ST. ANNE'S

COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi. Affiliated to Anna University, Chennai)

(An ISO 9001: 2015 Certified Institution)

ANGUCHETTYPALAYAM, PANRUTI – 607 106.

QUESTION BANK

PERIOD: MARCH 2021 - JUNE 2021 **BATCH**: 2020 – 2024

BRANCH: ECE **YEAR/SEM:** II/IV

SUB CODE/NAME: EC8453 LINEAR INTEGRATED CIRCUITS

UNIT I: BASICS OF OPERATIONAL AMPLIFIERS

PART A

1. **Define slew rate. What causes slew rate? (D) Nov/Dec 2020 & Apr/May 2021 (May2014, 2015)**

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

   Slew rate = dV_0/dt V/μs.

   Causes:

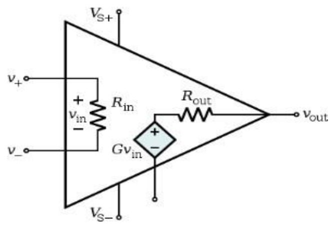
   Normally a capacitor used internally and externally in an op-amp to prevent oscillations. This Capacitor, Prevents the output voltage from responding immediately to fast changing input.

   For 741 op-amp I_{max} = 15 μA and internal compensation capacitor C= 30 pF

   S.R = I_{max}/30pF = 15 μA/30pF = 0.5 V/μS.

2. **What are the assumptions made from ideal Op-amp characteristics? (or) List the ideal characteristics of an op-amp (or) List the characteristics of ideal Op-amp and draw its equivalent circuits? (D) (Nov 2014, May 2017, Nov 2018, Nov 2019, Nov 2020, May 2021)**

   The ideal characteristics of an op-amp are as follows:

   Open loop voltage gain, A_{OL} =∞

   Infinite Input impedance, R_i = ∞

   Zero Output impedance, R_O =0

   Infinite Bandwidth, BW =∞

   Zero offset voltage, i.e. V_O = 0 when V_1 = V_2 =0;

3. **Why is collector resistance replaced by a constant current source in differential amplifier? (ID) (Nov/Dec 2019)**

   Large drop across R_c quiescent to maintain this high voltage need. The best idea to increase the open circuit voltage to use in differential amplifier.

4. **State the significance of current mirror circuit (D) (May2019)**

   The advantages of a current mirror are:

   1.Low input impedance makes the input current insensitive to the output impedance of the input source 2.High output impedance makes the output current insensitive to the impedance of the output load 3.Inversion of sources to sinks or sinks to sources 4.Accurate gain 5.Shifts between different power rails.

5. **Mention the application of LF155. (ID) (May2019)**
   Precision High Speed Integrators, Fast D/A Converters, High Impedance Buffers Wideband, Low Noise, Low Drift Amplifiers, Logarithmic Amplifiers, Photocell Amplifiers, Sample And Hold Circuits.
6. **Define Differential Mode gain.(D)(Nov2018)**
   Differential-Mode voltage gain is the gain given to a voltage that appears between the two input terminals. It represents two different voltages on the inputs.
7. **Enumerate any two blocks associated with Op-Amp block schematic? (D) (May2018)**
   The blocks of an OP-AMP can be given as the differential amplifier, Voltage amplifier and the Output Amplifier.
8. **What are the two methods can be used to produce voltage sources? (D) (May 2018)**
   A voltage source is a circuit that produces an output voltage V_0, which is independent of the load driven by the voltage source, or the output current supplied to the load. The two methods that can be used to produce a voltage source can be given as Voltage circuit using Impedance transformation and Common Collector type voltage source.
9. **Enumerate any four advantages of ICs over discrete component circuits. (D) (Nov2017)**
   Advantages of ICs over discrete components can be given as
   Reduction in Size
   Reliability is improved
   Reduction of Power Consumption
   Reduction of effects due to Noise.
10. **Find the maximum frequency for a sine wave output voltage of 12v peak with an OP-AMP whose slew rate is 0.5V/ µs. (ID) (Nov 2017)**
    Slew Rate = 2πfV
    f = slew rate/(2πV) = $0.5*10^6/(2\pi*12)$ = 6.6KHz
11. **Find the maximum frequency for sine wave output voltage 10Vpp with an op-amp whose slew rate is 1V/µs. (May2016) (ID)**
    V_{pp}=10V (given); Slew Rate = $2\pi f_{max}V_m$ = 1V/µs =>f_{max} = $(1 \times 10^6)/(2\pi \times 5)$ = 31.83 kHz.
12. **Differentiate the Ideal and Practical characteristics of an op-amp. (D) (May2016)**

S.No	Ideal Characteristics	Practical Characteristics
1.	Open loop gain = ∞.	Open loop voltage gain is several thousands.
2.	Input impedance = ∞.	Input impedance is greater than 1MΩ.
3.	Output impedance = 0.	Output impedance is few hundred ohms.
4.	Bandwidth = ∞.	Bandwidth is very small.
5.	Zero Offset Vo = 0 when V1=V2=0.	Offset voltage is some non zero value.

13. A differential amplifier has a differential voltage gain of 2000 and a common mode gain of 0.2. Determine the CMRR in dB.(ID) (May 2015)

CMRR = 20 log |Ad/Ac|

Ad = 2000, Ac=0.2.

(Given) CMRR = 2000 /

0.2 = 10000

CMRR in dB = 20 log |Ad/Ac| = 20 log 10000 = 20* 4 = 80dB.

14. **Define input bias current and input offset current of an operational amplifier.** (D) **(Nov 2015)**

Input Bias current: The average of currents entering into the (-) input terminal & (+) input terminal of an op-amp is called input bias current. Its value is 500nA for741C.

Input Offset Current: The algebraic difference between the currents into the (-) input and (+)input is referred to as input offset current .It is 200Na maximum for 741C.

15. Mention two advantages of active load over passive load in an operational amplifier. (D)(N'15)

The difference mode gain and CMRR is directly proportional to the R_C in differential amplifier. The resistance value of R_C is need to increase, to achieve high CMRR. But the use of large resistance value R_C occupies large chip area and it needs large power supply. So the passive load R_C is replaced by the current mirror as active load.

16. An operational amplifier has a slew rate of 4V/µs. Determine the maximum frequency of operation to produce a distortion less output swing of 12V. (ID) (Nov2014)

Slew rate (SR) =$2\pi f V_p / 10^6$ V/µs, V_p - Maximum amplitude of the output.

Given: SR = 4 V/µs, V_p= 12V

$f = SR\times10^6 / (2\pi\times12) = 53.078$kHz

17. List the advantages of IC over discrete component circuit. (D) (Nov 2013)

Low cost, Small size, High reliability, Improved performance.

18. Define input offset current and input offset voltage. (D) (Nov2013)

INPUT OFFSET CURRENT: The algebraic difference between the currents into the (-) input and (+)input is referred to as input offset current .It is 200Na maximum for 741C.

INPUT OFFSET VOLTAGE: Ideally, for an Op-amp when no input is applied output voltage must be zero. However, some output voltage is present though input is not applied. Thus, offset voltage is the voltage that must be applied between the input terminals of an op-amp to nullify the output.

Since this voltage could be positive or negative its absolute value is listed on the data sheet. For 741C, maximum value is 6mV.

19. Define CMRR AND PSRR. Mention their ideal values. (ID) (May2013)

PSRR: The change in an op-amp's input offset voltage due to variations in supply voltage is called supply voltage rejection ratio. It is also termed as power supply rejection ratio or power supply sensitivity and gives the figure of merit ρ for the differential amplifier.

$\rho = |Ad/Ac|$

where A_d = Differential mode gain, A_c = common mode gain, CMRR is typically infinite

For 741C, SVRR=150μV/V.

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20. 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 0.5 V/μs? (ID) (Nov2012)

Slew rate (SR)= $2\pi f V_p / 10^6$ V/μs, V_p- Maximum amplitude of the output Given: SR= 0.5 V/μs, f= 10kHz

$V_p = SR \times 10^6 / (2\pi \times 10k) = 1.99$ V

21. State the limitations of discrete circuits. (D) (May2013)

High cost, Large size, Low reliability, Reduced performance.

22. What is the purpose of a current source in integrated circuits? (ID) (Nov2012)

By improving the CMRR of differential amplifier, its performance can be improved. To improve CMRR, common mode gain Ac must be reduced as much as possible. When this happens RE will be tending to infinity. But there are practical limitations in selecting the magnitude of an enormous value of resistance. Use of a constant current bias instead of RE is the practical solution for this problem. Without physically increasing the value of RE, the transistor operated at a constant current gives the effect of very high value of resistance. This is the importance of a current source in an IC.

23. What is an op-amp? List its functions. (D)

The op-amp is a multi terminal device, which internally is quite complex. It is a direct-coupled high gain amplifier consisting of one or more differential amplifiers, followed by a level translator and an output stage. Function: Op-amp amplifies the difference between two input signals.

24. List the essential terminals of an op-amp. (D)

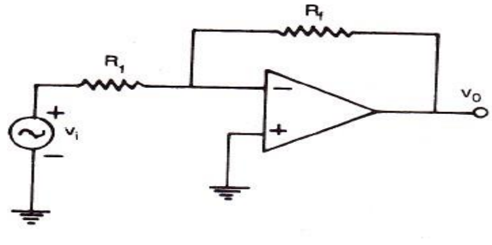
Op-amp has five basic terminals, that is, two input terminals, one output terminal and two power supply terminals. Inverting input terminal : Pin 2,Non- inverting input terminal : Pin 3,Output terminal Pin 6 and Power supply terminals : Pin 4& 7

25. Explain the virtual ground concept with a suitable example. (D)

We know that V_d = Va - V_b = 0; Node B is grounded. Therefore V_b = 0; But $V_d = 0; \Rightarrow V_a = V_b$; Node A is at virtual ground. ie since node B is at ground node A is also at ground imaginarily.

26. Design a circuit using op-amp whose gain is–3. (ID)

The op-amp inverting amplifier is shown.



$$Gain = \frac{V_0}{V_i} = -\frac{R_f}{R_1} = -3$$

$Let\ R_1 = 1k\Omega$

$R_f = 3 \times R_1 = 3k\Omega$

27. What are the factors that affect the stability of an op-amp? (D)

The factors that affect the stability of an op-amp are closed loop gain and phase shift.

28. What are the various methods available for frequency compensation? (D)

There are two types of compensating techniques used for frequency compensation. They are namely External compensation and Internal compensation. External frequency has two methods for compensation namely Dominant pole compensation and Pole-zero compensation.

29. Mention some applications of op-amp in open loop mode. (D)

Some of the applications of op-amp in open loop mode are as follows: Comparator, Zero crossing detector, Window detector, Time marker generator, Phase meter

30. Why are FET op-amps better than BJT op-amps? Op-amps using FETs in the input stage offer some very significant advantages over bipolar op-amps, especially in areas as input impedance, input bias and offset currents and slewing rate as shown in table. (ID)

Op-amps using FETs in the input stage offer significant advantages over bipolar op-amps especially in areas as input impedance, input bias and offset currents and slew rate as shown in table:

Parameter	**BJT**	**JFET**	**MOSFET**
Input resistance	KΩ	$10^9\Omega$	$10^{12}\Omega$
Input gate current	μA	1 nA	1 pA
Input offset current	20 nA	2 pA	0.5 pA
Slewing rate	1 V/μs	3 V/μs	10 V/μs

31. Explain thermal drift related to an op-amp. (D)

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

32. Why is current mirror circuit used in differential amplifier circuit? (D)

A constant current source makes use of the fact that for a transistor in the active mode of operation. Thus in active region the collector current equal to output current which is approximately equal to $I_{ref.}$

Part B

[FIRST HALF]

Current mirror and current sources

1. With neat sketches, explain in detail the working of Widlar and Wilson current sources. **(13) (D) (Nov 2020)**
2. With a neat circuit diagram and with necessary equations, explain the concept of Widlar current source used in op-amp circuit.**(8) (D)**
3. Briefly explain about constant current source.**(8) (D) (April 2015)**
4. Analyze the operations of basic BJT current mirror and thus explain its volt-ampere characteristics. (13)

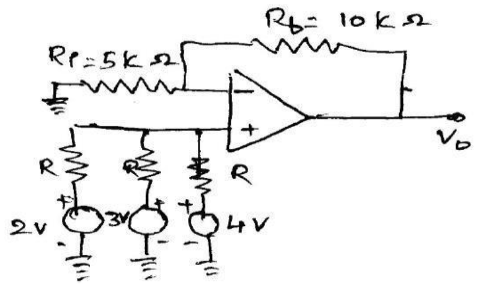
(D)(Nov 2019)

BJT Differential amplifier with active loads

5. 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. (13) **(D) (Nov 2019)**
6. Explain the working of BJT differential amplifier with active load.(12)**(D)(Nov 2013)**
7. Write down the characteristics and their respective values of an ideal operational amplifier.(4)**(D)(Nov 2013)**
8. Explain, with a circuit diagram, the working of BJT-emitter coupled differential amplifier. Also explain the concept of active load and sketch the relevant circuit diagram.(10)**(N/D'13,N/D'18) (D)**
9. Compare different configurations of differential amplifier.(8) **(May2013) (D)**
10. With the schematic diagram explain the effect of Re on CMRR in differential amplifier.(4)**(May 2016) (D)**
11. Discuss about the methods to improve CMRR. (12) **(May 2016) (D)**
12. For a dual input, balanced output differential amplifier, Rc=2.2kΩ, RE=4.7 kΩ, Rs1=Rs2=50Ω. The supply voltages are ± 10V. The hfe for the transistor is 50. Assume silicon transistors and hie= 1.4kΩ. Determine the operating point values, differential gain, common mode gain and CMRR. (8) **(ID)**
13. With simple schematic of differential amplifier, explain the function of operationalamplifier. (7) **(D)**
14. Discuss about the principle of operation differential amplifier using BJT.**(May 2018) (D)**

Basic information about op-amps – Ideal Operational Amplifier

15. Explain about Ideal Op-Amp in detail with suitable diagrams.(8) **(May2018) (D)**
16. For the non-inverting op-amp shown in the figure below, find the output voltage V_o. (8) **(ID)**



17. A non-inverting amplifier with the gain of 300 having an input offset voltage of ±3mV. Find the output voltage when the input is 0.01 sin ωt Volt. (4) **(May 2016) (ID)**

[SECOND HALF]

General operational amplifier stages

18. With a neat block diagram, explain the general stages of an OP-AMP IC.(6) **(N/D 17) (or)** List and explain the all basic building blocks of op-amp**(D)(13) (A/M 2019)**

Internal circuit diagrams of IC 741

19. With a neat diagram, explain the input side of the internal circuit diagram of IC 741. **(D)**(7) **(Nov2015)**
20. Derive the functional parameters for an inverting mode negative feedback gain circuit with an 741 op-amp in IC inverting mode with R1=1kohm Rf=1kohm and compute Af; Rif: Rof; BW; offset voltage.**(ID)**(7)

DC and AC performance characteristics,

21. List and explain the non-ideal DC characteristics ofop-amp.(8)**(D)**
22. Explain AC characteristics of op-amp. **(D)**(8) **(May 12,17, Nov 2013, Nov 2014,Nov 2017,May 2019)**
23. Draw the transfer characteristics of an operational amplifier and explain the linear and non-linear operation. **(D)**(8) **(Nov 2017, Nov2018)**
24. What is input and output voltage and current offset? How are they compensated? **(D)**(7) **(May'17)**
25. Briefly explain the techniques used for frequencycompensation. **(D)** (7)
26. Write a note on stabilitycriteriaand frequency compensation techniques applied in op- amp. **(D)**(12)
27. What is a need for frequency compensation in an op-amp? With the suitable illustration, explain the pole-zero frequency compensation technique.**(D)**(8)**(Nov2015)**

Slew Rate

28. Define Slew rate. In What way does it possess impact on performance of an op-amp circuit**.(D)(4) (Nov2018)**

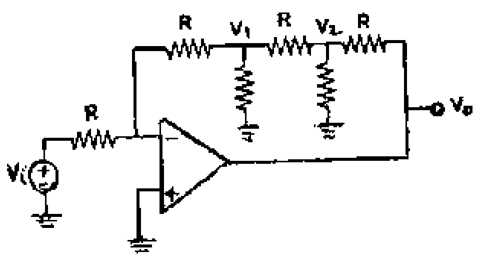
Open and closed loop configurations

29. How do the open loop and the closed loop gain of an op-amp differ?**(D)**(6) **(April 2015)**
30. 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**(D)**(13)**(Nov 2017, Nov2018)**

UNIT II: APPLICATIONS OF OPERATIONAL AMPLIFIERS

PART-A

1. **What are the disadvantages of basic operational amplifier differentiator?(D) (Nov/Dec 2019)**
   - At high frequency the ideal differentiator may become unstable and break into oscillation.
   - The input impedance decreases with increase in frequency thereby making the circuit sensitive to high frequency noise.
2. **Audio filters are usually butterworth filter. Justify.(ID)(Nov/Dec 2019)**
   - Filters in an electronic circuit which select a frequency. It passes the signal for specified range and attenuates the signal outside that specified range.
3. **Find the gain of V_o/V_i of the circuit.(ID)(May2019)**



Apply KCL at each node

$$\frac{Vi}{R}+\frac{V1}{R}=0$$

.......(1)

$$\frac{V1}{R}+\frac{V1}{R}+\frac{V1-V2}{R}=0$$

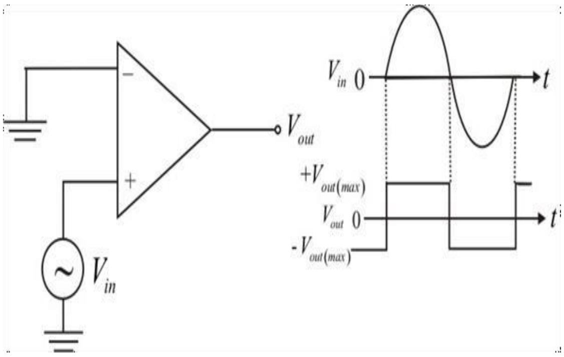
.....(2)

$$\frac{V2 - V0}{R} + \frac{V2}{R} + \frac{V1 - V2}{R} = 0 \qquad \frac{Vo}{Vi} = 8$$

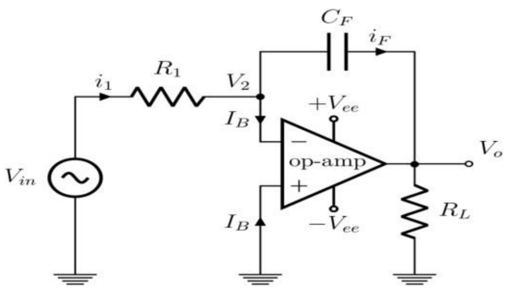
-----(3) By solving eqn 1,2 and 3 weget

4. **How does a zero crossing detector work?**(D)**(May2019)**

It is used to compare two voltages simultaneously and changes the o/p according to the comparison. As shown in the waveform, for a reference voltage 0V, when the input sine wave passes through zero and goes in positive direction, the output voltage Vout is driven into negative saturation. Similarly, when the input voltage passes through zero and goes in the negative direction, the output voltage is driven to positivesaturation

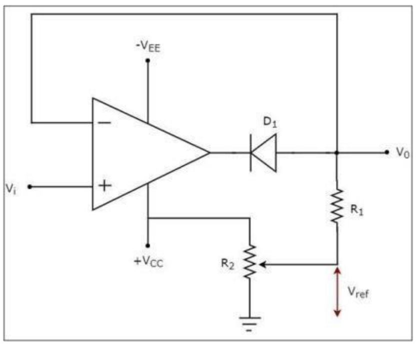


5. **How does operational amplifier work as integrator?**(D)**(Nov/Dec 2018)**



$$v_o = -\frac{1}{R_1 C_F} \int_0^t v_{in}\, dt$$

6. **Draw the circuit of clipper using op-amp. (D)(May2019)**



7. **What is the function of a phase shift circuit?** (D)**(May 2018)**

Phase Shift circuits are combinations of resistive and capacitive elements which are used to give a change in the phase of the signal which adds a delay to the signal applied as input to thecircuit.

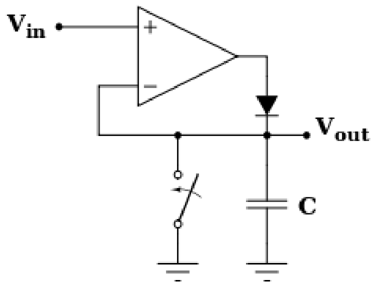
8. **Write the other name for clipper circuit.** (D)**(May2018)**

The clipper circuit can also be called as the Level Limiting circuit. The signal gets limited to the desired voltage level fixed during the design of the circuit.

9. **What is a transconductance amplifier amplifier and state any one application.**(D) **(Nov 2017)**

Transconductance amplifier is amplifier which takes the differential voltage input and gives the corresponding current output. The main application of the transconductance amplifier is the voltage to current conversion (V to I).

10. **How will you realize peak detector using a precision rectifier (D)(Nov2017)**



11. **What is the need for converting first order filter to second order filter? (ID)(May2017)**

The need for converting first order filter to second order filter is second order filters has a roll-off rate of -40dB/decade and also it eliminates the need of inductors.

12. **How is the current characteristics of PN junction employed in log amplifier?**(D) **(May'17)**

Log amplifier can be employed by using diode current equation given by I_E =Is($e^{qVe/kT}$-1).Since the reverse saturation current I_o for the diode changes with temperature, it is very difficult to set the Vref for the circuit. Thus the temperature affects the performance and accuracy of basic logarithmic amplifier circuit.

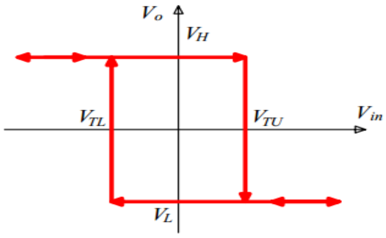
13. **What is a precision diode? How does it differ from the conventional amplifier?(D)(Nov.2012)**

A diode in the feedback loop of an op-amp behaves as a precision diode as its cut-in voltage gets divided by the open-loop gain of op-amp. This circuit is called the precision diode and is capable of rectifying input signals of the order of millivolt where the conventional diode cannot rectify below 0.7V**.**

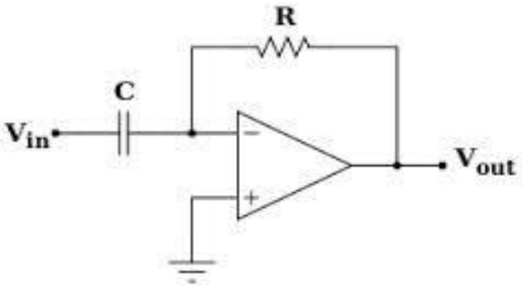
14. **What is hysteresis and mention the purpose of hysteresis in a comparator?** (D)**(May2015)**

If positive feedback is added to the comparator circuit, gain can be increased greatly. Consequently, thetransfercurveofcomparatorbecomesmoreclosetoidealcurve.Theoretically,iftheloopgain-

βA_{OL} is adjusted to unity, then the gain with feedback, A_{Vf} becomes infinite. This results in an abrupt (zero rise time) transition between the extreme values of output voltage. In practical circuits, however, it may not be possible to maintain loop gain exactly equal to unity for a long time because of supply voltage and temperature variations. So a value greater than unity is chosen. This gives an output waveform virtually discontinuous at the comparison voltage. This circuit, however, now exhibits a phenomenon called hysteresis or backlash. Parameters which determine the hysteresis are upper threshold V_{UT} and lower threshold V_{LT}.



15. **Draw the circuit diagram of an op-amp differentiator circuit.**(D) **(Nov2012)**



V_{out}= -RC (dV_{in}/dt)

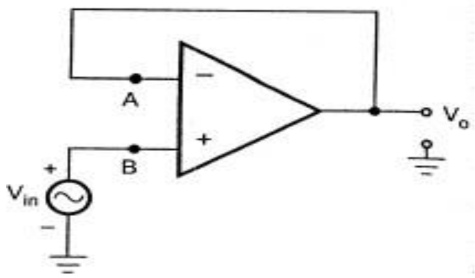
16. **Give an application of inverting amplifier.**(D) **(May2013)**

Differentiator, Integrator, Rectifiers, Summer.

17. **What is a voltage follower?** (D)**(May2014)**

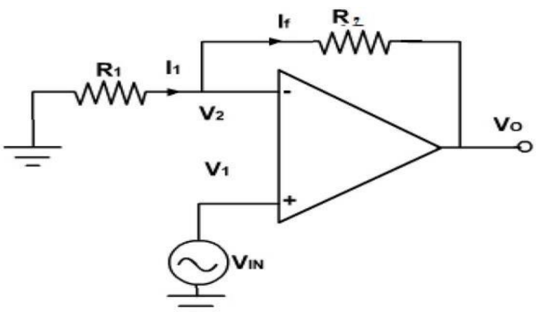
It is a circuit in which the output voltage follows the input voltage i.e. the output voltage is same as that of the inputvoltage.

Gain = V_0/V_i= 1 + (R_f/R_1) = 1+0 = 1. Hence V_0 = V_i

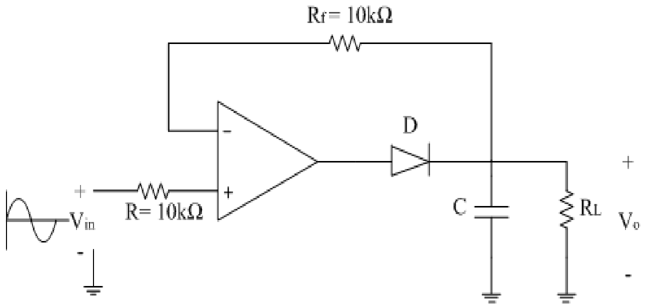


18. **Draw a non-inverting amplifier with voltage gain of 3.(ID) (Nov2013)**

Gain = V_0/V_i= 1 + (R_f/R_1) = 3 =>R_f/R_1 = 2 =>R_f = 2 R_1 let R_1 = 1 KΩ =>R_f = 2 KΩ



19. **Draw the circuit diagram of peak detector.** (D)**(May2014)**



20. **Determine the output voltage for the circuit shown in fig when a) Vin = -2V (b) Vin = 3V. (ID)(Nov 2015)**

The condition for the determining the output of the comparator.

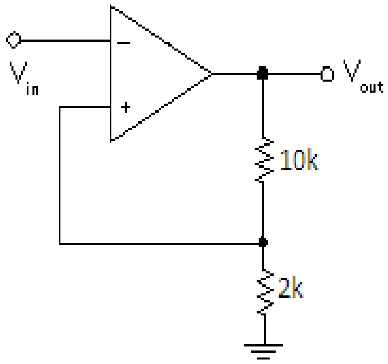
If Vin >Vref ;Vout = +Vcc.

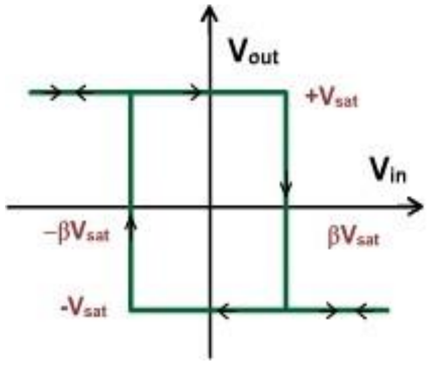
If Vin <Vref ;Vout = -Vcc

a. Vin = -2V (Given). As Vin<Vref, the output is+10V.

b. Vin = 3V (Given). As Vin>Vref, the output is-10V.

21. **Plot the transfer characteristics of the circuit shown below, the opamp saturates at ±12V.** (ID)**(Nov 2015)**



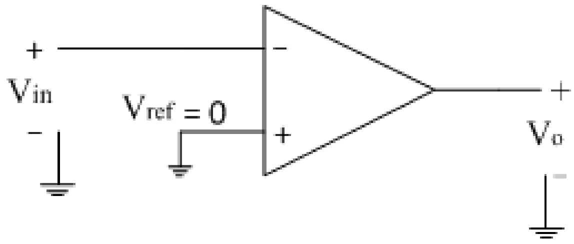


22. **How does precision rectifier differ from the conventional rectifier? (Nov 2012) (or) State the difference between conventional and precision rectifier? (Nov2014)**
(or)What is the difference between normal rectifier and precision rectifier? (May 2015)(ID)

In conventional rectifiers, as long as the input exceeds the cut-in voltage of the diode, it does not conduct. Due to this, the output is distorted producing cross over distortion. For the input voltage between ± 0.7V, the output remains zero which is the main limitation of the conventional rectifier. The open loop gain of the opamp is very large. Hence for very small amount of the input, it produces large output which makes the diode conduct. Thus the diode conducts for very small input voltages of the order of millivolts. Hence, the precision rectifiers are veryprecise.

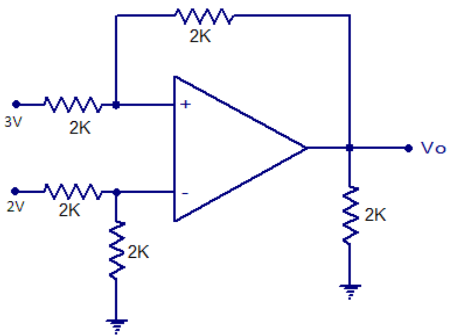
23. **What is a comparator? List the applications of comparator. (or) Draw the circuit diagram of the comparator. Mention its applications.** (D)**(May2016)**

A comparator is a circuit, which compares a signal voltage applied at one input of an op-amp with a known reference voltage at the other input. It is basically an open loop op-amp with analog inputs and digital output (+ or – $V_{sat} = V_{cc}$).



Circuit Diagram:

Application: Zero crossing detector, Window detector, Time marker generator and, Phase meter.



24. **Calculate the output voltage for the circuit shown below.** (ID)**(May2016)**

$V_o = R_f (V_1 - V_2) / R_i$ = 2k (3-2)/2k = 1V.

25. **What are the limitations of basicdifferentiator?(D)**

At high frequencies, a differentiator may become unstable and break into oscillation. The input impedance (ie., $1/\omega C_1$) decreases with increase in frequency, thereby making the circuit sensitive to high frequency noise.

26. **What is the limitation of basicintegrator?**(D)

At low frequencies, the feedback capacitor behaves as an open circuit and there is no negative feedback. The op-amp thus operates in open loop, resulting in an infinite gain. In practice, of course, output never becomes infinite, rather the output of the amplifier saturates at a voltage close to the op- amp positive or negative power supply depending on the polarity of the input dc signal.

27. **What is the use of differentiator and integratorcircuits?(D)**

The op-amp differentiator and integrator are useful for signal wave shaping.

28. **On what does the damping co-efficient of a filterdepend.**(D)

Damping is determined by the amplifier’s gain. Bessel filter is a heavily damped filter ($\alpha > 1.7$). It is very stable, but rolls-off very early in the pass band.

Butterworth filters (α = 1.414) gives maximally flat pass band. A Chebyshev filters ($\alpha < 1.4$) provides faster initial roll-off rate but gives poorest transient response.

29. **What is an instrumentationamplifier?**(D)

In a number of industrial and consumer applications, one is required to measure and control physical quantities. Some typical examples are measurement and control of temperature, humidity, light intensity, water flow etc. these physical quantities are usually measured with the help of transducers. The output of transducer has to be amplified so that it can drive the indicator or display system. This function is performed by an instrumentation amplifier.

30. **What are the features of an instrumentationamplifier?**(D)

High gain accuracy, High CMRR, High gain stability with low temperature coefficient, Low dc offset Low output impedance. There are specially designed op-amps such as μA 725 to meet the above stated requirements of a good instrumentation amplifier.

31. **What is the other name for voltage to current converter? What are the uses of V-to-I converters?**(D)

The other name for voltage to current converter is the transconductance amplifier. The V-to-I converters are useful in low voltage dc and ac voltmeters, LED and Zener diode testers.

32. **What is the other name for current to voltage converter? What are the uses of I-to-V converters?**(D)

The other name for current to voltage converter is the transresistance amplifier. The I-to-V converters are used for testing photo devices. Photocell, photodiode and photovoltaic cell give an output current that is proportional to an incident radiant energy or light. The current through these devices can be converted to voltage by using a current to voltage converter and thereby the amount of light or radiant energy incident on the photo device can be measured.

33. **Discuss the disadvantages of passivefilters.**(D)

Passive filters work well for high frequencies, that is, radio frequencies. However, at audio frequencies, inductors become problematic, as the inductors become large, heavy, and expensive. For low frequency application, more number of turns of wire must be used which in turn adds to the series resistance degrading inductor's performance, ie. Low quality factor results in high powerdissipation.

34. **Why are active filterspreferred?(D)**

Active filters are preferred over passive filters because they use op-amp as the active element, and resistors and capacitors as the passive elements. The active filters, by enclosing a capacitor in the feedback loop, avoid using inductors. In this way, inductor less RC active filters can be obtained. Also, as op-amp is used in non-inverting configuration, it offers high input impedance and low output impedance. This will improve the load drive capacity and load is isolated from the frequency-determining network. Because of the high input impedance of the op-amp, large value of resistors can be used, thereby reducing the value (size and cost) of the capacitors required in thedesign.

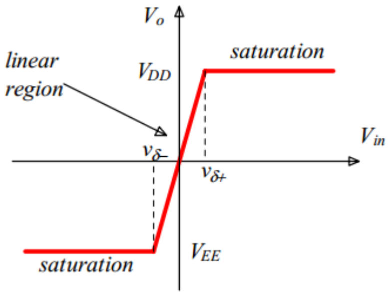
35. **What is a Sallen- Keyfilter?**(D)

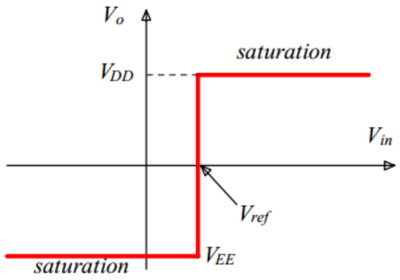
A second order filter consists of two RC pairs and has a roll-off rate of – 40 dB/decade. A general second order filter is known as Sallen –Key filter.

36. **What is Schmitttrigger?**(D)

Schmitt trigger is a comparator with positive feedback. In this circuit, the input voltage triggers the output every time it exceeds certain voltage levels called upper threshold V_{UT} and lower threshold V_{LT}. It converts slowly varying waveforms into square wave.

37. **Draw the transfer characteristics of an ideal comparator and a practicalcomparator.**(D)





Practicalcomparator **Ideal comparator**

PART B
[First Half]

V-TO-I AND I-TO-V CONVERTERS

1. Explain in detail about the V to I and I to V converters. D (8) (**A/M 2015)**
2. With a neat circuit diagram explain the working of voltage to current converter. D (8) **(N/D 2015) (A/M 2018)**

LOGARITHMIC AMPLIFIER, ANTILOGARITHMIC AMPLIFIER

3. With neat diagram explain logarithmic amplifier and antilogarithmic amplifier. D (16) **(M/J 2014)**
4. Draw the circuit of temperature independent logarithmic amplifier and explain its operation. Also deduce the expression for output voltage.**D (8) (N/D 2019)**

SCHMITT TRIGGER

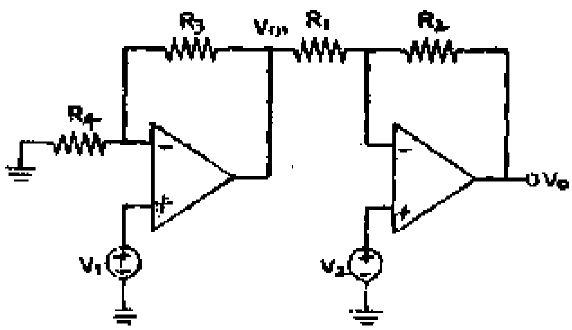
5. With a neat diagram explain the operation of Schmitt trigger. D (8) **(A/M 2015)**

PRECISION RECTIFIER

6. With a neat circuit diagram, explain the working of precision rectifier. D (8) (**N/D 2015**)
7. What is a precision rectifier? With circuit schematic explain the working principle of full wave rectifier? ID (6)(A/M 2016)
8. Explain the operation of precision full wave rectifier with neat sketch. D (16) **(N/D 2014)**
9. Explain the function of full wave rectifier using op-amp and diodes. **D (6) (N/D 2019)**
10. With neat diagram explain the application of op-amp as precision rectifier, clipper and clamper. D (16) **(M/J 2014)**

INSTRUMENTATION AMPLIFIER

13. Find Vo. Verify that if R3/R4=R1/R2, the circuit is an instrumentation amplifier with gain with A=1+R2/R1 **(ID)** (13) **(May2019)**



11. Draw the circuit diagram of an instrumentation amplifier and explain its operation .list few application? D (12)(**A/M 2016)**
12. What is an instrumentation amplifier? Draw a system whose gain is controlled by a variable resistance. D (7) (**N/D 2017)**
13. Explain the function of instrumentation amplifier and derive the expression for gain. (7) **(Nov/Dec 2019)**
14. Describe about the voltage follower circuit. D (7) **(A/M 2018)**
15. Write short notes on subtracted circuit D (6) (**A/M 2018**)

[Second Half]

SCHMITT TRIGGER

16. (i) With neat diagram explain the operation of Schmitt trigger, precision rectifier (13) (May 2019)

INTEGRATOR, DIFFERENTIATOR

17. Explain the application of operational amplifier as differentiator. D (8) (**N/D 2015)**
18. For performing differentiation in an operational amplifier, integrator is preferred to differentiator? Explain ID (6) **(N/D 2017**)
19. With neat figures describe the circuit using Op Amps on the functioning of. (i) Integrator. and double integrator circuit ' First order High pass filter. ID (7+6) **Aprl/May 2017**

LOW-PASS, HIGH-PASS AND BAND-PASS BUTTERWORTH FILTERS

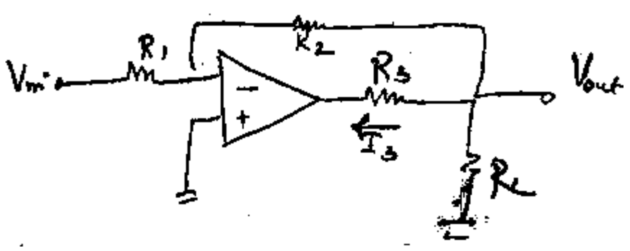
20. (i) Explain the issues and challenges in active filter design withexample. (5)**(ID)**

(ii) The circuit given is inverting amplifier except the resister R3 is added. Thecircuit parameters are R1=5kΩ, R2=25kΩ, R3=12.5kΩ, RL=5kΩ (10) **(May2019)(ID)**

A) Derive Voutexpression

B) Derive the expression forI3

C) What happen to I3 if R3 isdoubled?(R3=25kΩ)



21. Analyze second order narrow band pass active filter circuit and obtain the expressions for transfer function, quality factor, bandwidth and centre frequency. **(D) (15) (Nov/Dec 2019)**
22. Design a second order high pull butter worth filter having cut off frequency of 5 KHz. **(ID)** (6)(A/M 2016)
23. Differentiate between low pass, high pass, band pass and band reject filter. sketch the frequency plot. D (8) **(N/D 2016)**
24. Design a second order high pull butter worth filter having cut off frequency of 1 KHz. ID (6)(N/D 2016)

25. Mention two advantages of active e filter over passive filter. also design a second order filter using operational amplifier for upper cut off frequency of 2 KHz. assume the value of capacitor to be 0.1µ F. ID (8) **(N/D 2015)**
26. Design a wide band pass filter having f $_L$=400Hz, f_H = 2 KHz and pass band gain of 4. Find the value of Q of the filter. ID **(8) (A/M 2015)**
27. Design a second order low pass Butter worth filter for a cut off frequency of 1 KHz. (10) D

CLIPPER AND CLAMPER

28. With neat diagram explain the application of op-amp as zero cross detector, precision rectifier, clipper, and clamper.(8) **(Nov 2013, May 2014, Nov 2014, Nov 2015, May 2017,May2019)**
29. Explain the function of positive clipper circuit with its input and output waveforms.(D) **(5) (N/D 2019)**
30. Write short notes on **: D (N/D 2016)**

    i) Clipper and clamper circuits.(10) ii) Integrator. (6)
31. With neat figures describe the circuit using opamps on the functioning of **(D)** (**A/M 2017)**
    a. zero crossing detector ,clipper and clamper(7)
    b. Schmitt trigger (6)
32. With neat figures describe the circuit usingopamps on the functioning of **(D) (A/M 2017)**
    a. Integrator and double integrator circuits (7)
    b. First order high pass filter (6)
33. 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. (ID) (6)**May/June 2016**
34. With neat figures describe, the circuit using Op Amps on the operation of (i) Zero cross detector, clipper and clamper circuits (ii) Schmitt Trigger. D (7+6) **Aprl/May 2017**