II YEAR / IV SEMESTER

DEPARTMENT OF ELECTORNICS & COMMUNICATION ENGINEERING

SUBJECT CODE / NAME: EC8453 LINEAR INTEGRATED CIRCUITS

EC8453 LINEAR INTEGRATED CIRCUITS L T P C 3 0 0 3

UNIT I BASICS OF OPERATIONAL AMPLIFIERS 9

Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal Operational Amplifier - General operational amplifier stages -and internal circuit diagrams of IC 741,DC and AC performance characteristics, slew rate, Open and closed loop configurations-JFET operational amplifiers – LF155 and TL082

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

UNIT III ANALOG MULTIPLIER AND PLL 9

Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell – Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronization.

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 9

Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode *R -2R* Ladder types - switches for D/A converters, High speed sample-and-hold circuits, A/D Converters – specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type - A/D Converter using Voltage-to-Time Conversion - Over-sampling A/D Converters, Sigma-Delta converters.

UNIT V WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS 9

Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Monolithic switching regulator, Low drop – Out(LDO) regulators - Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. D.Roy Choudhry, Shail Jain, ―Linear Integrated Circuits‖, New Age International Pvt. Ltd., 2018, Fifth Edition. (Unit I – V)
2. Sergio Franco, ―Design with Operational Amplifiers and Analog Integrated Circuits‖, 4th Edition, Tata Mc Graw-Hill, 2016 (Unit I – V)

REFERENCES:

1. Ramakant A. Gayakwad, ―OP-AMP and Linear ICs‖, 4th Edition, Prentice Hall / Pearson Education, 2015.
2. Robert F.Coughlin, Frederick F.Driscoll, ―Operational Amplifiers and Linear Integrated Circuits‖, Sixth Edition, PHI, 2001.
3. B.S.Sonde, ―System design using Integrated Circuits‖ , 2nd Edition, New Age Pub, 2001.
4. Gray and Meyer, ―Analysis and Design of Analog Integrated Circuits‖, Wiley International,5th Edition, 2009.
5. William D.Stanley, ―Operational Amplifiers with Linear Integrated Circuits‖, Pearson Education,4th Edition,2001.
6. S.Salivahanan & V.S. Kanchana Bhaskaran, ―Linear Integrated Circuits‖, TMH,2nd Edition, 4 th Reprint, 2016.

UNIT I BASICS OF OPERATIONAL AMPLIFIERS

PART – A

1. **Mention the advantages of integrated circuits.** **(APR /MAY 2010)**
   - Miniaturization and hence increased equipment density.
   - Cost reduction due to batch processing.
   - Increased system reliability due to the elimination of soldered joints.
   - Improved functional performance.
   - Matched devices.
   - Increased operating speeds.
   - Reduction in power consumption.
2. **Mention the characteristics of an ideal op-amp.** **(MAY 2017)**
   - Open loop voltage gain is infinity.
   - Input impedance is infinity.
   - Output impedance is zero.
   - Bandwidth is infinity.
   - Zero offset.
3. **Define slew rate and CMMR.** **(Nov /Dec 2010) (Apr /May 2011) (APR /MAY 2013)**
   - Slew rate : It is defined as the maximum rate of rate of change of output voltage realize by a step input voltage .It is specified in V/µs,

     Slew rate= output voltage change / time
   - CMMR: The CMRR is defined as the ratio o the differential voltage gain A_{dm} to common mode voltage gain A_{cm} and is generally expressed in terms of decibels.

     CMRR=20 log$\frac{Adm}{Acm}$ db
4. **What is differential amplifier?**

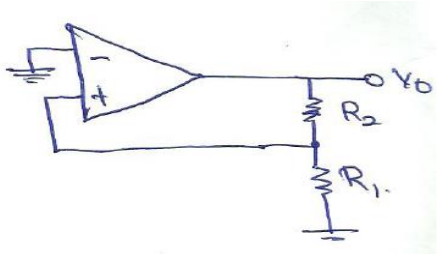
   A differential amplifier is an amplifier that amplifies the difference between two voltages and rejects the average or common mode value of two voltage. It provides the output voltage. Proportional to the difference between the input voltages.

   $V_0 = A_d(V_2 - V_1)$
5. **Why is an active load used in a differential amplifier?** **(Nov /Dec 2010)**

   Active loads are used in bipolar differential amplifier circuits to increase the differential mode gain by eliminating large loads resistance and parasitic capacitance.

6. **What is Schmitt trigger?**

   The Schmitt trigger or the bistable multivibrator uses positive feedback configuration with a loop gain greater than unity. The feedback elements are connected between the output terminal and the non-inverting terminal that results the effect is called hysteresis.



7. 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.

8. Design an amplifier with a gain of -5 and input resistance of 5kΩ.

A=-Rf/R1

Rf=-AR1 =-(-5)(5)=25 kΩ

9. Assume slew rate of 741 is 0.5V/μs. What is the maximum and undistorted sine wave that can be obtained for i) 12V peak ii) 5V peak?

Refer Linear Integrated Circuits by "D. Roy Choudhury" page No: 123-130

10. Assume I_{OS}=400Na,R_F=100kΩ and R_1=1kΩ. Determine the maximum output offset voltage.

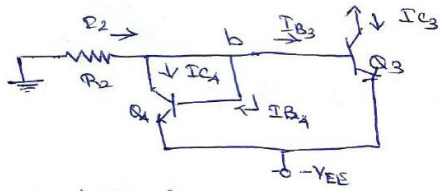
Refer Linear Integrated Circuits by "D. Roy Choudhury" page No: 145

11. Why IC 741 is not used for high frequency applications? (MAY 2015)

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.

12. What is current mirror? (APR /MAY 10,19)

The circuit in which the output current is forced to equal the input current is called ads current mirror circuit.



13. Define virtual ground of 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.

14. 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.

15. State the input terminals associated with an Op-amp. (April/May, 2017)

The ideal Op Amp has three important terminals in addition to other terminals. The input terminals are Inverting input and Non inverting input. The third terminal is the output which can sink and source current and voltage. The output signal is the amplifiers gain multiplied by the value of the input signal.

16. State the advantages of integrated circuits over discrete components. (April/May, 2017)

-IC's will give high reliability.

-They have lesser number of connections.

-These are available at low cost due to bulk production.

-IC's consume very tiny power or less power

17. Define offset voltage of a differential amplifier. (APRIL/MAY, 2017)

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

18. What are the two methods can be used to produce voltage sources? (APRIL/MAY, 2018)

There are 2 methods that can be used to produce voltage sources namely,
-using the impendence transforming properties of the transistor, which in turn determines the current gain of the transistor and
-using an amplifier with negative feedback.

19. Define differential mode gain. (NOV/DEC, 2018)

The A_d is the gain with which the amplifier amplifies the difference between two input signals. Hence it is called as the differential gain of differential amplifier. The differential mode gain is expressed as, $\mathbf{A_d = V_o / V_d}$

V_o – output voltage, V_d – difference voltage.

20. Define slew rate. (NOV/DEC, 2019)

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

PART – B

1. Design a Widlar and wilson current source and obtain the expression for output current. Also prove that widlar current source has better sensitivity than constant current source For Widlar current source, VT ln(Ic1/ Ic2) = Ic2 R2
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 38-39, 41-42 (**NOV 2016)**
2. Define slew rate . Explain the cause of slew rate and drive an expression for slew rate for an op-amp voltage follower?
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 49,123 (**NOV 2016)**
3. Explain in detail about DC performance characteristics of Op-amp.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No:104 (**MAY 2017)**
4. Explain inverting and non-inverting amplifier of ideal op-amp.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No:43,47
5. Draw the transfer characteristics of operational amplifier and explain its linear and non-linear operation.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No:43,47 **(Nov/Dec, 2018)**
6. Explain in detail about AC performance characteristics of Op-amp.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No:111 (**MAY 2017)**
7. Discuss the operation of the BJT amplifier with active loads.
   Refer Linear Integrated Circuits, 4nd edition by "D. Roy Choudhury" page No: **(Nov/Dec, 2018)**
8. Discuss about the principle of differential amplifier using BJT.
   Refer Linear Integrated Circuits, 4nd edition by "D. Roy Choudhury" page No: **(April/May, 2018)**

9. Analyze the operation of BJT current mirror and thus explain the volt-amp characteristics.

   Refer Linear Integrated Circuits, 4nd edition by "D. Roy Choudhury" page No: **(Nov/Dec 2019)**

10. Analyze the small signal model of the BJT amplifier using the h parameter and deduce the expression for differential and common mode gain for differential output.
    Refer Linear Integrated Circuits, 2nd edition by "D. Roy Choudhury" page No:118 **(Nov/Dec 2019)**
11. Draw the inverting and non-inverting amplifier circuits of an op-amp in closed loop configuration. Obtain the expressions for the closed loop gain in these circuits.
    Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No:130 **(Nov/Dec 2017)**
12. Perform the AC analysis of the operational amplifier 741.
    Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No:93 **(Nov/Dec 2017)**
13. (i) Compare different configurations of differential amplifier
    Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No:93 **(APRIL/MAY, 2017)**
    (ii) For a dual input, balanced output differential amplifier, R_c =2.2k**Ω**, R_E= 4.7 k**Ω**, R_{S1}=R_{S2}=50**Ω**. The supply voltage is ±10V. The hfe for the transistor is 50. Assume silicon transistors and hie = 1.4k**Ω**. Determine the operating point values, differential gain, common mode gain and CMRR.

    (APRIL/MAY, 2017)

14. State the advantages of integrated circuits over the discrete components. **(APRIL/MAY, 2017)**
15. Explain the fabrication process of monolithic integrated circuits with necessary diagrams.
    Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 12, 24

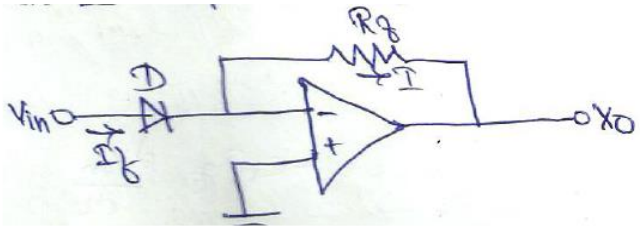
    (APRIL/MAY, 2017)

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS

PART – A

1. What is an antilog amplifier? Draw the circuit diagram of an antilog amplifier?

Log amplifier can be turned around to provide the antilog or exponential function which is called the antilog amplifier which can be obtained by using a diode/transistor.



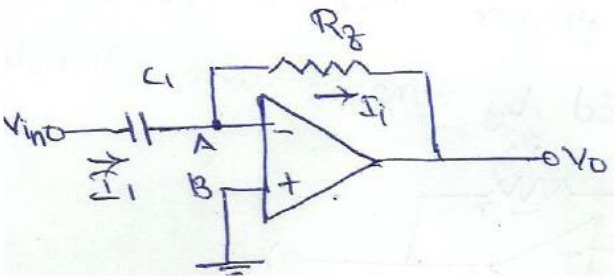
2. What is a function of current to voltage converter? Give an example? (APR /MAY 2010)

Current to voltage converter is a circuits which converts an input current source proportional to output voltage. Ex: photo detector, photo transistor. It is also known as current controlled voltage source (CCVS).

3. List the features of instrumentation amplifier.

- Very low output impedance
- Large voltage gain
- High CMRR
- Low input offset
- Flexibility
- Low temperature drift

4. Draw the circuit diagram of differentiator and give its output equation. (APR /MAY 2010)

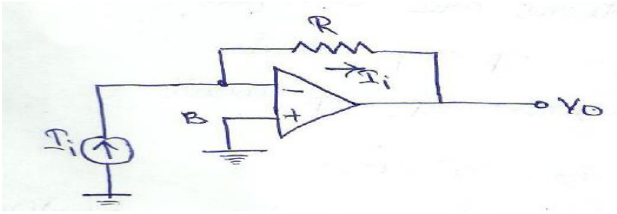


Output equation : $V_0 = -C_1 R_f \frac{dV_{in}}{dt}$

5. What is a precision rectifier? (APR /MAY 2011)

The signal processing application with very low voltage , current and power require rectifier circuits. The ordinary diode cannot rectify voltage below the cut in voltage of the diode . A circuit which can act as ideal diode or precision signal processing rectifier circuit for rectifying voltage which are below the level of cut in voltage of the diode can be designed by placing the diode in the feedback loop of an opamp.

6. Give the schematic of op-amp based voltage to current converter.

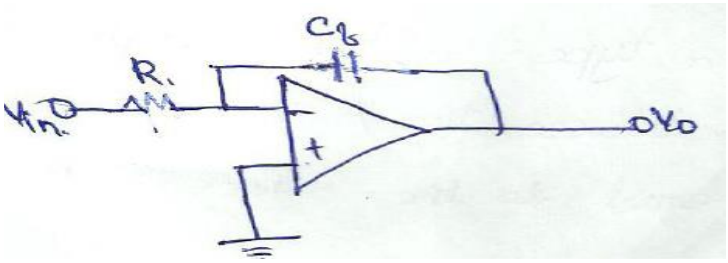


7. **What is adder/summing amplifier?**

   Summing amplifier is a type of linear amplifier which is used to combine two or more analog inputs signal. It provides the output equal to the linear summation of input signals. It classified into two types:

   - Inverting summer
   - Non inverting summer

8. **Draw the circuit diagram of integrator and give its output equation.**



9. **State two advantages of active filters over passive filters.**

   A passive filter is a kind of electronic filter that is made only from passive elements – in contrast to an active filter, it does not require an external power source (beyond the signal). An active filter is a type of analog electronic filter, distinguished by the use of one or more active components and require an external power source

10. **Give the comparison of Clipper and clamper**. **(MAY 2015)**

Parameters	**Clipper**	**Clamper**
Definition	Clipper delimits the amplitude of the output voltage.	Clamper shifts the DC level of the output voltage.
Output Voltage	Less than the input voltage.	Multiples of input voltage.
Energy storage component	Not required	Requires (Capacitor is used as energy storage element)
Shape of Output Waveform	Shape changes (Rectangular, sinusoidal, triangular etc.)	Shape remains same as input waveform.
DC Level	Remains same	DC level get shifted
Applications	In transmitters, receivers, amplitude selector, noise limiter etc.	In voltage multiplying circuits, Sonar, Radar system etc.

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11. **State the errors in an ideal differentiator.**

    - At high frequencies, a differentiator may becomes unstable and enters into oscillation.
    - The input impedance decreases with increase in frequency, thereby making the circuit sensitive to high frequency noise.

12. When inverting amplifier is called phase inverter?

The gain is a factor which is multiplied to input signal to get the output signal. Thus we can say that the scale of the input signal can be changed by changing the scale of the amplifier i.e. the gain. Hence the circuit is also called as scale changer. If the gain is 1 it is called as phase inverter.

13. Define Sign changer and scale changer. (NOV 2015)

The basic inverting amplifier configuration using an op-amp with input impedance Z 1 and feedback impedance Z f .

If the impedance Z 1and Z f are equal in magnitude and phase, then the closed loop voltage gain is -1,and the input signal will undergo a 1800 phase shift at the output. Hence, such circuit is also called phase inverter. If two such amplifiers are connected in cascade, then the output from the second stage is the same as the input signal without any change of sign.

Hence, the outputs from the two stages are equal in magnitude but opposite in phase and such a system is an excellent paraphase amplifier.

Scale Changer:

Referring the above diagram, if the ratio Zf / Z1 = k, a real constant, then the closed loop gain is –k, and the input voltage is multiplied by a factor –k and the scaled output is available at the output. Usually, in such applications, Zf and Z1 are selected as precision resistors for obtaining precise and scaled value of input voltage.

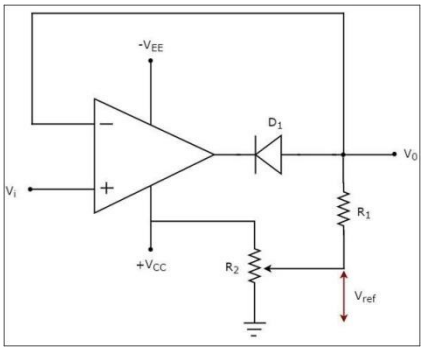
14. How to detect the peak signal and draw the circuit for that.

Peak detector is a circuit which converts the applied sinusoidal input into square wave output. The output of Schmitt trigger swings between upper and lower threshold voltages, which are the reference voltage of the input waveform.

15. How does operational amplifier work as an integrator? (NOV/DEC, 2018)

As the name implies, the **Op-amp Integrator** is an operational amplifier circuit that performs the mathematical operation of **Integration** that is we can cause the output to respond to changes in the input voltage over time as the op-amp integrator produces an *output voltage which is proportional to the integral of the input voltage*. In other words the magnitude of the output signal is determined by the length of time a voltage is present at its input as the current through the feedback loop charges or discharges the capacitor as the required negative feedback occurs through the capacitor.

16. Draw the circuit of clipper using an Op-Amp. (NOV/DEC, 2018)



17. What is the function of phase shift circuit? (APRIL/MAY, 2018)

The phase shift circuits produce phase shifts that depends uoin the frequency and maintain a constant gain. These circuits are also called as *constant-delay filters or all-pass filters*. The constant delay refers to the fact that the time difference between input and output remains constant when

frequency is changed over a range of operating frequencies. This is called as all-pass because normally a constant gain is maintained for all the frequencies within the operating range.

18. Write the other name for clipper circuit. (APRIL/MAY, 2018)

The clipper is also called as an amplitude limiter, consist of an inverting amplifier circuit with a back-to-back zener diode and a single diode connected in the feedback loop.

19. What are the disadvantages of basic operational amplifier differentiator? (NOV/DEC, 2019)

The **Op-amp Differentiator** circuit in its basic form has two main disadvantages:
- it suffers from instability at high frequencies as mentioned above,
-the capacitive input makes it very susceptible to random noise signals and any noise or harmonics present in the source circuit will be amplified more than the input signal itself. This is because the output is proportional to the slope of the input voltage so some means of limiting the bandwidth in order to achieve closed-loop stability is required.

20. Audio filters are usually Butterworth filters. Justify. (NOV/DEC, 2019)

The Butterworth filter is a type of signal processing filter designed to have as flat frequency response as possible (no ripples) in the pass-band and zero roll off response in the stop-band. Butterworth filters are one of the most commonly used digital filters in motion analysis and in audio circuits. Thus audio filters are usually Butterworth filters.

PART – B

1. Draw the circuit diagram of a second order Butterworth active low pass filter and derive an expression for its transfer functions and explain a second order low pass filter.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 265 **(DEC 2016)**
2. Explain the working of full precision rectifier.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 232 (**MAY 2016)**
3. Design a differentiator to differentiate an input signal that varies in frequence from 10Hz to about 1Khz.
   Refer Linear Integrated Circuits, 2nd edition by "D. Roy Choudhury" page No: 324 (**MAY 2015)**
4. Discuss the need for an instrumentation amplifier? Give a detailed analysis for the same.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 141 **(MAY 2017)**
5. (i)Explain the function of instrumentation amplifier and derive the expression for gain.
   (ii)Explain the function of full wave rectifier using Op-Amp and diodes. **(Nov/Dec, 2019**)
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No:141,
6. (i) Draw the circuit of temperature independent logarithmic amplifier and explain its operation. Also deduce the expression for output voltage.
   (ii)Explain the function of positive clipper circuit with its input and output waveforms.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 208, 242 **(Nov/Dec, 2019**)
7. With a neat diagram, explain voltage-current converter. (**APRIL/MAY, 2018)**
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 146

8. (i) Describe about the voltage follower circuit.
   (ii) Write short notes on subtractor circuit.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No:175, 186 **(APRIL/MAY, 2018)**
9. With a suitable diagram, explain the working principle of an instrumentation amplifier and derive its gain.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 141 **(NOV/DEC, 2018)**
10. Design a second order Butterworth low-pass filter having upper cut-off frequency of 2.1961 KHz.
11. Explain the working principle of instrumentation amplifier and Schmitt trigger.
    Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 189, 230 **(April/May, 17)**
12. Explain the working principle of precision full wave rectifier and integrator.
    Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 232, 195 **(April/May, 17)**
13. Design a clipper circuit for a clipping level of +0.61V, given an input sine wave signal of 0.5V peak. Assume the gain of the amplifier is 12 and it has an input resistance of 1kΩ connected. **(May, 17)**
14. Design a second order Butterworth low-pass filer having upper cut-off frequency of 2.5 kHz. **(April/May, 17)**
15. Draw the operational diagram and explain the working principle of antilogarithmic amplifier and Schmitt trigger.
    Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 210 **(Nov/Dec, 18)**
16. Design a clipper circuit for a clipping level of +0.83V, given an input sine wave signal of 0.3V peak. Assume the gain of the amplifier is 9 and it has an input resistance of 2.2 kΩ connected. **(Nov/Dec, 18)**

UNIT III ANALOG MULTIPLIER AND PLL

PART – A

1. **Define capture range of PLL.**
   The range of frequencies over which the PLL can acquire lock with the input signal is called as capture range.
2. **Write the significance of Lock range of a PLL.** **(MAY 2014)**
   When PLL is in lock, it can trap freq changes in the incoming signal. The range of frequencies over which the PLL can maintain lock with the incoming signal is called as lock range.
3. **What is an operational transconductance amplifier?** **(MAY 2013)**
   It is basically a voltage to current converter . The constant of proportional between input and output is nothing but the transconmductance of the amplifier.
   Relation between input and output is given by

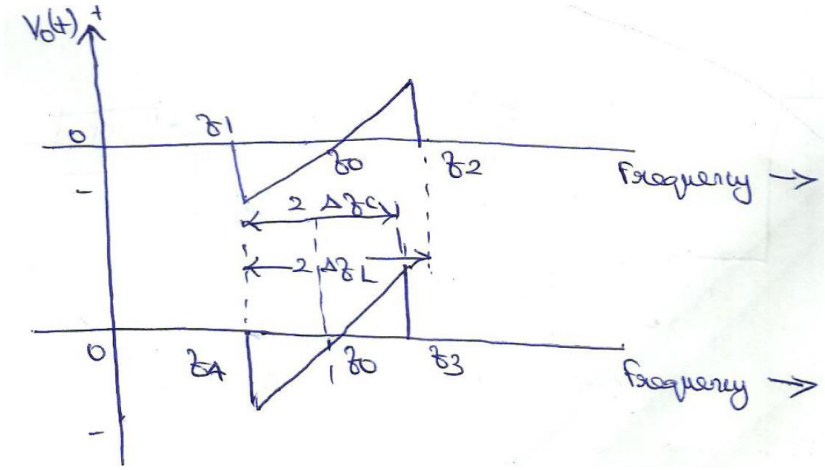
$$I_0 = g_m V_{in}$$

where,

g_m=transconductance or gain of OT

V_{in}=differential input +V_{CC}

4. **Draw the relation between the capture range and lock range in a PLL.** **(NOV 2013)**



The frequency range f_3 and f_1 is called capture range and frequency range f_2 and f_4 is called lock range.

5. **How do you convert a basic multiplier to a squaring and square root circuit?** **(MAY 2017)**
   Refer Linear Integrated Circuits, by "A.P.Godse" page No: 4-59
6. **Mention the application of analog multiplier.**
   Analog multiplier is an active network which is produces an output proportional to the multiplication of two input $V_1$and V_2.based on the input it is divided into two types voltage multiplier and current multiplier.
7. **What is a four quadrant multiplier?**
   The four quadrant operation indicates that the output voltage is directly proportional to the product of the two input voltages regardless of the polarity of the inputs and such multipliers can be operated in all the four quadrants of operation.

8. How VCO differ from Oscillators?

- Frequency modulation
- Tone generator
- FSK
- FM modulation
- Frequency generator and frequency multiplier.

9. What is a frequency synthesizer?

A frequency synthesizer is an electronic circuit that generates a range of frequencies from a single reference frequency. A frequency synthesizer may use the techniques of frequency multiplication, frequency division, direct digital synthesis, frequency mixing, and phase-locked loops to generate its frequencies. The stability and accuracy of the frequency synthesizer's output are related to the stability and accuracy of its reference frequency input. Consequently, synthesizers use stable and accurate reference frequencies, such as those provided by crystal oscillators.

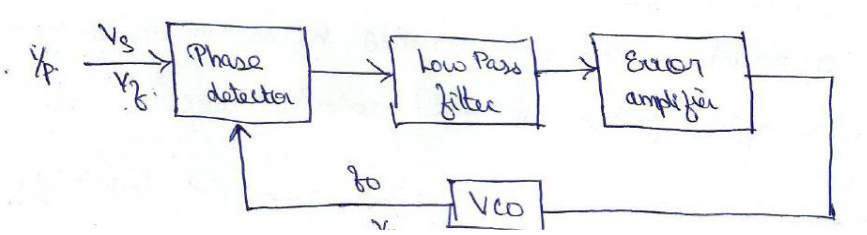
10. **List the applications of analog multiplier**. **(NOV 2014)**

- Multiplication
- Division
- Squaring
- Gain control stage
- Square root extraction
- Bandwidth control stage

11. **Give the relation between the capture range and lock range in a PLL?**

The frequency range f_3 and f_1 is called capture range and frequency range f_2 and f_4 is called lock range.

12. Draw the basic functional diagram of a PLL? (MAY 2015)



13. Define pull out and Pull in range.

The maximum frequency range which breakdown the progressive phase lock is called pull out range.

The total time taken by the PLL to establish a lock is called pull in time.

14. List the applications of multiplier ICs. (NOV/DEC, 2019)

The multiplier ICs are used for the following purposes:

(i) Voltage squarer
(ii) Frequency doublers
(iii) Voltage divider
(iv) Square rooter
(v) Phase angle detector
(vi) Rectifier

15. Differentiate Lock-in-range and capture range of PLL. (NOV/DEC, 2019)

The range of frequencies over which PLL will track the input frequency signal and remains locked is referred as ***PLL Lock range***. The lock range is usually band of frequencies above and below the PLL free running frequency as described earlier. If the frequency of the input signal is outside the PLL lock range than PLL will not be able to lock. Under this condition, VCO frequency jumps to its fundamental free running frequency. As described earlier when the frequency within PLL lock range is applied to the circuit. The circuit will adjust and will remain in locked condition. Any deviation thereafter will be adjusted due to Phase detector, LPF and VCO functionalities. Once input signal is captured, PLL will remain in locked state and will track the changes in the input signal till it remains within lock range. The range of input frequencies over which PLL will capture the input signal is referred as ***PLL capture range,*** it is much narrower compare to the PLL lock range.

16. Mention the significance of Gilbert multiplier cell. (NOV/DEC, 2018)

Gilbert cell, in electronics, is a type of mixer. It produces output signals that are proportional to the product of two input signals. The advantage of this circuit is the output current is an accurate multiplication of the (differential) base currents of both inputs.

17. State the applications of phase locked loop. (NOV/DEC, 2018)

The IC 565 PLL is used for the applications such as

(i) Frequency multiplication/division
(ii) AM detection
(iii) FM detection
(iv) FSK modulation/demodulation
(v) Frequency synthesizing

18. What is Gilbert multiplier cell. (APRIL/MAY, 18)

Gilbert multiplier cell is a modification of the emitter coupled cell and this allows four-quadrant multiplication. Therefore, it forms the basis of the most of the integrated circuit balanced multipliers. Two-cross coupled emitter-coupled pairs in the series connection with an emitter coupled pair form the structure of the Gilbert multiplier cell.

19. State any 2 terminologies associated with multiplier characteristics. (APRIL/MAY, 18)

The commonly used terminologies associated with the multiplier characteristics are

1. Accuracy 2. Linearity 3. Squaring mode accuracy 4. Bandwidth

20. What is reference generator (RG)?

Reference generator is a linear device that generator the analog input signal for the phase locked loop. Normally since wave generator are used as an input section to generate the analog input signal.

PART B

1. Explain the process of capturing the lock and also derive for capture range and lock range.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 337 (**NOV 2016, 19)**
2. Explain the working principle of four quadrant variable form transconductance multiplier
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 404 (**MAY 2016, 17)**
3. Explain in detail about any one application of PLL.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 437 (**MAY 2016)**
4. Analyze the Gilbert's four quadrant multiplier cell with a neat circuit diagram.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 404 (**MAY 2017, 19)**
5. Discuss the Working principles of Frequency synthesizer.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 442 (**MAY 2017)**
6. Explain how operations of division and taking square root can be carried out using a multiplier IC.
7. With a neat functional diagram, explain the operation of VCO and also derive an expression.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 334
8. Discuss briefly about analog multiplier ICs.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 406 **(APRIL, 2018)**
9. Explain the operation of the basic PLL with a neat schematic diagram.
   Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 327 **(APRIL, 2018)**
10. Explain in detail on the operation of a basic phase locked loop.
    Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 327 **(APRIL, 2018)**
11. How are PLLs applied for frequence synthesizing and FM detection?
    Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 327 **(APRIL, 2018)**
12. Obtain the expression for free running frequency of voltage controlled oscillator.
    Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 334 **(April, 2018, 19)**
13. Show that PLL IC can be used as AM demodulator.
    Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 337 (**NOV, 2019)**

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS

PART – A

1. **What is a sample and hold circuit? Where it is used? (NOV 2015)**

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

2. **Which type ADC is the fastest? Why?**

   Flash ADC is the fastest ADC .flash A/D converter, also known as simultaneous or parallel comparator ADC, because the fast conversion speed is accomplished by providing $2^n - 1$ comparator and simultaneously comparing the input signal with unique reference level spaced, LSB part.

3. **Define resolution of DAC. (NOV 2014)**

   Resolution is the number of different analog output values that can be provided by a DAC. For n-bit DAC resolution =2n.Resolution is also defined as the ratio of a change in output V and resulting from a change of 1 LSB at the digital inputs.

   $$\text{Resolution} = \frac{V\ \ OFS}{2n-1}$$

4. **Define conversion time of DAC.**

   It is a time required for conversion of analog digital into its digital equivalent. It is also called setting time

5. **List the application of analog to digital converter.**

- Computer and scanner
- Digital signal processing
- Modem
- Music recording

6. **Compare binary ladder and R-2R Ladder type DAC.**

BINARY LADDER	R-2R LADDER
Wide range of resistor value is required	Easily to build accurately with two metal film resistors
It is unpractical to fabricate large value of resistors	Easy to fabricate
Finite resistance of the switch disturb the binary weighted relationship among various currents	Voltage remain constant with changing input binary words

7. **A 12 bit D/A converter has a resolution of 20mV/LSB. Find the full scale output voltage. MAY 2016**

   Refer Linear Integrated Circuits, 2nd edition by "D. Roy Choudhury" page No: 159

8. **List out the direct type ADCs.**
   - Flash type converter
   - Counter type converter
   - Tracking or servo converter
   - Successive approximation type converter
9. **What would be produced by a DAC, when output range is 0 to 10v and whose input binary number is 10111100(for 8 bit DAC)? (MAY 2016)**

   Resolution= $\frac{V\ \ OFS}{2n-1}$= $\frac{10}{256-1}$=0.0392V.

10. **Mention the advantages of R-2Rladder type DAC when compared to weighted resistor type DAC. (NOV 2016)**

    Number of bits can be expanded by adding more sections of same R-2R values.
    In R-2R node voltages remain constant with changing input binary words.

11. **Determine the number of comparators and resistors required for 8bit flash type ADC?**

    Refer Linear Integrated Circuits, 2nd edition by "D. Roy Choudhury" page No: 357

12. **A 12 bit D/A converter has a resolution of 20mV/LSB. Find the full scale output voltage.**

    Refer Linear Integrated Circuits, 2nd edition by "D. Roy Choudhury" page No: 368

13. **Draw the binary ladder network of DAC. If the value of the smaller resistance is 10K,what is the value of the other resistance. (NOV 2016)**

    Refer Linear Integrated Circuits, 2nd edition by "D. Roy Choudhury" page No: 367

14. **What are the demerits of weighed resistor digital to analog converter? (NOV, 2019)**

    -The disadvantage of the weighted resistor DAC is the numerous resistor values. For instance, if we take an 8-bit converter, the 8 resistors will range from R to 128R in binary weighted steps.
    -The accuracy and stability of this type DAC depends on the accuracy of the resistors used.

15. **Differentiate direct type and integrated type in ADC converters. (NOV, 2018)**

Direct type ADC	Integrated type ADC
1. It compares a given analog signal with an internally generated equivalent analog signal.	1. It performs the A/D conversion in an indirect manner. It is a special class of converter which used either a reference voltage, or integrates the signal during the conversion process.
2. Flash type, counter type are examples for direct type DAC	2. For example, many of the digital voltmeters employ integrating ADC in the circuit.

16. **What is the need for sample and hold circuit? (NOV, 2018)**

    Sample & Hold Circuit is used to sample the given input signal and to hold the sampled value. Sample and hold circuit is used to sample an analog signal for a short interval of time in the range of 1 to 10µS and to hold on its last sampled value until the input signal is sampled again.

17. Define OverSampling.

The technique of increasing the apparent sampling frequency of a digital signal by repeating each digit a number of times, in order to facilitate the sub-sequent filtering of unwanted noise.

18. Write the names of switches used in MOS transistors. (APRIL, 2018)

Totem pole MOSFET switch

Switches using CMOS inverter.

19. How is the classification of A/D converters carried out based on their operational features? (NOV/DEC, 2017)

1. **Type 1:** ADC can be classified into 2 groups: (a) programmed (b) non-programmed ADC
2. **Type 2:** (a) closed-loop or feedback type ADC (b) open-loop type ADC
3. **Type 3:** (a) capacitor-charging type ADC (b) discrete voltage comparison type ADC
4. **Type 4:** (a) direct type ADC (b) integrating type ADC

20. Define monotonicity of a DAC.

A monotonicity D/A converter is one which the output always increases as the input increased. If the maximum DNL error is less than 1 LSB, the D/A converter is guaranteed to be monotonic.

PART B

1. Describe the operational features of R-2R ladder type D/A converter.

Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 352 (**NOV, 2018, 17) (May, 17)**

2. Discuss the various switches employed for D/A converter.

Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 461 (**NOV, 2018)**

3. (i)With a neat block diagram, explain the operation of flash and successive approximation type A/D converter.

Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 358, 361 **(NOV, 18)**

(ii)What is oversampling? Give examples for oversampling converter.

Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 495 **(NOV, 2018)**

4. Enumerate the specifications of D/A converter.

Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 366 (**APRIL, 2018)**

5. Describe in detail about the single slope type ADC with neat sketch.

Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 488 **(APRIL, 2018)**

6. Explain in detail on the operational features of 4-bit weighed resistor type D/A converter.

Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 349 (**NOV, 2017)**

7. With neat internal diagram explain the Successive approximation ADC.

Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 361 (**May, 2017)**

8. With the neat block diagram explain the working dual slope ADC.

Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 363 **(May, 2017)**

9. Design a suitable D/A converter to convert 8-bit binary i/p in parallel form. Binary '0' corresponds to 0V and binary '1' to 5V. Maximum output is +5V. Assume any other data that may be required. Explain its operation. **(April, 2017)**

10. Write a note on high speed sample and hold circuits.

Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 472 **(April, 2017)**

11. With circuit diagram, explain the operation of a flash type ADC.

Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 358 **(April, 2017)**

12. Draw the block diagram and explain single slope type ADC.

Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 488 **(April, 2019)**

13. Compare the properties of successive approximation type and dual slope type converters.

Refer Linear Integrated Circuits, 4th edition by "D. Roy Choudhury" page No: 361 (**April, 2017)**

UNIT V WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS

PART – A

1. **List the characteristics of Opto coupler.**
   - Current transfer ratio
   - Isolation voltage
   - Response time
   - Common mode rejection
   - V_{ce} (max)
   - I_L (max)
2. **What is a function of frequency to voltage converter?**

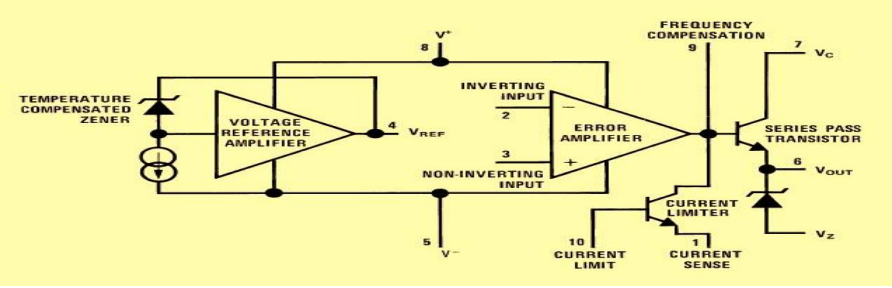
   Frequency to voltage converter is performs in an inverse operation of voltage to frequency converter that it provides an analog output voltage from the function of the frequency of the input signal. An ideal F/V converter is produces an analog output voltage proportional to the input frequency.

   $V_o=K_f f_{in}$

   K=Frequency sensitivity constant (Volts/Hz)
3. **Define the ripple rejection of voltage regulator** **(NOV 2015)**

   Ripple rejection is the ratio of the AC ripple voltage on the output to the AC ripple in the input voltage i.e., ability of ripple rejection

   Ripple rejection=$20\frac{log10vo}{DV\ \ in}$
4. **Draw the functional block diagram of 723 regulator.**



5. **State the two condition for oscillations.**

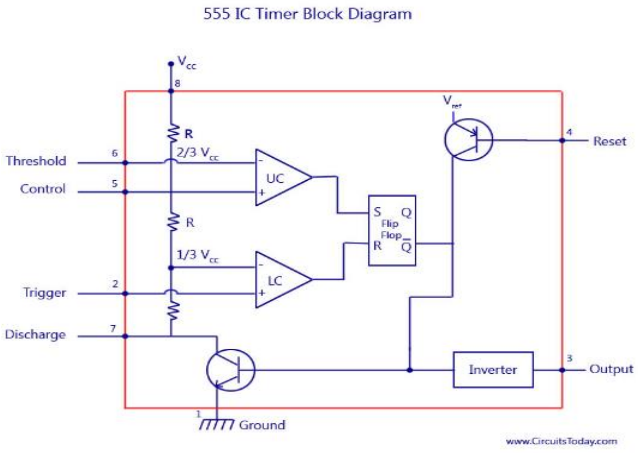
   1. The magnitude of the loop gain must be one

   2. Total phase shift of the loop gain must be equal to 0^0 or 360^0
6. **What are the advantages of a switched capacitor filter?**
   - Very high value of resistors can be easily simulated using small values capacitors of the order of 10Pf
   - Complete active filters can be easily obtained on a monolithic IC chip
   - Accuracy is very high
   - The overall cost of the system is low

7. **List four features of audio power amplifier ICLM380.**

- Wide supply voltage range
- High peak current capability
- High input impedance :150KΩ
- Fixed voltage gain at 50

8. **Draw the block schematic of IC 555 timer.** **(NOV 2016)**



9. **What is the function of voltage regulator? Name few IC voltage regulators? (NOV 2016)**

A voltage regulator generates a fixed output voltage of a preset magnitude that remains constant regardless of changes to its input voltage or load conditions

10. **Mention the two application of frequency to voltage converter**. (**NOV 2015)**

- Frequency to voltage converter in tachometers.
- Frequency difference measurement.

11. **A Hartley oscillator has L1=10mH, L2=5mH and C=200pF.Calculate the frequency of oscillation.** **(MAY 2016)**

F=10 kHz

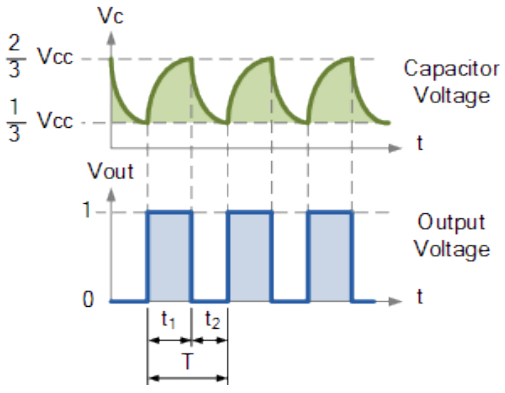
12. **What is an isolation amplifier? Mention its applications.**

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

13. **State the two conditions for oscillation.**

1. The magnitude of the loop gain must be one
2. Total phase shift of the loop gain must be equal to 0^0 or 360^0

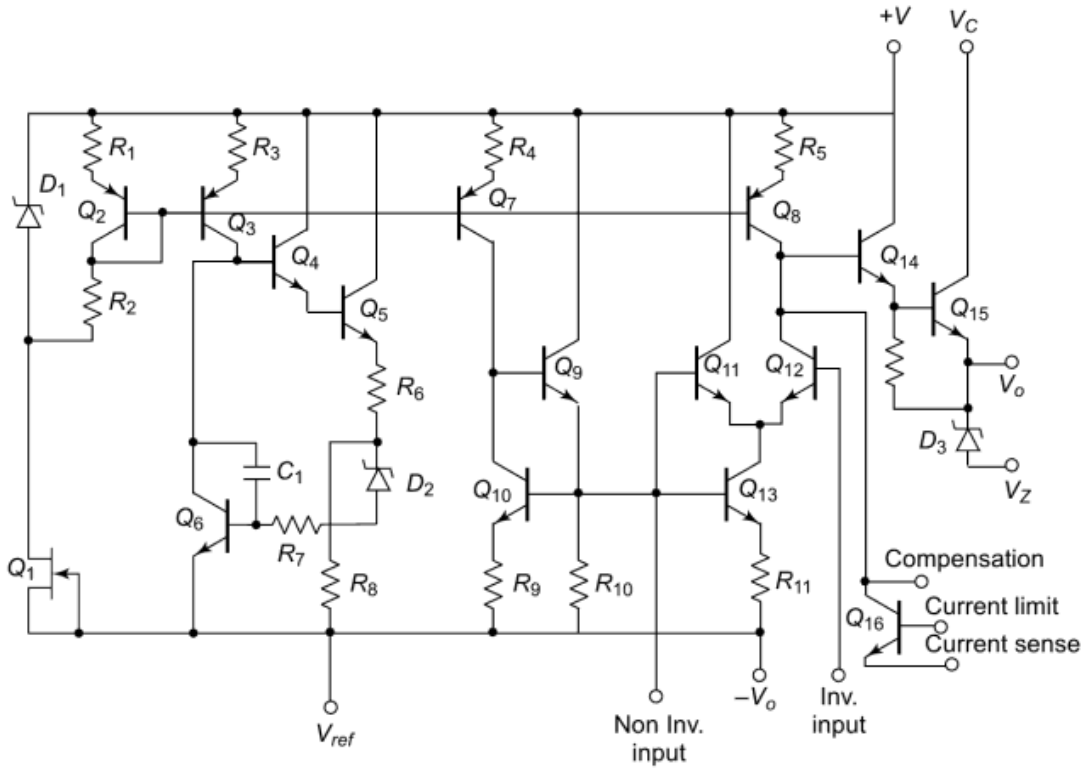
14. **Define the duty cycle in astable multivibrator using IC 555.**



15. **List the various applications of multivibrators.** **(NOV, 2018)**

-The monostable multivibrator is used as delay and timing circuits.
-It is also used for temporary memories.
-It is often used to trigger another pulse generator. It is used for regenerating old and worn out pulses.

16. **Draw the circuit diagram of a general purpose voltage regulator.** **(NOV, 2018)**



17. **Name some LC oscillator circuits.** **(MAY, 2018)**

(i) Tuned collector oscillator

(ii) Tuned base oscillator

(iii) Hartley oscillator

(iv) Colpitts oscillator

(v) Clapp osciallator

18. **Define Line regulation.** **(MAY, 2018)**

Line regulation is the ability of the power supply to maintain its specified output voltage over changes in the input line voltage. It is expressed as percent of change in the output voltage relative to the change in the input line voltage.

19. **List the limitations of 3 terminal IC voltage regulator.** **(NOV, 2019)**

-Limited power dissipation in available packages
-Limited current ranges
-Fixed voltage versions (although you can make in-between values with a few resistors the regulation is not as good)
-Dropout voltage - there are some low dropout versions but it still exists and limits efficiency
-Need external bypass capacitors on the input and output in most cases to stabilize

20. **Identify 2 basic requirements for sustained oscillations. (MAY, 2019)**

-circuit must have positive feedback'

-when positive circuit is used in the circuit, the overall circuit gain should be given by

$$A_f = A / (1-A\beta)$$

PART B

1. Explain the operation of an astable and monostable multivibrators with necessary diagrams.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 329 **(NOV, 2018, 17)**
2. State the significant difference between fixed and adjustable voltage regulators.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 360 **(NOV, 2018)**
3. Explain the working principle and salient features of a triangular wave generator and saw tooth wave generator.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 334 **(MAY,NOV, 2018)**
4. Discuss briefly about Opto-couplers.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 532 **(MAY, 2018)**
5. With neat functional and connection diagram, explain low voltage regulator.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 364 **(NOV, 2017)**
6. Explain in detail about: (i) audio power amplifier (ii) video power amplifier
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 521,528 **(MAY, 16&17)**
7. Draw the block diagram of a typical IC audio power amplifier and briefly explain their salient features.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 521
8. Describe the working of IC723 voltage regulator and explain its importance of current limiting techniques.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 375 (**MAY, 2016)**
9. With suitable diagram, explain the working of a switched capacitor filter. Also explain how resistor can be realized using switched capacitor filter.
   Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 387
10. Draw the internal circuit diagram of an IC723 regulator and explain.
    Refer Linear Integrated Circuits, 4th edition by "S. Salivahanan" page No: 375 **(NOV, 2019)**

55

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 80339

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fourth Semester

Electronics and Communication Engineering

EC 6404 — LINEAR INTEGRATED CIRCUITS

(Common to Medical Electronics and Robotics and Automation Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

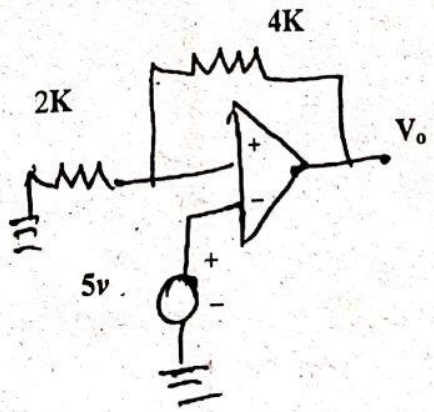
Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the block diagram of a general opamp.

2. Draw the circuit diagram of a symmetrical emitter coupled differential amplifier.

3. For the opamp shown in figure determine the voltage gain.



4. Draw the circuit diagram of a peak detector with waveforms.

5. Draw the block diagram of IC 566 VCO (Voltage Controlled Oscillator).

6. Enlist any four applications of NE 565 PLL.

7. What are the advantages of inverted R – 2R (current type) ladder D/A converter over R – 2R (voltage type) D/A converter?

8. What is the need for electronic switches in D/A converter?

9. Draw the block schematic of IC 555 timer.

10. What is the function of a voltage regulator? Name few IC voltage regulators.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the significance of virtual ground in an opamp. (6)

(ii) With diagram explain the operation of an inverting amplifier in closed loop configuration. Obtain the expression for closed loop gain. (6)

(iii) Assuming a slew rate for 741 IC is 0. 5 $v/\mu s$. What is the maximum undistorted sinewave that can be obtained for 12 v peak. (4)

Or

(b) (i) Explain the operation of a current mirror circuit. (6)

(ii) Compare the features of ideal and practical opamp circuit. (6)

(iii) A differential amplifier has CMRR = 1000. Differential inputs $V_1 = 1100\mu v$ and $V_2 = 900\mu v$. Calculate the difference in output voltage if the differential gain AD = 25000 (4)

12. (a) (i) Differentiate between low pass, high pass, band pass and band reject filter. Sketch the frequency plot. (6)

(ii) Design a second order low pass Butter worth filter for a cut off frequency of 1 KHz. (10)

Or

(b) Write short notes on :

(i) Clipper and clamper circuits. (10)

(ii) Integrater.

13. (a) Explain the operation of a variable transconductance multiplier. (16)

Or

(b) (i) With block schematic explain the working principle of PLL IC NE 565. (12)

(ii) Brief the application of PLL IC for frequency multiplication. (4)

14. (a) (i) With a neat sketch explain the working principle of flash type A/D converter. (10)

(ii) An 8 bit A/D converter accepts an input voltage signal of range 0 to 10 v.

(1) What is the minimum value of the input voltage required to generate a change of 1 LSB? (3)

(2) What input voltage will generate all '1's at A/D converter output? (3)

Or

(b) With functional block diagram explain A/D converter using voltage to time converter with input and output waveforms. (16)

15. (a) Write a technical note on : (8 + 8)

(i) isolation amplifier

(ii) opto coupler.

Or

(b) (i) Discuss the functionalities and working of switched mode power supply. (12)

(ii) Design a monostable multivibrator using 555 timer for a pulse period of 2 ms. (4)

Reg. No. | | | | | | | | | | | | |

Question Paper Code : 73448

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fourth Semester

Electronics and Communication Engineering

EC 2254/EC 44/10144 EC 405/EC 1254/080290022 — LINEAR INTEGRATED CIRCUITS

(Regulations 2008/2010)

(Common to PTEC 2254 Linear Integrated Circuits for B.E. (Part – Time) Third Semester – ECE – Regulations 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the advantages of integrated circuits over discrete components.

2. Define offset voltage of an operational amplifier.

3. Design and sketch an operational amplifier subtractor circuit.

4. What is the difference between basic comparator and Schmitt trigger?

5. What is a two Quadrant multiplier?

6. Define frequency synthesizing.

7. Mention any two specifications of a D/A converter.

8. For an n-bit flash type A/D converter, how many comparators are required? State the disadvantage of that type of converter.

9. State the need for current limiting in voltage regulators.

10. How does switched capacitor emulate resistor?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Compare different configurations of Differential Amplifier. (8)

(ii) For a dual input, balanced output differential amplifier, Rc = 2.2 kΩ, R_E= 4.7 kΩ, $R_{S1} = R_{S2} = 50\Omega$. The supply voltages are ± 10V. The hfe for the transistor is 50. Assume silicon transistors and hie = 1.4 kΩ. Determine the operating point values, differential gain, common mode gain and CMRR. (8)

Or

(b) (i) State the advantages of Integrated circuits over discrete components. (4)

(ii) Explain the fabrication process of Monolithic Integrated circuits with necessary diagrams. (12)

12. (a) Explain the working principle of

(i) Instrumentation amplifier (8)

(ii) Schmitt trigger. (8)

Or

(b) Explain the working principle of

(i) Precision Full wave rectifier (8)

(ii) Integrator. (8)

13. (a) Draw the analog multiplier IC and explain its features. (16)

Or

(b) Explain the basic blocks of PLL and determine expressions for lock-in range and capture range. (16)

14. (a) (i) Design a suitable D/A converter to convert 8-bit binary input in parallel form. Binary '0' corresponds to OV and binary '1' to 5V. Maximum output is +5V. Assume any other data that may be required. Explain its operation. (10)

(ii) Write a note on high speed sample and hold circuits. (6)

Or

(b) (i) With circuit diagram explain the operation of a flash type A/D converter. (8)

(ii) Compare the properties of successive approximation type and dual slope type converters. (8)

15. (a) (i) Draw the circuit using op-amp to generate triangular wave- Explain its operation. (8)

(ii) With a neat diagram, explain the working principle of step down switching regulator. (8)

Or

(b) With a suitable circuit diagrams, explain the working of the following

(i) video amplifier. (8)

(ii) Voltage to frequency converter. (8)

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50440

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017

Fourth Semester

Electronics and Communication Engineering

EC 6404 – LINEAR INTEGRATED CIRCUITS

(Common to Medical Electronics/Robotics and Automation Engineering)

(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Draw the dc transfer characteristics of a BJT differential amplifier and define differential mode input voltages.
2. The power supply rejection of an op-amp is 80dB for a 1V change in supply voltage. Calculate the change in offset voltage.
3. State the limitations of an ideal integrator.
4. How will you realize a peak detector using a precision rectifier ?
5. Mention the need of pre-distortion circuits in Gilbert analog multiplier and how is the configuration of Gilbert multiplier done with pre-distortion circuits.
6. Define capture-range and lock-range of PLL.
7. How is the classification of A/D converters carried out based on their operational features ?
8. Find the number of resistors required for an 8-bit weighted resistor D/A converter. Consider the smallest resistance is R and obtain those resistance values.
9. Define current transfer ratio of an opto-coupler.
10. Draw a fixed voltage regulator circuit and state its operations.

PART – B (5×13=65 Marks)

11. a) i) With a help of a block diagram, explain the various stages present in an operational amplifier. (6)

ii) Draw the transfer characteristics of an operational amplifier and explain the linear and non-linear operation. (7)

(OR)

b) i) Draw the inverting and non-inverting amplifier circuits of an op-amp in closed-loop configuration. Obtain the expressions for the closed-loop gain in these circuits. (8)

ii) Perform the AC analysis of the operational amplifier 741. (5)

12. a) i) For performing differentiation in an operational amplifier, integrator is preferred to differentiator – Explain. (6)

ii) What is an instrumentation amplifier ? Draw a system whose gain is controlled by a variable resistance. (7)

(OR)

b) i) Design a clipper circuit for a clipping level of +0.61V, given an input sine wave signal of 0.5V peak. Assume the gain of the amplifier is 12 and it has an input resistance of 1k-ohm connected. (7)

ii) Design a second order Butterworth low-pass filter having upper cut-off frequency of 2.5 kHz. (6)

13. a) i) Write notes on basic analog multiplication techniques. (5)

ii) Explain the operation of a variable transconductance multiplier circuit. Derive the expression for its output voltage. (8)

(OR)

b) i) Derive the expression for free running frequency of voltage controlled oscillator.

ii) Explain the process of FSK demodulation using PLL. How is the stability of the frequency obtained in a PLL by the use of voltage controlled oscillator ?

14. a) 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.

(OR)

b) i) With a neat block diagram, explain the operation of successive approximation type A/D converter in detail. (5)

ii) An 8-bit A/D converter accepts an input voltage signal of range 0 to 9V. What is the minimum value of the input voltage required for generating a change of 1 least significant bit ? Specify the digital output for an input voltage of 4 V. What input voltage will generate all 1s at the A/D converter output ? (8)

15. a) i) With neat diagram, explain the operation of an astable and monostable multivibrators. (8)

ii) Draw the functional diagram and connection diagram of a low voltage regulator and explain. (5)

(OR)

b) i) Draw the block diagram of a typical IC audio power amplifier and briefly explain their salient features. (6)

ii) Design a frequency to voltage converter using IC VFC 32 for a full scale output of 8 V for a full scale input frequency of 80 kHz with a maximum ripple of 8 mV. (7)

PART – C (1×15=15 Marks)

16. a) i) Design a differentiator to produce an output of 4 V when the input changes by 2 V in 60 micro seconds. (5)

ii) A PLL has a free running frequency of 400 kHz and the band-width of the low pass filter is 8 kHz. Will the loop tend to acquire lock for an input signal of 550 kHz ? Explain. In this case, assume that the phase detector produces sum and difference frequency components. (10)

(OR)

b) i) Design a square wave generator using 555 timer for a frequency of 120 Hz and 60% duty cycle. Assume C = 0.2 μF . (7)

ii) For a 4-bit R-2R ladder D/A converter assume that the full scale voltage is 12 V. Calculate the step change in output voltage on input varying from 1001 to 1111. (8)

Reg. No. : | | | | | | | | | | | | | 43

Question Paper Code : 40958

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Fourth Semester
Electronics and Communication Engineering
EC 6404 – LINEAR INTEGRATED CIRCUITS
(Common to : Medical Electronics/Robotics and Automation Engineering)
(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Enumerate any two blocks associated with Op-Amp block schematic.
2. What are the two methods can be used to produce voltage sources ?
3. What is the function of a phase shift circuit ?
4. Write the other name for clipper circuit.
5. State any two terminologies associated with multiplier characteristics.
6. What is Gilbert Multiplier Cell ?
7. Define Sampling.
8. Write the names of the switches used in MOS Transistors.
9. Name some LC oscillator circuits.
10. Define Line regulation.

PART – B (5×13=65 Marks)

11. a) Discuss about the principle of operation differential amplifier using BJT. (13)

(OR)

b) Explain about Ideal Op-Amp in detail with suitable diagrams. (13)

12. a) i) Describe about voltage follower circuit.
ii) Write short notes on subtractor circuit.

(OR)

b) With a neat diagram explain about V-I converter.

13. a) Discuss briefly about analog multiplier ICs.

(OR)

b) Explain the operation of the basic PLL with a block schematic.

14. a) Enumerate the specifications of D/A converter.

(OR)

b) Describe in detail about the single slope type ADC with neat sketch.

15. a) Explain about sawtooth wave generator with neat sketch.

(OR)

b) Discuss briefly about opto-couplers.

PART – C

(1×15=15 Marks)

16. a) Discuss in detail about instrumentation amplifier with suitable diagrams.

(OR)

b) Explain in detail about VCO using suitable diagram.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 20414

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Fourth Semester

Electronics and Communication Engineering

EC 6404 – LINEAR INTEGRATED CIRCUITS

(Common to Medical Electronics, Robotics and Automation Engineering)

(Regulations 2013)

(Also common to PTEC 6404 – Linear Integrated Circuits for B.E. (Part-time) – Third Semester – Electronics and Communication Engineering – Regulations 2014)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define differential mode gain.

2. State the ideal characteristics of an operational amplifier.

3. How does operational amplifier work as an integrator?

4. Draw the circuit of clipper using op-amp.

5. Mention the significances of Gilbert Multiplier cell.

6. State the various applications of phase locked loop.

7. Differentiate between direct type and integrating type in ADC converters.

8. What is the need for sample and hold circuit?

9. List the various applications of multivibrators.

10. Draw the circuit diagram of a general purpose voltage regulator.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Draw the transfer characteristics of an operational amplifier and explain its linear and non-linear operation. (8)

(ii) Discuss the operation of BJT differential amplifier with active loads. (5)

Or

(b) (i) Present the inverting and non-inverting amplifier circuits of an op-amp in closed-loop configuration. Derive the expressions for the closed-loop gain in these circuits. (9)

(ii) Define slew rate. In what way does it possess impact on the performance of an op-amp circuit? (4)

12. (a) (i) With a suitable circuit diagram, explain the operating principle of an instrumentation amplifier and derive its gain. (7)

(ii) Design a second order Butterworth low-pass filter having upper cut-off frequency of 2.1961 kHz. (6)

Or

(b) (i) Design a clipper circuit for a clipping level of +0.83V, given an input sine wave signal of 0.3 V peak. Assume the gain of the amplifier is 9 and it has an input resistance of 2.2 k-Ohm connected. (5)

(ii) Draw the operational diagram and explain the working principle of antilogarithmic amplifier and Schmitt trigger. (8)

13. (a) (i) Explain in detail on the operation of a basic phase locked loop. (5)

(ii) How are PLLs applied for frequency synthesizing and FM detection? (8)

Or

(b) (i) Obtain the expression for free running frequency of voltage controlled oscillator. (6)

(ii) Design an analog multiplier employing an emitter coupled transistor pair. (7)

14. (a) (i) Describe the operational features of R-2R ladder type D/A converter. (7)

(ii) Discuss the various switches employed for D/A converters. (6)

Or

(b) (i) With a neat block diagram, explain the operation of flash and successive approximation type A/D converter. (10)

(ii) What is oversampling? Give examples for oversampling converter. (3)

15. (a) (i) Explain the operation of an astable and monostable multivibrators with necessary diagrams. (10)

(ii) State the significant difference between fixed and adjustable voltage regulators. (3)

Or

(b) Explain the working principle and salient features of triangular wave generator and saw tooth wave generator. (13)

PART C — (1 × 15 = 15 marks)

16. (a) (i) Design a differentiator to produce an output of 6 V when the input changes by 2 V in 40 micro seconds. (5)

(ii) A PLL has a free running frequency of 600 kHz and the band-width of the low pass filter is 4 kHz. Will the loop tend to acquire lock for an input signal of 520 kHz? Explain in this case, assume that the phase detector produces sum and difference frequency components. (10)

Or

(b) (i) Design a wave generator using 555 timer for a frequency of 110 Hz and 80% duty cycle. Assume C = 0.16 μF. (7)

(ii) 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 0111 to 1111. (8)

Question Paper Code : 52913

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth Semester

Electronics and Communication Engineering

EC 6404 — LINEAR INTEGRATED CIRCUITS

(Common to Medical Electronics / Robotics and Automation Engineering)

(Regulation 2013)

(Also Common to PTEC 6404 – Linear Integrated Circuits for B.E. (Part-Time) – Third Semester – Electronics and Communication Engineering – Regulation – 2014))

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is a Current Mirror circuit?
2. State the input terminals associated with an ideal Op-Amp.
3. What is the function of a sign changer?
4. List some important applications of a Comparator circuit.
5. State the commonly used terminologies associated with multipliers.
6. Illustrate the need of Gilbert multiplier cell.
7. Why the analog to digital data conversion is needed?
8. Outline any two specifications of ADC.
9. Identify the two basic requirements for sustained oscillations.
10. Why the bias voltages in electronic circuits need to be regulated?

PART B — (5 × 13 = 65 marks)

11. (a) Describe about BJT differential amplifier using active loads with neat sketch.

Or

(b) Explain about the various stages of a general Op-Amp circuit.

12. (a) (i) Describe the details of voltage follower circuit.

(ii) Outline the details about Voltage to Current converter.

Or

(b) Describe in detail about the Schmitt Trigger with suitable circuit and waveforms.

13. (a) Explain the internal configuration of the multiplier IC and explain.

Or

(b) Describe in detail about the voltage controlled oscillator with a suitable block diagram.

14. (a) Draw the current mode R-2R Ladder DAC and explain in detail.

Or

(b) Draw the block schematic of a Single Slope type ADC and explain the same in detail.

15. (a) Draw the internal circuit diagram of an IC723 regulator and explain.

Or

(b) Derive the frequency of oscillation of a saw tooth waveform generator using an Op-Amp and explain.

PART C — (1 × 15 = 15 marks)

16. (a) Summarize the open-loop Op-Amp configurations in detail.

Or

(b) Explain the operation of a video amplifier IC with neat sketch.

Question Paper Code : 90185

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019
Fourth Semester
Electronics and Communication Engineering
EC 8453 – LINEAR INTEGRATED CIRCUITS
(Common to Medical Electronics/Biomedical Engineering/Robotics and Automation Engineering)
(Regulations 2017)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. What are the characteristics of an ideal operational amplifier ?
2. Why is collector resistance replaced by a constant current source in differential amplifier ?
3. What are the disadvantages of basic operational amplifier differentiator ?
4. Audio filters are usually Butterworth filter. Justify.
5. List the applications of Multiplier ICs.
6. Differentiate Lock-in-Range and Capture Range of PLL.
7. What are the demerits of weighted resistor Digital to Analog Converter ?
8. Estimate the conversion time of a 10 bit successive approximation Analog to Digital Converter, if the input clock is 5 MHz.
9. List the limitations of three terminal IC voltage regulator.
10. Compute the pulse width of a monostable multivibrator using OP-AMP, if $R_1 = R_2$, R = 10 K ohms and C = 0.1 microfarad.

PART – B

(5×13=65 Marks)

11. a) Analyze the operation of basic BJT current mirror and thus explain its volt-ampere characteristics.

(OR)

b) Analyze the small signal model of BJT differential amplifier using h parameter and deduce the expression for differential and common mode gains for differential output.

12. a) i) Explain the function of Instrumentation amplifier and derive the expression for gain. (7)

ii) Explain the function of full wave rectifier using OP-AMP and diodes. (6)

(OR)

b) i) Draw the circuit of temperature independent logarithmic amplifier and explain its operation. Also deduce the expression for output voltage. (8)

ii) Explain the function of positive clipper circuit with its input and output waveforms. (5)

13. a) i) Draw and explain the block diagram of Voltage controlled oscillator and show that the output frequency is directly proportional to the applied control voltage. (8)

ii) Show that the lock-in range of PLL is directly proportional to the free running frequency of voltage controlled oscillator. (5)

(OR)

b) i) Explain the function of Gilbert Multiplier cell and obtain the output differential current in terms of hyperbolic function. (7)

ii) Show that PLL IC can be used as AM demodulator. (6)

14. a) i) Describe the function of R-2R Ladder Digital to Analog Converter with suitable diagrams. (8)

ii) Estimate the value of LSB, MSB and full scale output for an 8-bit DAC for the 0 to 10V range. (5)

(OR)

b) i) Draw the basic circuit of Flash type A/D converter and elucidate its function with the help of truth table. (7)

ii) Sketch the functional block diagram of successive approximation A/D converter and describe its function for a typical analog input. (6)

15. a) i) Draw the circuit of Wien bridge oscillator and explain its function. Derive the expression for frequency of oscillation. (8)

ii) Design a phase shift oscillator using operational amplifier to oscillate at 1000 Hz with C = 0.1 μf. (5)

(OR)

b) With suitable functional block diagram, explain the function of low voltage regulator using 723 IC. Discuss the current foldback technique in 723 voltage regulator.

PART – C (1×15=15 Marks)

16. a) Show that the ON and OFF time of astable multi-vibrator using 555 timer IC is $T_{HIGH} = 0.69 (R_A + R_B) C$, $T_{LOW} = 0.69 R_B C$. Also evaluate the free running frequency and duty cycle, if $R_A = 6.8$ KΩ, $R_B = 3.3$ KΩ and C = 0.1 μf.

(OR)

b) Analyze second order narrow band pass active filter circuit and obtain the expressions for transfer function, quality factor, bandwidth and centre frequency.