 4–bit binary weighted resistor DAC for the following specifications: Use LM741 op-amp, R = 10kΩ, Vref =2.5V and full scale output = 5V.

PART-C

1.(i)For a 4-bit R-2R ladder D/A converter assume that the full scale voltage is 16V.Calculate the step change in output voltage on input varying from 01111 to 1111.
ii.)Discuss the important specification of Data Converters.

2.(i)Compare single slope ADC and dual slope ADC.
ii.)Draw the circuit and explain the working of dual slope A/D converter.
iii.)Calculate t2 for a particular dual slope ADC, t1 is 83.33ms and the reference voltage is 100mv if
1. V1 is 100 mv and 2. 200 mv

3.Design the R-2R 4-bit converter and assume that feedback resistance Rf of the op-amp is variable, the resistance R=10kΩ and VR =10V. Determine the value of Rf that should be connected to achieve the following output conditions.
(i)The value of 1 LSB at the output is 0.5V
(ii)An analog output of 6V for a binary input of 1000.
(iii)The Full-scale output voltage of 12V
(iv)The actual maximum output voltage of 10V

4.(i)Derive the Inverted or Current mode R-2R Ladder Digital to analog converter and explain.

9202 - CACET

ii.)Examine the inverted R-2R ladder (refer above question) has R=Rf=10kΩ and VR=10V. Calculate the total current delivered to the op-amp and the output voltage when the binary input is 1110.

UNIT V

WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS

1. What are the basic blocks of 555 Timer?

The basic blocks of 555 Timer are

(i) Potential divider circuit
(ii) Comparators
(iii) RS flip flop
(iv) Power amplifier (Inverter)

2. Write the main function of 555Timer.

The 555 Timer is a highly stable device for generating accurate time delay or oscillation.

3. Mention the applications of 555 Timer.

The applications of 555 Timer are:

(i) An Oscillator
(ii) Pulse generator
(iii) Ramp and square wave generator
(iv) Monoshot multivibrator
(v) Burglar alarm
(vi) Traffic light control
(vii) Voltage monitor

4. Mention the applications of the monostable mode of operation of 555IC.

The applications of the monostable mode of 555 IC are:

(i) Missing pulse detector
(ii) Linear ramp generator
(iii) Frequency divider and
(iv) Impulse width modulation

5. **Write the main function of voltage regulator.**

The main function of voltage regulator is to provide a stable DC voltage for processing other electronic circuits.

6. List the different types of voltage regulators.

The different types of voltage regulators are:

(i) Fixed output voltage regulator (positive or negative),
(ii) Adjustable output voltage regulators (positive or negative)
(iii) Switching regulator sand
(iv) Special regulators

7. 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.

8. What are the four main parts of voltage regulators?

The four main parts of the voltage regulators are:

(i) Reference voltage circuit

(ii) Error amplifier

(iii) Series poles transistor and

(iv) Feedback network

9. Define Load regulation of a regulator.

Load regulation of a regulator is defined as the change in output voltage for a change in load current. It is usually expressed in milli volts or as a percentage of Vo.

$$\text{Load regulation} = \frac{\Delta V_o}{\Delta I_L}$$

Where ΔV_o is output voltage and ΔI_L is load current

10. Define Line regulation of a regulator. [June 2018]

Line regulation of a regulator is defined as the percentage change in the output voltage for a change in the input voltage. It is also called input regulation. It is usually expressed in milli volts.

$$\text{Line regulation} = \frac{\Delta V_0}{\Delta V_i}$$

where ΔV_o is output voltage and ΔV_i is input voltage

11. Define duty cycle of a periodic pulse waveform.

Duty cycle is defined as the ratio of ON period of pulse to total time period (ON and OFF period) of pulse. Duty cycle is often represented in percentage.

$$\text{Duty cycle} = \frac{T_{ON}}{T_{ON}+T_{OFF}}$$

12. List the main advantages of voltage regulators.

The main advantages of voltage regulators are:

(i) Short circuit protection and

(ii) Variable output voltage (positive or negative can be varied).

13. List the limitations of IC-723regulators.

The limitations of IC-723regulatorsare:

(i) Poor efficiency compared to SMPS

(ii) Larger transformer size and weight

(iii) Floating load must be used to get output voltage greater than 37V

14. List the drawbacks of series regulators.

The drawbacks of series regulators are:

(i) The input step-down transformer used is bulky and most expensive component

(ii) Since it operates at low line frequency, large values of filter capacitors are required

(iii) Efficiency is less and

(iv) More power is dissipated in the series pass-transistor, which is always in the active region

15. What is power amplifier?

Power amplifier is a large signal amplifier that supplies large signal current to the current operated loads such as speakers and motors.

16. What is switched capacitor filter?

A switched capacitor filter is a filter with no external reactive components such as capacitors or inductors. It contains an on chip MOS transistor switch with an on chip capacitor to simulate the behavior of a resistor. The resistance of this resistor depends on capacitance 'C' and clock frequency.

17. What are the advantages of switched capacitor filter over active filters?

(i) Less external component count

(ii) High accuracy

(iii) Excellent temperature stability

(iv) Less weight because of avoiding bulky coils

18. Why are series regulators called as linear regulators?

Since the transistors conduct in the active or linear region, these regulators are called as linear regulators.

19. Define ripple rejection.

Ripple rejection is a measure of a regulator's ability to reject ripple voltage. It is expressed in dB.

20. Write the uses of voltage regulators.

Voltage regulators are commonly used for on-card regulation and laboratory type power switches.

Switch type regulators are used as control circuits in Pulse Width Modulation and series type switch mode supplies.

21. Where are switched capacitor filter used?

Switched capacitor filter are

(i) used in Analog and Digital signal processing

(ii) used in universal filter used to realize all types of filter

(iii) used as filter in IC's using MOS technology

(iv) used where there is a continuous requirement to change the parameter of filter

22. What is frequency to voltage converters?

A converter which generates an output voltage that is linearly proportional to the input frequency waveform is called frequency to voltage converter.

23. Define resonance.

At a particular frequency, when the inductive reactance X_L equals the capacitor reactance X_C, then the circuit behaves as a purely resistive

circuit. This Phenomenon is called as resonance.

24. Define opto-coupler.

A combination of LED at input side and photodiode at output side is called as an opto-coupler. It is used to couple input and output device that are electrically isolated and optically coupled.

25. Mention the main advantages of opto-coupler.

The advantage of an opto-coupler is the electrical isolation between the input output circuits.

With an opto-coupler, the only contact between the input and output is a beam of light. Because of this, it is possible to have an insulation resistance between the two circuits in thousands of mega ohms.

26. List the advantages of using optic fiber .

The advantages of using optic fiber are:

(i) Immunity to crosstalk

(ii) Immunity to static interferences

(iii) Environmental immunity

(iv) Safety, security and longer lasting.

27. What is an isolation amplifier?

It is an amplifier which offers electrical isolation between its input and output. The amplification factor of isolation amplifier is provided by the op-amps inside it. Isolation amplifier isolates input devices from output devices with the help of LED-PHOTODETECTOR pair.

28. Give two advantages of an isolation amplifier.

(i) It provides voltage difference of several thousands of volts between input and output.

(ii) Very high isolation resistance between input and output

29. Define SMPS

SMPS is Switched Mode Power Supply. This power supply uses switching regulator with pass transistor acting as a control switch. It is operated at cutoff or saturation state. This type of regulator switch reduces power dissipation and acts as low impedance switch as compared to linear voltage regulators.

30. In a linear voltage regulator, the input voltage is 20V and output voltage is 15V, for a load current of 1 ampere, calculate the power dissipated in the series pass element.

$$V_{in} = V_o + V_{sense}$$

$$20V = 15V + V_{sense}$$

$$V_{sense} = 5V$$

$$Power\ dissipated\ P_d = V_{sense} * I_L$$

$$P_d = 5V * 1A = 5W$$

31. State the two conditions for oscillation. [May 2015]

The conditions required for oscillation is termed as Barkhausen criterion which states

(i) The total phase shift around the loop is precisely 0° or 360° or integral multiples of 2π radians.

(ii) The magnitude of the product of open loop gain of amplifier (A) and the feedback factor β is unity.

i. i.e., $|A\beta|=1$

32. What is the purpose of connecting a capacitor at the input and output side of an IC voltage regulator? [Nov 2015]

(i) Capacitor connected at input side between input and ground is to cancel inductive effects due to long distribution leads.

(ii) Similarly capacitor at the output side and ground is to improve the transient response.

33. Mention 2 applications of frequency to voltage converter. [Nov 2015]

(i) Tachometer

(ii) Speedometers

(iii) RPM indicators

34. List the various applications of multivibrator. [Nov 2018]

(i) **Astable multivibrator** is used as square wave frequency generator

(ii) As a timing oscillator or clock for computer system

(iii) **Monostable multivibrator** used as delay and timing circuits

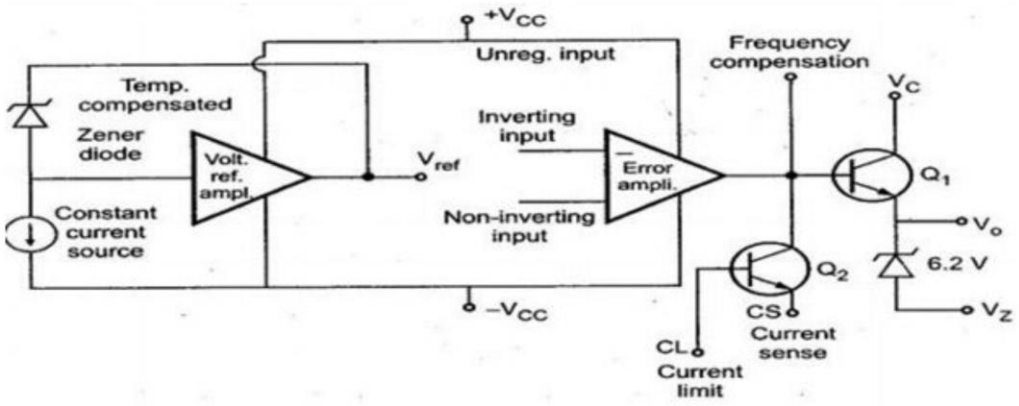
(iv) Used to trigger another pulse generator

35. Name some LC oscillator circuits. [June 2018]

(i) Hartley and

(ii) Colpitts oscillator

36. Draw the circuit diagram for a general purpose voltage regulator. [Nov 2018]



Part B:

1.Write a short notes on
(i)Opto couplers
(ii)Switched capacitor filter (iii)Audio power amplifier
2.(i)Demonstrate and explain the functional diagram of LM 380
(ii) Power amplifier.
Illustrate the essential characteristics of power amplifier.
3.(i)What is 555 timer? Explain the working of 555 timer as Monostable Multivibrator.
(ii)Derive an expression for the frequency of oscillation with relevant waveforms.
4.(i)Analyze and explain the operation of switching regulator with neat diagram.
(ii)Examine the operation of frequency to voltage converters.
5.(i)Show the working of Astable Multivibrator using op-amp.
(ii)Outline any one application of Astable Multivibrator in detail.
6.(i)Design a phase shift oscillator to oscillate at 100 Hz.
(ii)Design a frequency to voltage converter using IC VFC 32 for a full scale output of 8V for a full scale input frequency of 80kHz with a maximum ripple of 8mV.
7.(i)Define voltage regulator and explain the working of Linear Voltage regulator with neat circuit diagram using op-amps.
ii.)List any two important features of linear voltage regulator IC723.
8.(i)Assess the working principle of monolithic switching regulator.
ii.)Evaluate how the frequency is computed using voltage to frequency converter.

PART-C

1.(i)In a astable multivibrator using 555 timer Ra=6.8K,Rb = 3.3K, C=0.1uF.Calculate the free running frequency.
ii.)Design a square wave generator using 555timer for a frequency of 120Hz and 60% duty cycle. Assume C=0.2uF.
2.(i)Analyze the important features and pin details of switched capacitor filter IC MF10.
ii.)Design a wave generator using 555 timer for a frequency of 110Hz and 80 % duty cycle. Assume C =0.12µF
3.Derive the expression and circuit operation for LM 380 Audio power amplifier.
4. Design an adjustable voltage regulator circuit using LM 317 for the following specifications: Input dc voltage =13.5 V; Output dc voltage = 5 to 9V; Load current (maximum) = 1A.

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Faculty In charge **( )**	**Head of the Department** **( )**
HoD Remarks:	

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