

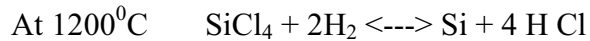
EE: 673-LINEAR INTEGRATED CIRCUITS AND APPLICATIONS

UNIT I – IC FABRICATION

1. Write the basic chemical reaction in the epitaxial growth process of pure silicon.

(A/M-11)

The basic chemical reaction in the epitaxial growth process of pure silicon is the hydrogen reduction of silicon tetrachloride.



2. What are the advantages of integrated circuits over discrete circuits?

(A/M-11, M/J-13)

The advantages of integrated circuits over discrete circuits are

- 1) Miniaturization and increased equipment density
- 2) Cost reduction due to batch processing
- 3) Increased system reliability due to elimination of soldered joints
- 4) Improved functional performance
- 5) Increasing operating speeds
- 6) Reduction in power consumption

3. Why are inductors difficult to fabricate in IC's?

(M/J-13)

IC devices are essentially two dimensional as the depth dimension is very small compared to the lateral dimensions. IC inductors can be made in the form of flat metallic thin films spirals by successive deposition of conduction patterns. Very small values of inductance of the order of nano-henry with low quality factor can only be obtained. For any reasonable inductance value, a three dimensional coil structure is needed to obtain a large number of turns.

4. What is the purpose of oxidation process in IC fabrication?

(A/M-10)

The two main purposes of oxidation process in IC fabrication are

1. SiO_2 is an extremely hard protective coating and is unaffected by almost all reagents except hydrochloric acid. Thus it stands against any contamination.
2. By selective etching of SiO_2 , diffusion of impurities through carefully defined windows in the SiO_2 can be accomplished to fabricate various components.

5. What is meant by parasitic capacitance?

(A/M-10)

In p-n junction isolation technique, there is presence of transition capacitance at the isolating p-n junctions, resulting in an inevitable capacitor coupling between the components and the substrate. These parasitic capacitances limit the performance of the circuit at high frequencies.

6. Compare monolithic IC with hybrid IC.**(N/D-10)**

Monolithic ICs	Hybrid ICs
All circuit components and their interconnections are manufactured on top of a single silicon chip	All circuit components are attached to a ceramic substrate and interconnected by means of either metallization pattern or wire bonds.
Ideal for applications where identical circuits are required in very large quantities.	More adaptable to small quantity custom circuits
Provides lowest per-unit cost and highest order of reliability	Provides highest per-unit cost and lowest order of reliability

7. What is meant by lithography?**(N/D-10)**

Lithography is a process by which the pattern appearing on the mask is transferred to the wafer. It involves two steps:

- i. The first step requires applying few drops of photo resist to the surface of the wafer
- ii. The second step is spinning the surface to get an even coating of the photo resist across the surface of the wafer.

8. List out the basic processes used in IC Fabrication.**(N/D-11)**

The basic processes used in IC Fabrication are

- 1) Silicon wafer (substrate) preparation
- 2) Epitaxial growth
- 3) Oxidation
- 4) Photolithography
- 5) Diffusion
- 6) Ion implantation
- 7) Isolation technique
- 8) Metallization
- 9) Assembly processing & packaging

9. What is meant by ion implantation?**(N/D-11)**

Ion implantation is a technique used to introduce impurities into a silicon wafer. In this process, silicon wafers are placed in a vacuum chamber and are scanned by a beam of high energy dopant ions.

10. List out the various isolation techniques used in IC's.

The various isolation techniques used in IC's are

- 1) p-n junction isolation
- 2) Dielectric isolation

11. List out the steps involved in the preparation of silicon wafers.

The steps involved in the preparation of silicon wafer are

- 1) Crystal growth & doping
- 2) Ingot trimming & grinding
- 3) Ingot slicing
- 4) Wafer polishing & etching
- 5) Wafer cleaning

12. What is meant by metallization?

The process of producing a thin metal film layer that will serve to make interconnection of the various components on the chip is called metallization.

UNIT II - CHARACTERISTICS OF OP-AMP**1. List out the characteristics of an ideal op-amp.****(A/M-10)**

The characteristics of an ideal op-amp are

1. Open loop voltage gain is infinite
2. Input impedance is infinite
3. Output impedance is zero
4. Bandwidth is infinite

2. Design an amplifier with a gain of -10 and input resistance of 10 kΩ.**(A/M-10)**

Since the gain of the amplifier is negative, an inverting amplifier has to be designed,

$$R_1 = 10 \text{ k}\Omega$$

$$R_f = -A_{CL}R_1$$

$$R_f = -(-10) * 10 \text{ k}\Omega = 100 \text{ k}\Omega$$

3. What are the different kinds of packages of IC741?**(A/M-11)**

The different kinds of packages of IC741 are

- 1) Metal can (TO) package
- 2) Dual-in-line package
- 3) Flat package

4. What is meant by thermal drift?**(N/D-11)**

The bias current, offset current and offset voltage change with temperature. A circuit carefully nulled at 25°C may not remain so when the temperature rises to 35 °C. This

is called thermal drift. Often, offset current drift is expressed in $\text{nA} / ^\circ\text{C}$ and offset voltage drift in $\text{mV} / ^\circ\text{C}$. These indicate the change in offset for each degree Celsius change in temperature.

5. Define – Input Offset Voltage.

(N/D-11)

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

6. What is the input impedance of a non-inverting amplifier?

(M/J-13)

Input impedance of a non-inverting amplifier is very high and the output voltage follows the input voltage exactly. Hence the non-inverting circuit is also called voltage follower.

7. Define – Slew Rate

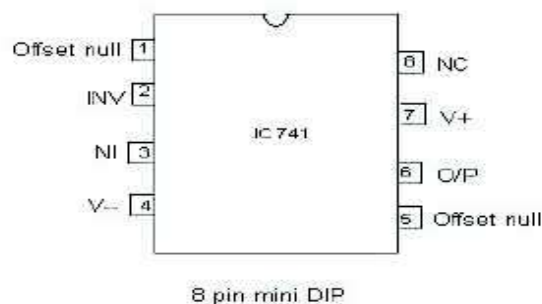
The slew rate is defined as the maximum rate of change of output voltage caused by a step input voltage and is usually specified in $\text{V} / \mu\text{s}$. An ideal slew rate is infinite which means that op-amp's output voltage should change instantaneously in response to input step voltage. Slew rate is an important parameter to be considered for selecting an op-amp for high frequency applications.

8. Define – Common Mode Rejection Ratio (CMRR) of an op-amp

It is defined as the ratio of the differential mode voltage gain to common mode voltage gain.

$$\text{CMRR} = \rho = A_d / A_c$$

9. Draw the pin configuration of IC741.



11. What are the DC characteristics of op-amp?

- 1) Input Bias current.
- 2) Input offset current.
- 3) Input offset voltage.
- 4) Thermal Drift.

12. What are the AC characteristics of op-amp?

- 1) Slew rate.
- 2) Frequency response.

13. What are the features of IC 741?

- 1) No frequency compensation required.
- 2) Short circuit protection provided.
- 3) Offset voltage null capability.
- 4) No latch up.
- 5) Large common mode and differential voltage range.

UNIT III - APPLICATIONS OF OPAMP**1. What is the need for an instrumentation amplifier?****(A/M-11)**

In a number of industrial and consumer applications, the measurement of physical quantities is usually done 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.

2. Define – Conversion Time of ADC.**(A/M-11)**

Conversion time of ADC is defined as the total time required for converting an analog signal into its digital output. It depends on the conversion technique used and the propagation delay of circuit components. The conversion time of a successive approximation type ADC is given by

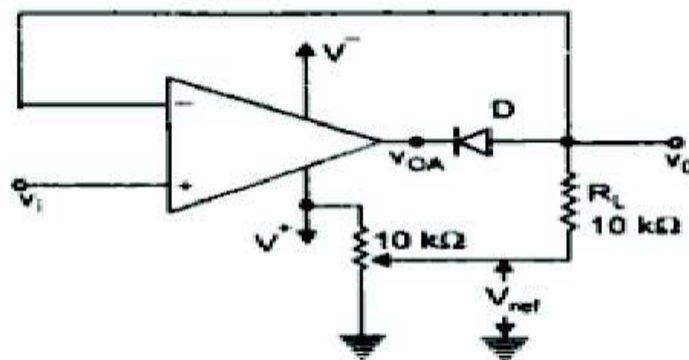
$$T_c = T(n+1)$$

where

$T_c \rightarrow$ conversion time

$T \rightarrow$ clock period

$n \rightarrow$ no. of bits.

3. Draw the circuit diagram of an op-amp based positive clipper.**(N/D-10)**

Positive clipper circuit

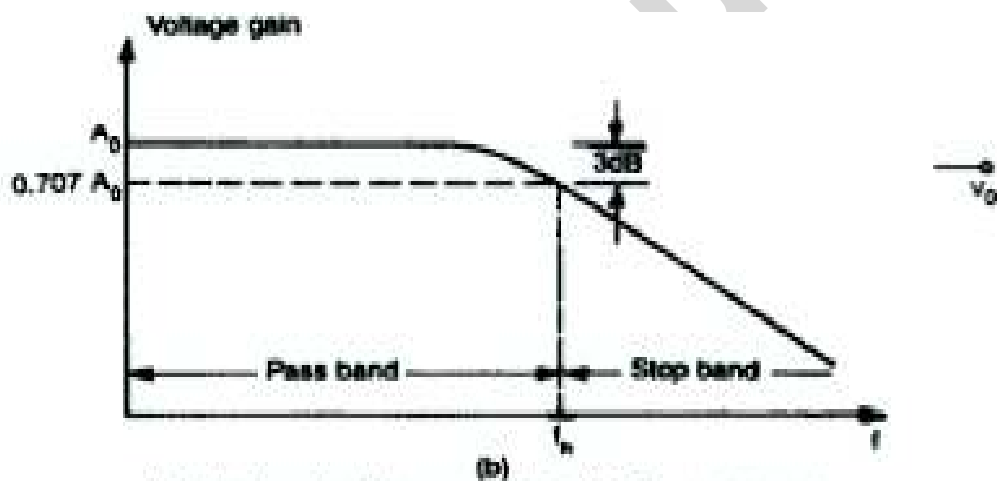
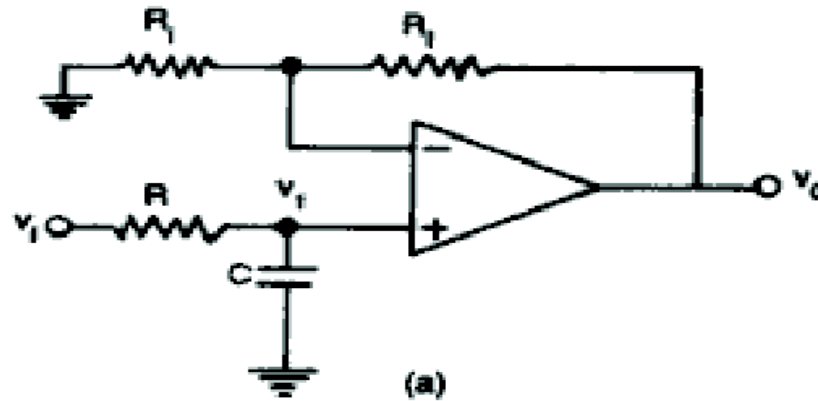
4. Which is the fastest ADC and why?

(N/D-10)

The parallel or flash type ADC is the fastest ADC because it has high speed, as the conversion takes place simultaneously rather than sequentially.

5. Draw the circuit of first order active filter.

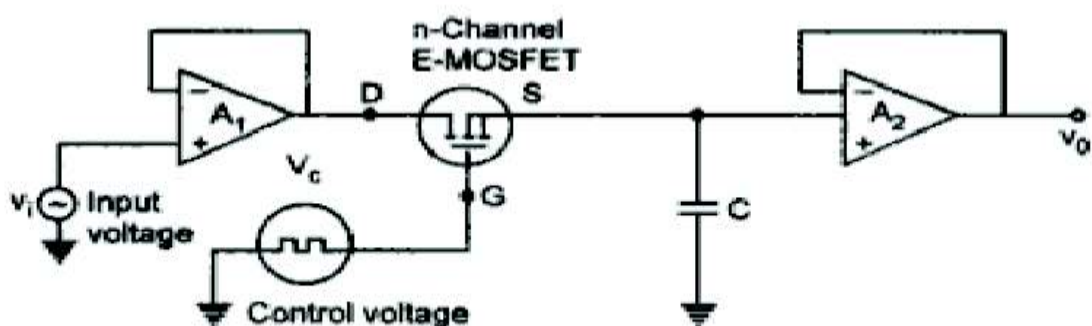
(N/D-11)



(a) First order low-pass filter (b) Frequency response

6. Draw the circuit diagram of sample and hold circuit.

(N/D-11)



Sample and hold circuit

7. List out the applications of analog multipliers.**(M/J-13)**

- 1) In communication circuits for angle, phase or frequency modulation
- 2) In instrumentation and control for the measurement of velocity, position etc.
- 3) For voltage controlled attenuators
- 4) For frequency converters, frequency doublers and frequency shifters
- 5) For squaring and square-root calculations
- 6) In oscillators and various waveform generators

8. Write the significance of lock in range of Phase Locked Loop (PLL).**(M/J-13)**

Once the PLL is locked, it can track the frequency changes in the incoming signals. The range of frequencies over which the PLL can maintain lock with the incoming signal is called lock in range.

9. An 8 bit DAC has a resolution of 20mV/bit. What is the analog output voltage for the digital input code 00010110 (the MSB is the left most bit)?**(A/M-10)**

$$V_o = \text{Resolution} * D$$

Given:

$$\text{Resolution} = 20\text{mV/bit}$$

$$D = \text{equivalent of } 00010110 = 22$$

Solution:

$$V_o = (20 * 10^{-3}) * 22 = 0.44 \text{ V}$$

UNIT IV**1. Why V_{CO} is called voltage to frequency converter.****(N-12)**

The V_{CO} provides the linear relationship between the applied voltage & the output frequency. So it is known as voltage to frequency converter.

2. In an astable multivibrator using 555 timer, $R_A = 6.8 \text{ k}\Omega$, $R_B = 3.3 \text{ k}\Omega$, $C = 0.1 \mu\text{F}$.**Calculate the free running frequency.****(N-12)**

$$\text{Time for one cycle, } T = 0.693(R_A + 2R_B) C$$

$$R_A = 6.8\text{k}\Omega$$

$$R_B = 3.3\text{k}\Omega$$

$$C = 0.1\mu\text{F}$$

$$T = 0.693(6.8 * 10^3 + 2 * 3.3 * 10^3) * 0.1 * 10^{-6}$$

$$= 1.157\text{msec}$$

$$f = \frac{1}{T} = \frac{1}{1.157 * 10^{-3}} = 864.07\text{Hz}$$

3. List out the applications of 555 timer.

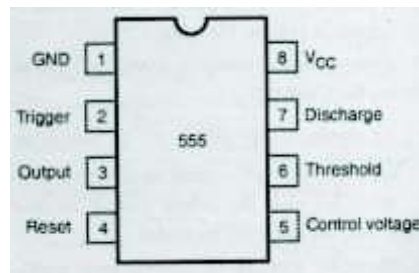
(M-12)

The applications of 555 timer are:

- (1) Astable multivibrator
- (2) Monostable multivibrator
- (3) Frequency divider
- (4) Pulse width modulation

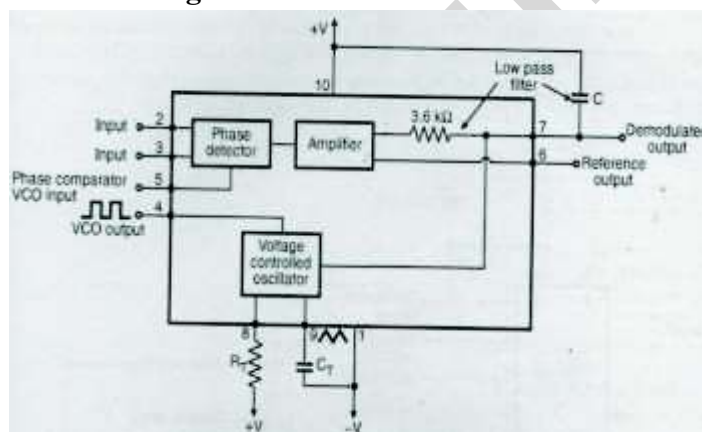
4. Draw the pin diagram of IC 555 timer.

(M-10)



5. Draw the basic block diagram of a PLL IC?

(M-10)



6. What is meant by lock range in a PLL?

(M-09)

When PLL is in lock, it can trap frequency 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.

7. List out the applications of VCO.

(M-11)

The applications of VCO are:

- (1) FM Modulation
- (2) Signal generation
- (3) In frequency multipliers
- (4) Tone generation

8. List out the features of 555 timer circuit.**(N-09)**

The features of 555 timer are:

- (1) It has two operating modes – monostable and astable.
- (2) It has a high temperature stability.

9. List out the applications of Analog multiplier.**(N-08)**

It is used in the following applications:

- (1) In frequency converters
- (2) In communication, in amplitude modulation and in frequency modulation.

10. Define – Pull-in Time

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

UNIT V - APPLICATION IC's**1. List out the important parts of regulated power supply.****(A/M-10)**

The important parts of regulated power supply are:

- (1) Transformer
- (2) Rectifier
- (3) Filter
- (4) Regulator

2. What are the advantages of switch mode power supplies?**(A/M-10)**

The advantages of switched mode power supply are

- (1) Low power dissipation
- (2) High efficiency
- (3) Small size
- (4) High power handling capacity

3. 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.

4. List out the important advantages of opto-couplers.**(A/M-11)**

The important advantages of opto-coupler are:

- 1) Better isolation between the two stages.
- 2) Impedance problem between the stages is eliminated
- 3) Wide Frequency response
- 4) Easily interfaced with digital circuit

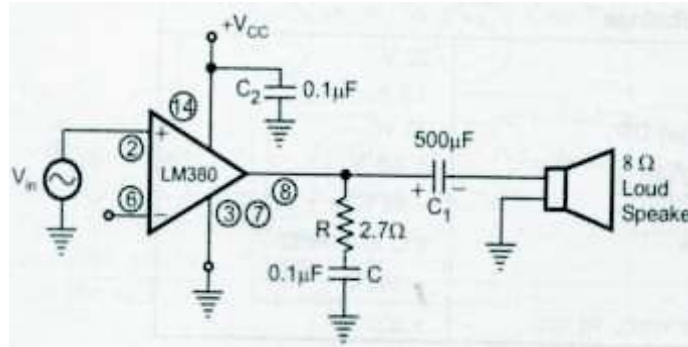
5. What are the advantages of LM 317 regulator over fixed voltage regulator?

The advantages of LM 317 regulator over fixed voltage regulator are:

- 1) Improved line & load regulation by a factor of 10 or more
- 2) Improved reliability for the power supply
- 3) Improved overload protection i.e., greater load current can be drawn over the given operating temperature range

6. Using LM380 draw the circuit for audio power amplifier.

(N/D-10)



7. What are the disadvantages of linear voltage regulators?

(N/D-11)

The disadvantage of linear voltage regulators are:

- (1) The efficiency of linear regulators are very low of the order of 40-50%.
- (2) Large heat sink for the power transistor is required that makes the regulator bulky.
- (3) Bulky transformers are required.

8. What is meant by isolation amplifier?

0

(N/D-11)

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

9. What is the function of voltage regulator?

(M/J-13)

The function of voltage regulator is to provide stable DC voltage for powering other electronic circuits.

10. What is the principle of switched mode power supplies?

(M/J-13)

The SMPS is a series regulator where a pulse generator generates rectangular pulses which are applied to the control terminal of an electronic switch. This switch is turned on and off with the help of the rectangular pulses. Here the average output voltage is dependent on the duty cycle D.