Chettinad College of Engineering & Technology Approved by AICTE-New Delhi and Affiliated to Anna University-Chennai		
Academic Year 2024-2025		
Question Bank		
Year/Semester: II/IV **Date:07/05/2025**	**Department : EEE** **Subject Code/Title : EE3402 / LINEAR INTEGRATED CIRCUITS** **Faculty Name : Dr.M.Senthil Kumar, Prof/EEE**	**Unit: I, II, III, IV,V** **Section : Part A/B/C**

UNIT – 1 IC FABRICATION

PART-A (2-MARKS)

1. List the advantages of integrated circuits over discrete component circuit.

a) Practically size of an IC is thousands of times smaller than the discrete circuits, which increases the equipment density.

b) Thousands of silicon wafers consisting individually millions of components, can be produced or manufactured simultaneously, known as mass production. Due to this, the cost of IC is very very low

c) As the number of components are fabricated on a single silicon wafer, which are not similar to the conventional one, the weight of IC reduces as compared to the discrete circuits with same number of components.

d) ICs operate at low voltages. The power consumption of ICs is very low.

e) In ICs, soldered joints are absent and thus the high reliability of the system is the main feature of ICs.

2. What are the limitations of integrated circuits ?.

- The capacitors more than 30 pF cannot be fabricated.
- The resistors more than 100 k£2 cannot be fabricated.
- The coils or inductors cannot be fabricated.
- The ICs can handle limited amount of power.

3. **Give classification of integrated circuits on the basis of application, device used and chip complexity.**
   a) Depending upon the functional utility, the integrated circuits are classified as linear ICs and digital ICs. From the point of view of structural considerations, ICs can be divided as monolithic ICs, thick-thin film ICs and hybrid ICs.
   b) On the basis of the active devices used, the ICs are classified as bipolar ICs and unipolar ICs.
   c) Depending upon the isolation technique used, the bipolar ICs are further classified as p-n junction isolation ICs and dielectric isolation ICs.
   d) Depending upon the type of FET used, the unipolar ICs are further classified as MOSFET unipolar ICs and JFET unipolar ICs.
4. **Differentiate between thin film and thick film technology in 1C fabrication**.

   Generally thick-thin film ICs are used to produce only passive elements. The thick film technology is comparatively easier and inexpensive while the thin film technology is slightly complicated and expensively. The thin film technology produces components with greater precision as compared to those produced by the thick film technology.

5. **What are the different levels of Integration?.**

   Depending upon the number of active devices per chip, there are different levels of integration. When the active devices per chip are less than 100, then it is referred as small scale integration (SSI). When the count of active devices per chip is between 100 to 1000, then it is referred as medium scale integration (MSI). In large scale integration (LSI) ICs, the number of active devices per chip ranges between 1000 to 100,000. When the active devices per chip are over hundreds of thousands, then it is referred as very large scale integration (VLSI). Almost all modem chips employ VLSI technique,

6. **What do you mean by monolithic process?**

   The process in which all the active as well as passive elements or components along with their interconnections are manufactured on a single silicon crystal is known as monolithic process.

7. **What is meant by hybrid ICs?**

   The hybrid ICs are the integrated circuits used for high power application. The hybrid ICs may combine two or more monolithic ICs or combine monolithic ICs with thick-thin film IC in one single package.

8. **What is meant by planar technology?**

   The fabrication of different discrete devices such as diodes, transistors and integrated circuits is carried out by the same technology. The various processes involved in the fabrication of different devices are carried out in a single plane. Hence this is also referred as a planar technology.

9. List basic planar processes involved in IC fabrication.

- Crystal growth and wafer preparation.
- Oxidation.
- Reactive plasma etching.
- Ion implantation.
- Assembly techniques and packaging

10. Why silicon is preferred as basic material for fabrication of semiconductor devices?

- It is comparitively suitable for all applications as junction leakage currents are negligible as the energy band gap is comparitively broader (1.1 eV).
- Silicon devices can be operated upto 200 °C temperature.
- Silicon dioxides are the most wanted for the planar processes.
- The intrinsic resistivity without any dopant is 230,000 Ω-cm hence most suitable for high voltage rectifying devices as well as infrared sensing devices.
- Silicon is cheaper as compared to germanium.

11. What is meant by crystal growth ? How it is carried out?

Basically silicon is the element, found in nature in the form of silica and silicates. It is found abundantly in the nature in the form of silicon dioxide. So this silicon dioxide constitutes almost 20 % of the earth's crust. So obviously one can not start fabricating integrating circuits using silicon dioxide with the earth's crust. The sand can be converted into pure silicon through number of processes. For the fabrication of ICs, the silicon must be in crystalline form. The crystalline form of silicon is the pure silicon with no deflects and no contaminations. For fabrication of ICs a crystalline silicon is needed. The single crystal silicon can be obtained by using method known as crystal growth. The primary method of the crystal growth is Czochralski.

12. Explain briefly about in got slicing?

The slices of the ingot are called wafers and typically the thickness of wafer may very from 0.4 mm to 1 mm. This process is very important as it is necessary to maintain the flat plane and desired surface orientations. The slicing also determines the orientation of the surface. In general, there are two orientations < 100 > and < 111 >. Out of these orientations, the wafers with < 100 > orientations are cut 'on orientation' ; while wafers with < 111 > orientations are cut 'off orientations'.

13. What is epitaxial growth?

In epitaxy a monocrystalline film is formed on the top of a monocrystalline surface. Thus epitaxy is crystalline growth process in which the foundation layer i.e. substrate works as seed crystal.

14. Write down advantages of epitaxial process?

- Because of one or more buried layers, the designer can control the doping in the structure.
- The properties of the epitaxial layer and the bulk material are different.
- Using epitaxial structures the performances of RAMs (Random access memories) and CMOS ICs can be improved.

PART-B

1. (i) Describe the epitaxial growth process.

   (ii) Explain in detail about the photolithography process with neat diagram.

2. Explain how monolithic transistors and diodes are fabricated.

3. Explain the basic processes used in silicon planar technology with neat diagram.

4. Explain how monolithic transistors and diodes are fabricated.

5. Explain with diagram how a JFET is fabricated in monolithic IC implementation.

6. Explain the different isolation techniques**.**

PART-C

1. Explain the basic process involved in the silicon planar technology with neat diagram.

2. Describe metallization process, assembly processing and packaging with diagram.

3. Explain how monolithic transistors and diodes are fabricated.

UNIT-2 CHARACTERSITICS OF OP-AMP

PART-A (2-MARKS)

1. One op-amp has CMRR of 100 dB and other has CMRR of 40 dB. Which you will prefer and why.

The dB value of the CMRR is 20 Log (CMRR). More the value of CMRR, better is the performance of the differential amplifier as it greatly rejects the unwanted common mode signals and produce the output almost proportional to the difference voltage at its input terminals. Thus the differential amplifier with higher CMRR is always preferred so that having CMRR 100 dB is preferred over the other having CMRR of 40 dB.

2. What is an operational amplifier?

The operational amplifier is basically an excellent high gain differential amplifier. It amplifies the difference between its two inputs. Due to its use in performing mathematical operations it has been given a name operational amplifier.

3. Which circuits are commonly used for the various stages of an 1C op-amp.

1. Internal stage : Dual input balanced output differential amplifier.
2. Intermediate stage : Multistage amplifiers without coupling capacitors and single ended
3. Level shifting stage : Various transistor circuits to reduce the d.c. output level.
4. Output stage: Push-pull complementary symmetry amplifier in Class AB operation.

4. List the requirements of the internal stage of IC op-amp.

1.High voltage gain , 2. High input impedance, 3. Two input terminals,4. Small offset voltages, 5. Small offset currents, 6. High CMRR.

5. Why level shifting is required in op-amp?

As coupling capacitors are not used in the intermediate stage of the op-amp, the d.c. biasing voltage level propagates through the chain of the amplifiers. Finally it appears as a significant d.c. component present at the output along with the desired a.c. output. Such a d.c. level distorts the output and limits the maximum output voltage swing. Hence it is necessary to reduce this d.c. level before the output stage for which level shifting circuit is used.

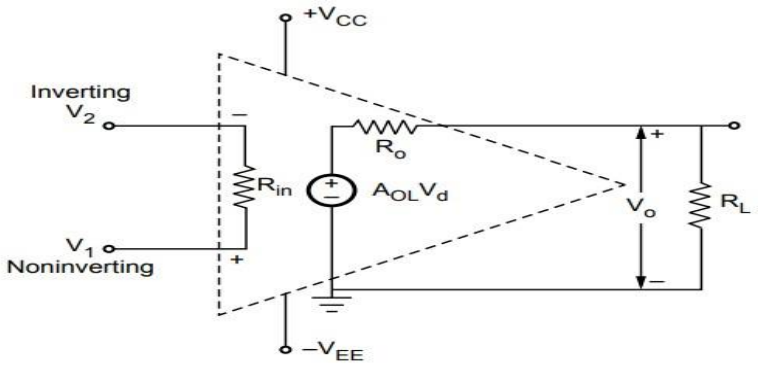
6. List the requirements of the output stage of IC op-amp.

1. High output voltage swing 2. High output current swing 3. Low output impedance.

7. List the important characteristics of ideal op-amp.

1. Infinite voltage gain 2. Infinite input impedance 3. Zero output impedance. 4. Infinite bandwidth 5. Infinite CMRR 6. Infinite slew rate

8. Draw the equivalent circuit of practical op-amp.



9. What is input offset voltage?.

When both the input terminals of the op-amp are grounded, ideally the output should be zero. But practically op-amp produces the small output voltage .To nullify this voltage, some voltage is required to be applied to either of the two input terminals in the particular direction.

10. What is input bias current and input offset current?.

The base currents of the transistors used in the input stage of the differential amplifier are practically finite and the two currents differ in magnitude as perfect matched transistors are not possible in practice. These currents are responsible for the input bias current and input offset current of op-amp.

The input bias current is the average of the two base currents Ib,and Ib2 while the input offset current is the difference between the two base currents Ib,^d Ib2.

11. What is output offset voltage ? Which parameters are responsible to produce it?.

The output voltage present when both the input terminals of the op-amp are grounded is called output offset voltage. The input offset voltage, input bias current and input offset current are responsible to produce output offset voltage.

12. What is slew rate ? State slew rate equation?

The maximum rate of change of output voltage with respect to time is called slew rate of the op-amp.

The slew rate equation is, $S = 2\pi f V_m$ V / sec.

13. What is frequency response of the op-amp?

The plot showing the variations in magnitude and phase angle of the gain of op-amp due to the changes in the input frequency is called the frequency response of the op-amp.

14. What is frequency compensation?

The method of modifying loop gain frequency response of the op-amp so that it behaves like single break frequency response which provides sufficient positive phase margin is called frequency compensation technique.

15. List the methods used to provide the external frequency compensation?

1. Dominant pole compensation
2. Pole-Zero compensation
3. Feed-Forward compensation

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Part B

1. List the six characteristics of an ideal op-amp and explain in detail.
2. Explain and derive the condition for DC-characteristics of an operational amplifier.
3. Explain and derive the condition for AC-characteristics of an operational amplifier.
4. With neat diagram explain the working principle of V/I converter.
5. Draw and Explain the operation of a current to voltage converter.
6. Explain the inverting and non- inverting summing amplifier.
7. Explain the operation of the differential amplifier

Part C

1. With neat figures describe the working of an integrator using op-amp.
2. Derive the expression for output voltage of an practical integrator.
3. Design an op-amp to get the output expression as Vo= $4V_1$-$3V_2$+$5V_3$-V_4 where V_1,V_2,V_3 and V_4 are the inputs.
4. Design a practical differentiator circuit to differentiate signal from 500Hz to 1000 Hz. Assume the input capacitance 0.1 µF, if the input signal is 0.4 sin 2Π (1000) t volts. Express the output voltage.

UNIT-3 APPLICATION OF OP-AMP

PART-A (2-MARKS)

1. Define logarithmic amplifier

Logarithmic amplifier gives the output proportional to the logarithm of input signal.If Vi is the input signal applied to a differentiator then the output is Vo = K*ln(Vi)+l where K is gain of logarithmic amplifier,l is constant.

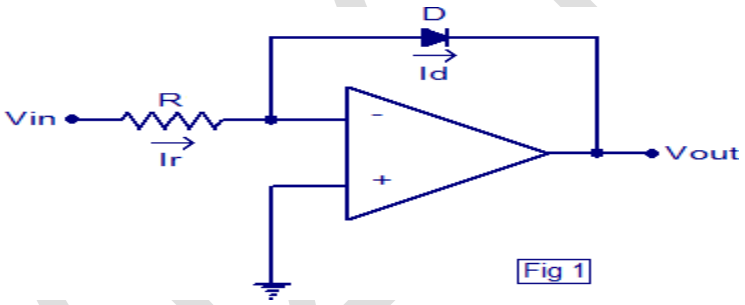
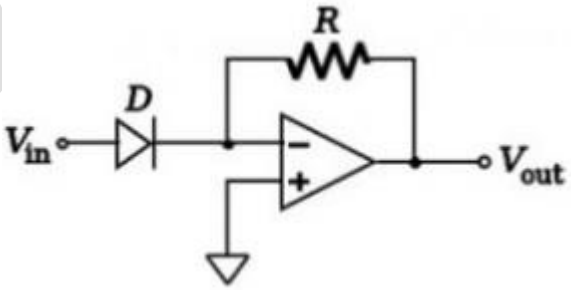


Fig 1

2) What is Anti log amplifier?

Anti log amplifier is one which provides output proportional to the anti log i.e. exponential to the input voltage.If V_i is the input signal applied to a Anti log amplifier then the output is V_o=K*exp(a*V_i) where K is proportionality constant, a is constant.



3) What is an instrumentation amplifier? What are the features of it?

An instrumentation amplifier is a device that amplifies the difference between two input signal voltages while rejecting any signals that are common to both inputs. The in-amp, therefore, provides the very important function of extracting small signals from transducers and other signal sources. Some of their key features include very high common mode rejection ratio (CMRR), high open loop gain, low DC offset, low drift, low input impedance, and low noise

4) List the application of instrumentation amplifier.

Instrumentation amplifiers are used in data acquisition from small o/p transducers like thermocouples, strain gauges, measurements of Wheatstone bridge, etc. These amplifiers are used in navigation, medical, radar, etc.

5) What is an electric filter?

An electric filter is a circuit that selectively allows certain frequencies (or frequency bands) to pass through while attenuating or blocking others, used in various applications like audio processing, power supply conditioning, and radio communications.

6) Why active filters are preferred?

Active filters are often preferred over passive filters because they offer advantages like the ability to provide gain, better signal isolation, and the ability to realize complex filter functions with fewer components and less space, while also being tunable over a wide range.

7) What are the advantages of active filters with op amps?

- More reliability.
- Can eliminates harmonics easily.
- Smaller size.
- Has better resonance stability.
- Voltage regulation is also possible.
- No loading effect.
- Gain can be introduced

8) List commonly used filter.

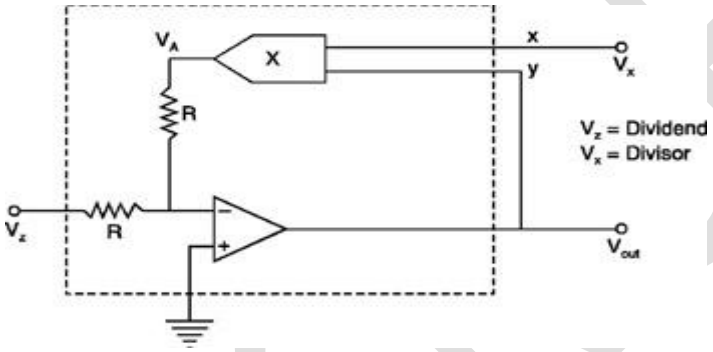
There are four different types of filters:

band-pass (BPF), high-pass (HPF), low-pass (LPF), and band-stop (BSF).

9) Define analog multiplier.

An analog multiplier is a device that takes two analog input signals and produces an output signal that is proportional to the product of the two input signals.

10) Draw the voltage divider using multiplier.



11) What is zero crossing detector?

A zero-crossing detector (ZCD) is a circuit that detects when an alternating voltage or current signal crosses a zero-voltage level, transitioning from positive to negative or vice versa. It's commonly used in power electronics and other applications where timing relative to the AC waveform is crucial.

12) Give any four application of Comparator.

Comparators find use in various applications, including analog-to-digital conversion (ADC), threshold detection, zero-crossing detection, and relaxation oscillators.

13) What is a sample and Hold circuits?

A sample and hold (S&H) circuit is an analog device that captures (samples) the voltage of a continuously varying analog signal and holds (locks) that value at a constant level for a specified time, commonly used to stabilize signals for analog-to-digital conversion.

14) Mention some characteristics of Comparator.

1. Speed operation
2. Accuracy
3. Compatibility of output

PART-B

1. Explain the working principle of Instrumentation amplifier**.**
2. Sketch the logarithmic amplifier circuit using op-amp and explain its operation with suitable expression **.**
3. What is an anti-log amplifier? Discuss the operation of the circuit by giving necessary expression**.**
4. Explain the first order low pass filter with a neat diagram. Drive its frequency response and plot the same
5. Design a second order Butterworth low pass filter having upper cut-off frequency of 1 kHz
6. Design a second order Butterworth low pass filter with cut-off frequency of 2 kHz
7. Explain the operation of a triangular waveform generator using op-amp

PART-C

1.Draw and explain the circuit of a second order low pass filter and drive the transfer function.

2. Explain the following application of OP-AMP

i) Clippers

ii) Clampers

iii) S/H Circuits

3. With aid of neat diagram briefly explain

i) Weighted resistor DAC

ii)R-2R ladder

UNIT 4 SPECIAL ICs.

PART-A (2-MARKS)

1. Name a few applications of an analog multiplier.

Applications of analog multiplier are:

- Frequency doubling.
- Frequency shifting.
- Phase angle detection.
- Squaring.
- Multiplication.
- Division.

2. Define pull time of PLL.

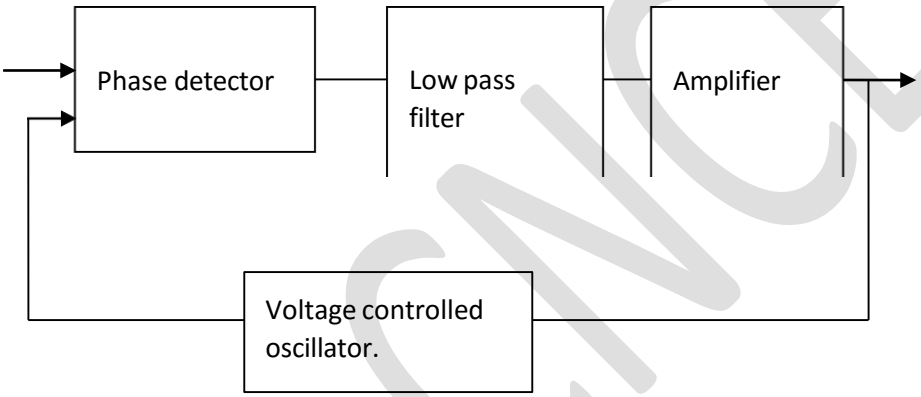
Pull time of a PLL is defined as the total time taken by the PLL to establish lock**.**

3. What are the functional blocks of PLL?

The functional blocks of PLL are

- Comparator
- Low pass filter.
- Error amplifier.
- Voltage controlled oscillator.

4. Draw the functional block diagram of a PLL?

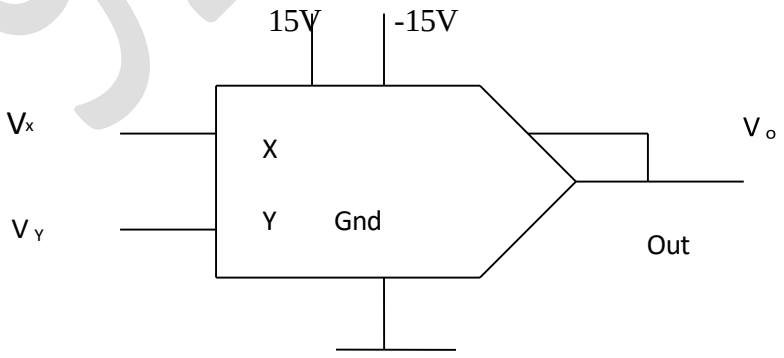


5. Mention a few applications of PLL.

The applications of PLL are:

- Frequency multiplication.
- Frequency division.
- AM detection.
- FM detection.
- FSK demodulator.
- Frequency translation.

6. Give the schematic symbol of multiplier.



7. **Define multiplier**.

The multipliers are defined as circuits used for multiplying two applied signals.
Apart from this, multipliers can be used for phase angle detection, frequency doubling and shifting and for demonstrating the principle of amplitude modulation and demodulation.

8. Give the classification of multiplier?

The classifications of multipliers are:

- One-quadrant multiplier.
- Two- quadrant multiplier.
- Three - quadrant multiplier.
- Four- quadrant multiplier.

9. List the characteristics of multipliers.

The characteristics of multipliers are:

- ❖ Bandwidth.
- ❖ Feed through.
- ❖ Zero train.
- ❖ Quadrant.
- ❖ Scale factor.
- ❖ Scale-factor train.
- ❖ Accuracy.
- ❖ Linearity.

10. What is a trans-conductance multiplier?

- Log-amps require the input and reference voltages to be of the same polarity.
- This restricts log-antilog multipliers to one quadrant operation.
- A technique that provides four quadrant multiplication is called trans-conductance multiplier.

11. What is four quadrant multiplier.

- If both inputs are positive, the IC is said to be a one-quadrant multiplier.
- A two- quadrant multiplier will function properly if one input is held positive and the other is allowed to swing both positive and negative.
- If both inputs are either positive or negative, the IC is called a four quadrant multiplier.

12. List the various multiplier techniques.

The various multiplier techniques are:

- ❖ Logarithmic multipliers
- ❖ Quarter square multipliers
- ❖ Pulse width/height modulation multipliers
- ❖ Variable trans-conductance multipliers.

PART-B

1. Sketch the functional block diagram of IC555 and explain their working principle.
2. With neat diagrams, explain the working of IC555 in mono stable mode.
3. With neat diagrams, explain the working of IC555 in Astable mode.
4. Give the block diagram of IC 566 VCO and explain its operation.
5. Explain the principle and operation of a PLL.
6. Narrate the process of FSK demodulation using PLL
7. Write short notes on Analog multiplier ICs **.**

PART-C

1.Mention briefly the applications of PLL.

2. Discuss the modes of operation and applications of analog multiplier

3. Discuss in detail the various applications of multiplier ICs

UNIT-5 APPLICATION ICs

PART-A

1. What is a voltage regulator?

A voltage regulator is an electronic circuit that provides a stable dc voltage independent of the load current, temperature, and ac line voltage variations.

2. Give the classification of voltage regulators.

The classification of voltage regulators are,

- Series / Linear regulators
- Switching regulators.

3. What is a linear voltage regulator.

→ Series or linear regulator uses a power transistor connected in series between the unregulated dc input and the load and it conducts in the linear region.

→ The output voltage is controlled by the continuous voltage drop taking place across the series pass transistor.

4. **What is a switching regulator?**

→ Switching regulators are those which operate the power transistor as a high frequency on/off switch, so that the power transistor does not conduct current continuously.

→ This give improved efficiency over series regulators.

5. **What are the advantages of IC voltage regulators?.**

The advantages of IC voltage regulators are,

- Low cost
- High reliability
- Reduction in size
- Excellent performance

6. **Give some examples of monolithic IC voltage regulators. Or Give the seven output voltage option available in fixed voltage series regulator?**

Some examples of monolithic IC voltage regulators are,

- 78XX series fixed output, positive voltage regulators (5V,6V, 8V, 12V, 15V, 18V,24V)
- 79XX series fixed output, negative voltage regulators (-5V,-6V, -8V, -12V, -15V, -18V,-24V)
- 723 general purpose regulators.

7. **Define line regulation?**

→ Line regulation is defined as the percentage change in the output voltage for a change in the input voltage.

→ It is expressed in milli volts or as a percentage of the output voltage.

8. **Define load regulation. Or Define load cell.**

→ Load regulation is defined as the change in output voltage for a change in load current.

→ It is expressed in mill volts or as a percentage of the output voltage.

9. What are the different protection circuits used inside the monolithic IC regulator?.

→ Short-circuit protection

→ Thermal overload protection / thermal shut down

→ Current limiting and current sensing

→ Ripple rejection

10. What is meant by current limiting?

Current limiting refers to the ability of a regulator to prevent the load current from increasing above a preset value.

11. What are the limitations of IC723 general purpose regulator.

→ Poor efficiency compared to SMPS

→ Spends more time on high dissipation transitions.

→ Larger transformer size and weight

→ Floating load must be used to get output greater than 37V.

12. **List the types of multivibrators.**

- Astable multi vibrator
- Mono stable multi vibrator
- Bi stable multi vibrator

13. Mention the advantages of Opto-couplers?

The advantages of Opto-couplers are,

→ Better isolation between the two stages.

→ Impedance problem between the stages is eliminated.

→ Wide frequency response.

→ Easily interfaced with digital circuit.

→ Compact and light weight.

→ Problems such as noise, transients, contact bounce, are eliminated.

14. List the characteristics of Opto-coupler?

→ Collector-emitter voltage

→ Forward current and voltage

→ Collector dark current

→ Response time and bandwidth

→ Current-transfer ratio (CTR)

15. What are the three different waveforms generated by IC 8038?

The three waveforms are

→ Square wave

→ Triangle wave

→ Sine wave

PART-B

1. Explain in detail about AD623 instrumentation amplifier.
2. Elaborate with neat diagram, the working of IC 723 as low voltage and high voltage regulators.
3. Discuss in detail on the function generator IC 8038.
4. Explain the working principle of basic linear voltage regulator using op- amp.

PART-C

1. Discuss with neat diagram, the working of IC 7805 regulator as

i. Current source
ii. Boosting regulator output current
iii. IC 7805 regulator as current source.

2. Explain the function of SMPS with neat diagram and waveforms.