# Assignment:- 7

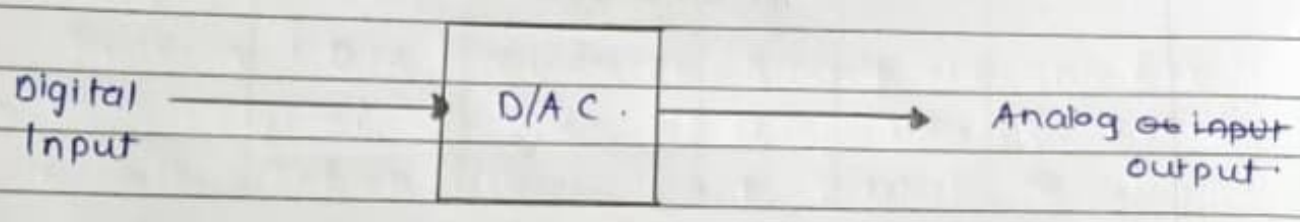
## D/A and A/D converters:-

(1) Explain D/A converter R-2R ladder circuit.

→ A digital to analog converter converts a digital input signal into an analog output signal.

→ The Digital signal is represented with a binary code, which is combination of bits 0 and 1.

→ Block diagram:-



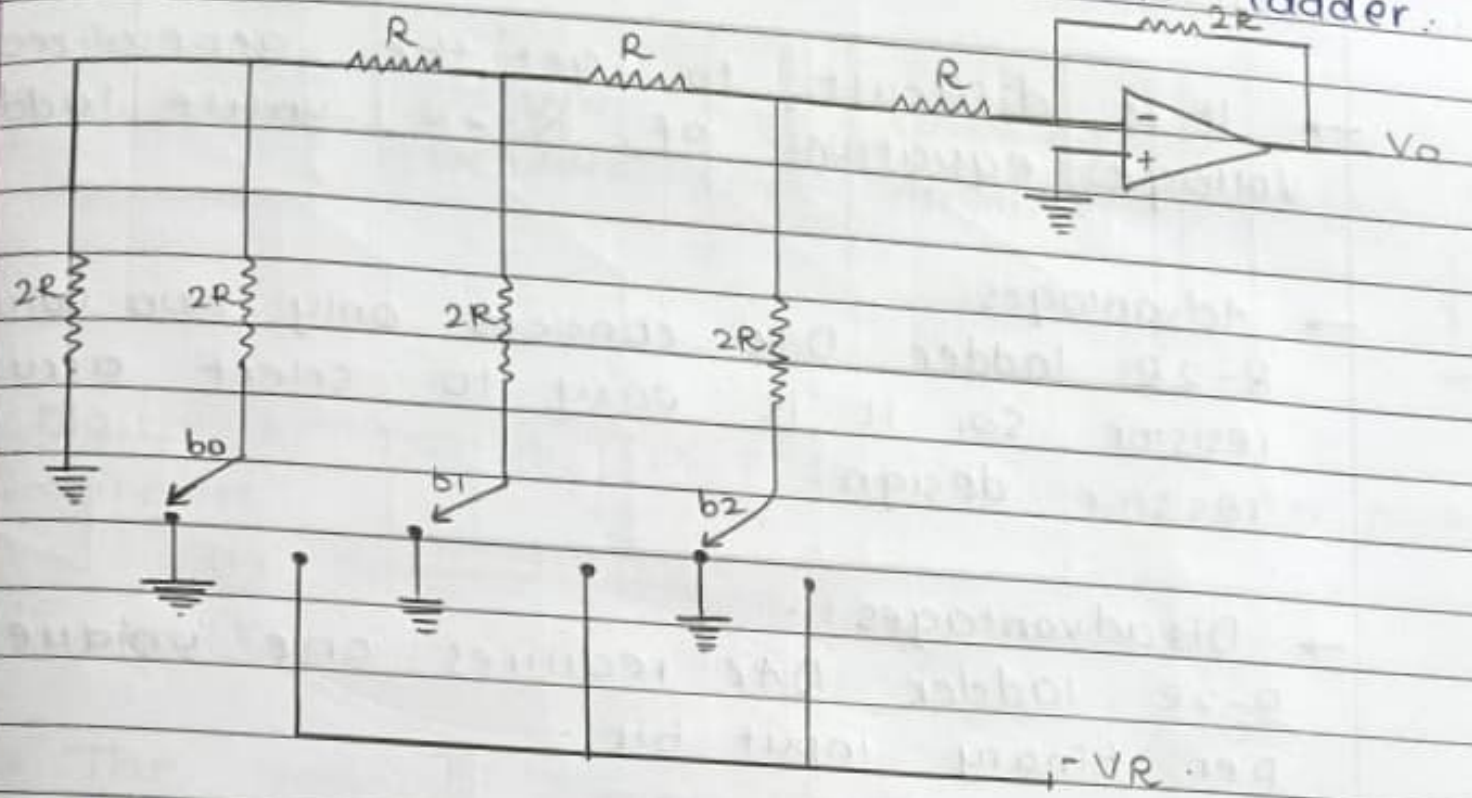

→ R-2R ladder circuit:-

→ R-2R ladder is removed the disadvantage of binary weighted resistor to design more accurate resistor.

→ R-2R ladder is produceds an analog output which is almost equal to digital input signal by using ladder.

→ The R-2R ladder network uses just two resistor value. R and 2R.

→ Circuit diagram of 3-Bit R-2R ladder.




→ This is a 3-bit binary input R-2R ladder so input is $b_2$, $b_1$ and $b_0$.

→ In this circuit diagram, $b_2$ input is denoted by most d significant Bit.

→ bo input is denoted by least significant bit.

→ In this ckt, Digital switch are connected to ground, then corresponding ~~to ground~~ input bits are equal to '0'.

→ In this ckt, Digital switch are connected to the negative reference voltage - VR the

corresponding input bits are equal to '1'.

→ It is difficult to get the generalized output voltage equation of R-2R ~~value~~ ladder.

→ Advantages:-
R-2R ladder DAC consists only two values of resistor so, it is easy to select accurate resistor design.

→ Disadvantages:-
R-2R ladder DAC requires one unique value per binary input bit.

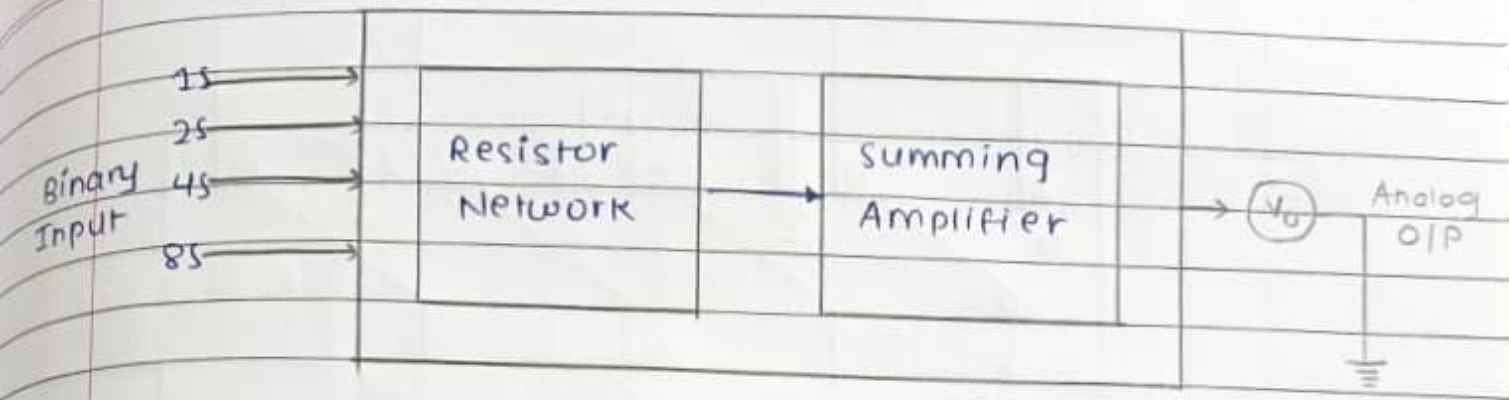
(2) Explain D/A converter binary weighted resistor

→ A weighted resistor DAC produces an analog output. which is almost equal to digital input signal by using binary weighted resistor.

→ Binary weighted Resistor is a type of Data converter which converts a digital binary number into a equivalent analog output number.

→ Block Diagram :-

→




Digital to Analog Converter's converts into two circuits.

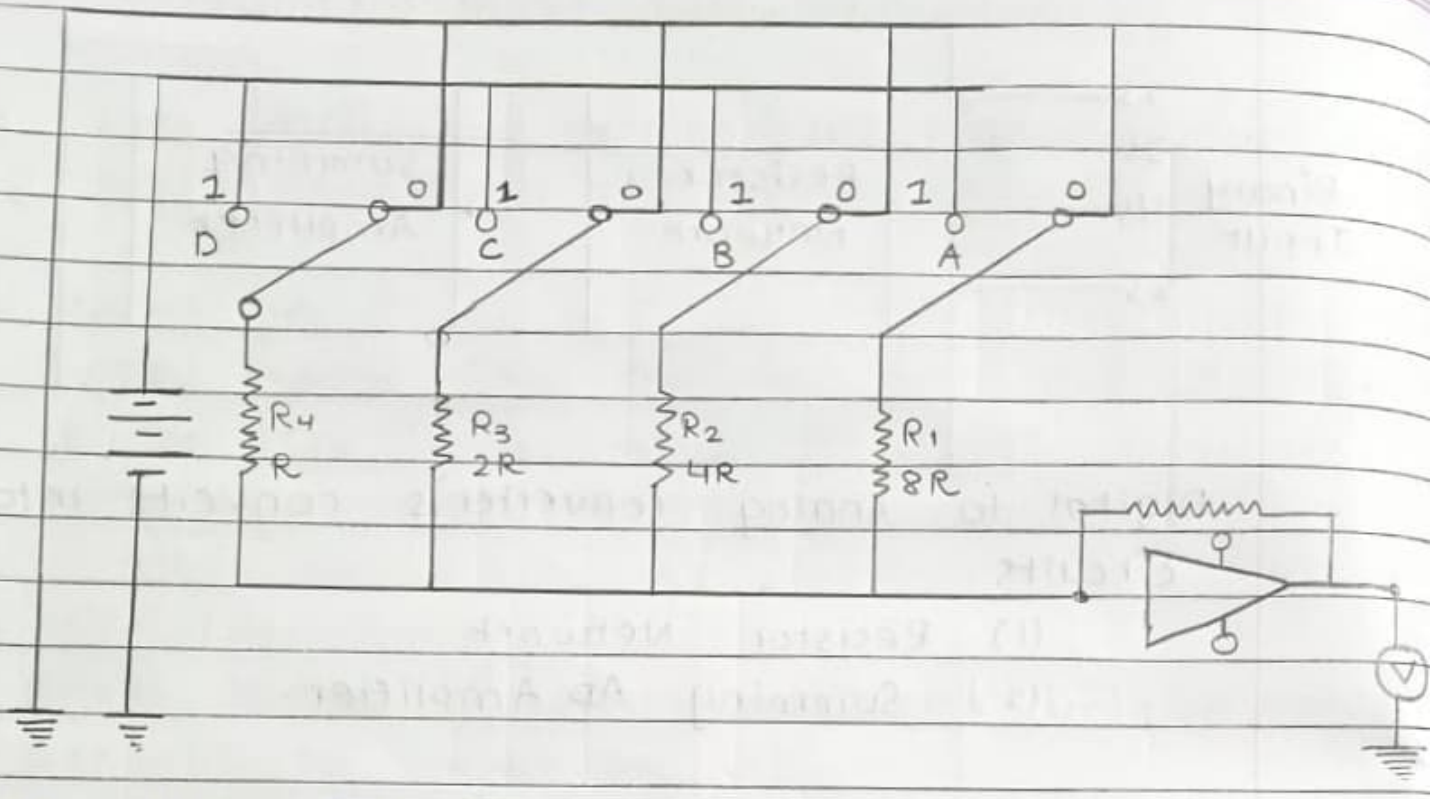
(1) Resistor Network
(2) Summing Amplifier.

→ The analog output voltage is monitered with a voltmeter.

→ In Resistor Network most lowest resistor value is called most significant Bit.

→ In Resistor Network most highest resistor value is called least significant Bit.

→ Circuit Diagram :-




→ In this Ckt diagram, Most lowest Resistor value is $R_4$, so, $R_4$ is a most significant bit in the resistor network.

→ Most highest value is $R_1$. so, $R_1$ is a least significant bit in the Resistor network.

→ When all the Bit are high in the ckt then,

Current for A Bit $I_0 = \frac{V_{in}}{8R}$

Current for B Bit $I_1 = \frac{V_{in}}{4R}$

Current for C Bit $I_2 = \frac{V_{in}}{2R}$

Current for D Bit $I_3 = \frac{V_{in}}{R}$

Total current in the ckt,

$I = I_0 + I_1 + I_2 + I_3$

$= \frac{V_{in}}{8R} + \frac{V_{in}}{4R} + \frac{V_{in}}{2R} + \frac{V_{in}}{R}$

$= \frac{V_{in}}{R} (0.125 + 0.25 + 0.5 + 1)$

$= I = 1.875 \frac{V_{in}}{R}$

→ When Bit are low in the ckt then, Total current $I = 0$.

→ Advantages: Binary weighted Resistor is simple in construction and provides fast conversion.

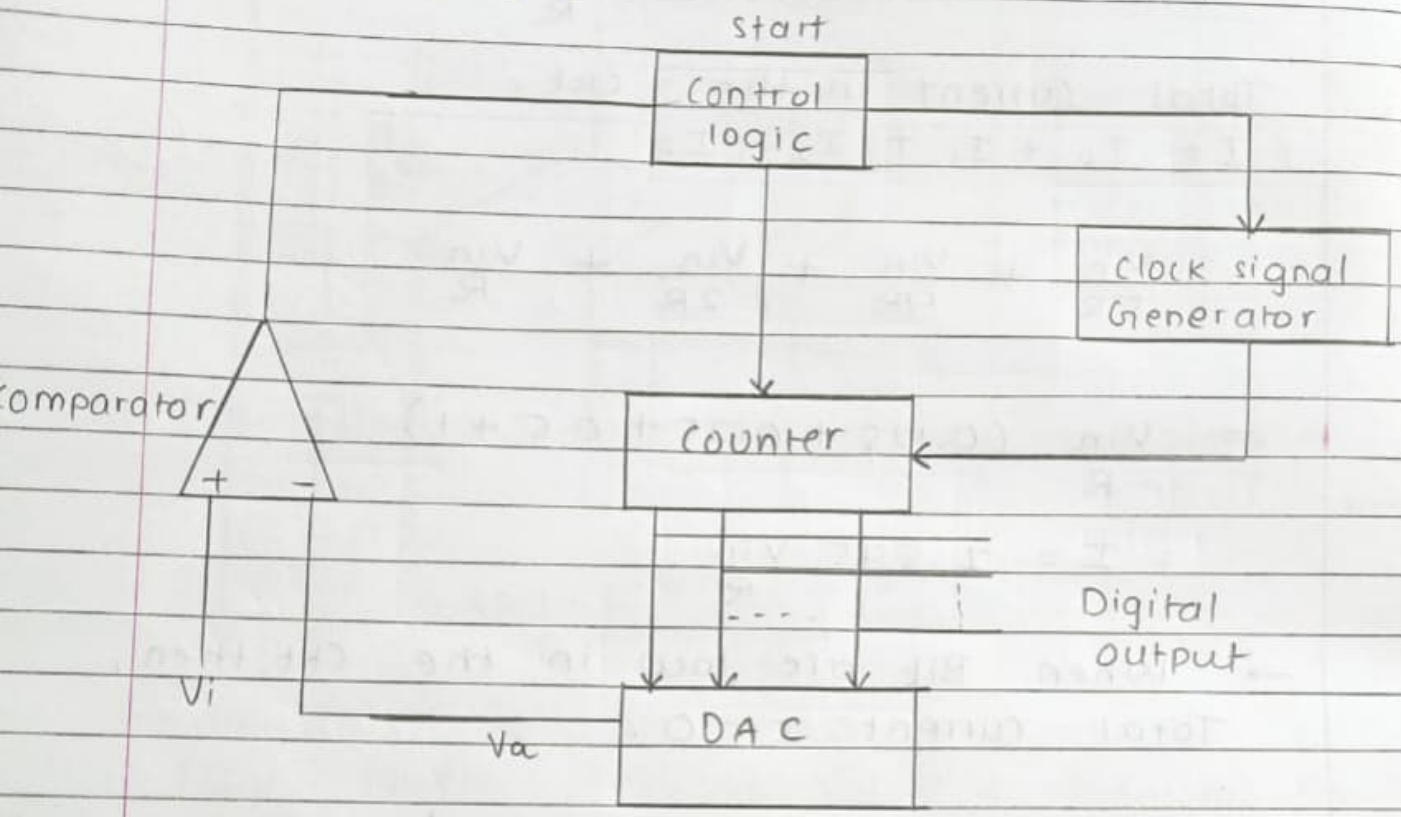
→ Disadvantages:- It is difficult to design more accurate resistor in the resistor Network.

(3) Explain counter type A/D converter.

→ A counter type ADC produces a digital output which is approximately equal to analog input.

→ A counter type ADS produces a digital output using comparator and counter operation.

→ Block Diagram.




→ This counter type ADC consist comparator, counter, control logic, clock signal generator and DAC

→ Working:

The control logic reset the counter and enables to clock signal and send a clock pulse to the counter.

→ Counter gets incremented by every clock pulse and its binary format output applied as an input of DAC.

→ DAC converts the received binary input into the analog output.

→ Comparator compares the analog value Va with external analog input Vi

→ If Vi > Va, then output comparator will generate '1'.

→ If Vi ≤ va, then output comparator will generator '0'.

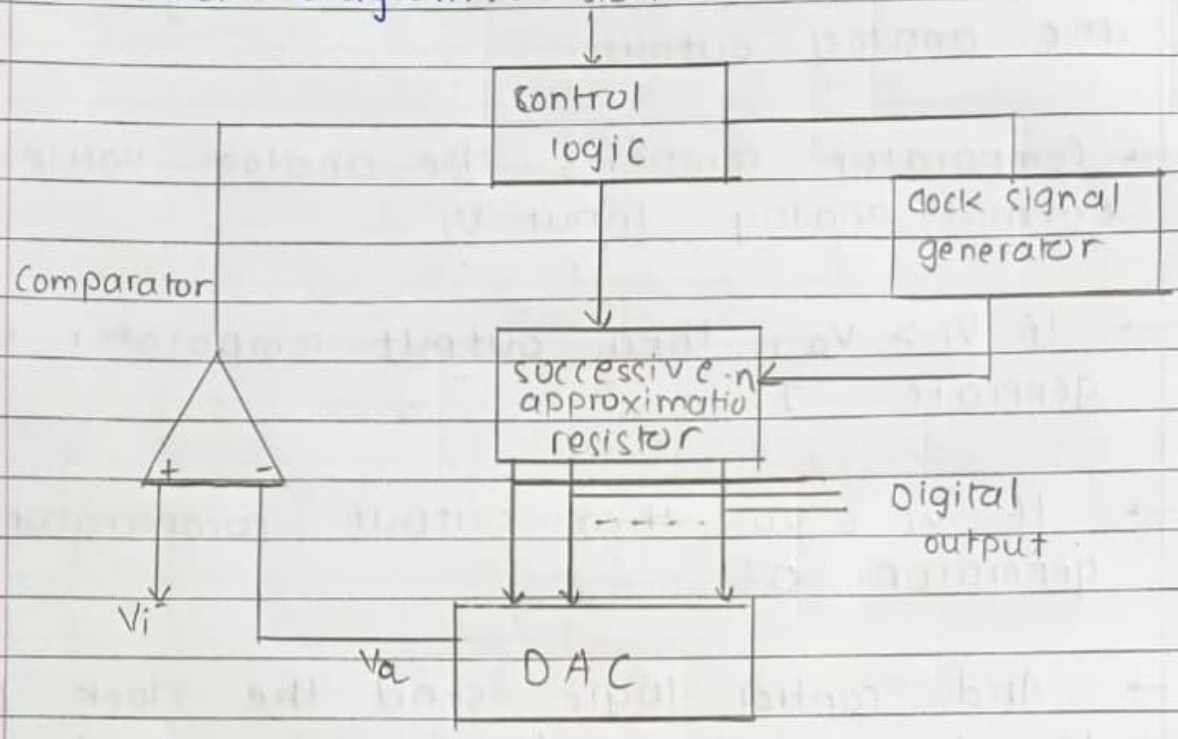
→ And control logic send the clock pulse to the counter and counter will display the digital output.

(4) Explain successive Approximation A/D converter.

→ A successive Approximation ADC produces a digital output which is approximately equal to analog input.

→ A successive Approximation ADC produces a digital output using successive approximation method.

→ Block Diagram :-




→ This Successive Approximation ADC consist comparator, control logic, clock signal generator, Successive Approximation Resistor and DAC.

→ Working :-

Control logic reset the Successive approxima^n resistor and enable to clock signal to send a clock pulse to the Successive register.

→ Successive Approximation Resistor update clock pulse and binary format output applied as a input of DAC.

→ DAC converts the received binary input into the analog output.

→ Comparator compares the analog value $V_a$ with external analog value $V_i$.

→ If $V_i > V_a$ then output comparator generates '1'.

→ If $V_i \leq V_a$, then output comparator generate '0'.

→ After that control logic send SAR with clock pulse and SAR display the digital output.

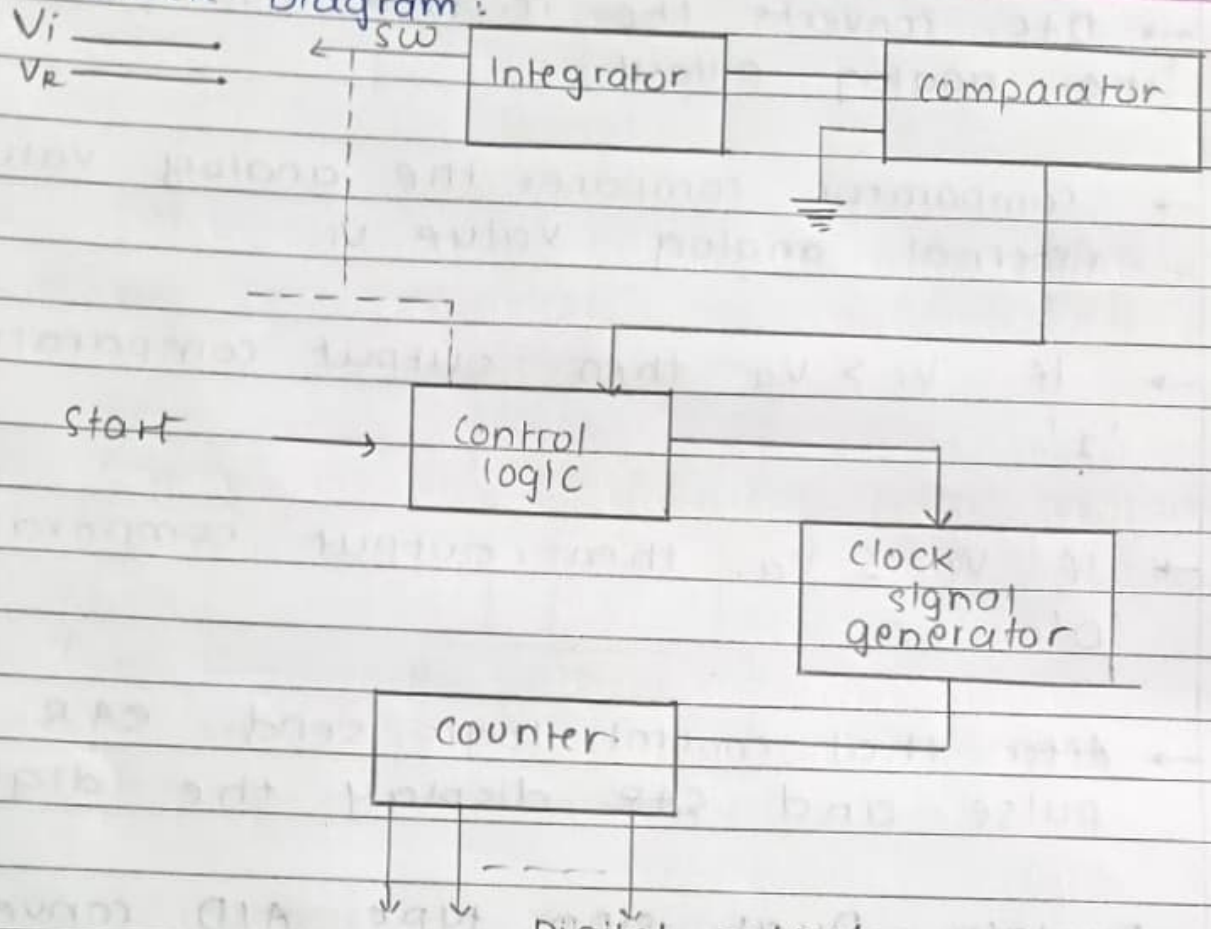
(5) Explain Dual slop type A/D converter.

→ A Dual slope ADC produces an equivalent digital output for a corresponding analog input.

→ A Dual slope ADC produces an digital output using Dual slope Technique.

→

→ Block Diagram:




→ The Dual slope ADC consist Integrator, comparator, clock signal generator, control logic and counter.

→ Working:

→ Control logic pushes the switch SW to connect the external voltage Vi, when it received the start signal.

→ The input voltage is applied to Integrator

→ The output of integrator is connected to the comparator input and second input of comparator connect with ground.

→ comparator compares the integrator output and ground input and produces output to applied the control logic.

→ The counter get increment by clock pulse and control logic push switch sw to connect negative reference voltage.

→ The negative reference voltage applied to Integrator and remove charge until it become zero.

→ The output of Integrator become input of comparator and comparator compare the both input having zero volts.

→ So, comparator send a signal to control logic. Control logic disable to clock signal and holds counter value.

→ The comunter value is display output as a digital signal.

) Explain D/A converter specifications.

→ A digital - to - Analog (D/A) converter (DAC) is an essential component in electronics, converting digital signals into analog signals.

→ Understanding its specifications is important for selecting the right DAC for specific applications.

→ (1) Resolution: Refers to the number of bits the DAC uses to represent an analog output.

→ Higher resolution provides finer granularity in the output signal.

→ (2) Sampling Rate: specifies how fast the DAC can convert digital data into analog signals.

→ Usually measured in samples per second, it determines the maximum frequency of the signal that the DAC can output accurately.

→ (3) Output Range:- The range of analog voltages or currents that the DAC can produces.

→ for example, a DAC with a 0 to 5V output range can generate signals between 0 and 5 volts.

(4) Linearity :- Describes how accurately the output analog signal matches the ideal straight-line response.

→ (5) Monotonicity :- Ensures that the DAC output either increases or stays the same as the digital input increases, without ever decreasing.

→ (6) Settling Time : The time it takes for the DAC output to stabilize within a specified error band after a digital input code is applied.

→ (7) Glitch energy :- Refers to unwanted signal transients that occur when the DAC switches between output levels, especially during significant code changes.

→ Lower glitch energy is preferable for smooth signal output.

(7) Explain the A/D converter specifications.

→ An analog-to-Digital (A/D) converter (ADC) converts analog signals into digital signals.

→ The performance of an ADC is critical in systems like data acquisition, signal processing, and communication systems.

→ The number of bits used to represent the analog signal in digital form is known as resolution.

→ Higher resolution is needed in applications requiring precise measurements.

→ The no. of samples the ADC can take per second, usually measured in samples per second (SPS) or Hertz (Hz).

→ High sampling rates are needed for high-frequency signals, such as in radar systems or digital communication.

→ The range of analog voltages that the ADC can convert to digital values.

→ Suitable for applications where the signal's amplitude varies greatly.

→ The ratio between the magnitude of the signal and the background noise.

→ Important in high-precision audio or instrumentation applications.

→ The actual resolution of the ADC when considering noise and other non-idealities.

→ Important in high-precision applications, where actual performance matters more than theoretical resolution.

(8) Explain Flash Type A/D converter.

→ A Flash type ADC produces an equivalent digital output for a corresponding analog input.

→ A Flash type ADC produces an digital output using priority encoder.

→ This is a 3-bit Flash type ADC circuit diagram

→ The 3-bit Flash type ADC consist a voltag divider network, 7 comparators and a priority encoder.

→ working: The voltage divider Network contains 8 equal resistor. $V_R$ voltage is applied to entire the network.

→ The external input voltage $V_i$ is applied to the non-Inverting terminal of comparator

→ At a time, all the comparator compare the external input with reference voltage.

→ If $V_i >$ voltage drop, then output comparator will generate '1'.

→ If $V_i \leq$ Voltage drop, then output comparator will generate '0'.

→ All the outputs of comparators are connected as the input of priority encoder.

→ This priority encoder produces a binary output.