Department	: CSE
Program	: B.Sc. in CSE
Course No.	: CSE-3215
Course Title	: Microcontroller Based System Design
Examination	: Semester Final
Semester(Session)	: Fall-2020
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27/10/2021

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Ans. to the Ques. No. 2

(a) Inter Integrated Circuit Protocol (I2C):

- It is a serial communication protocol allow to connect multiple slaves to a single master (like SPI) and multiple master controlling single or multiple slaves.

I2C works in the following ways.

- Data is transferred in messages.
- Messages are broken up into frames of data
- Each message has an address frame that containes the binary address of the slave and one or more data frames that contain the data being transmitted.

- The message also includes start and stop conditions, read/write bits, and ACK/NACK bits between each data frame.

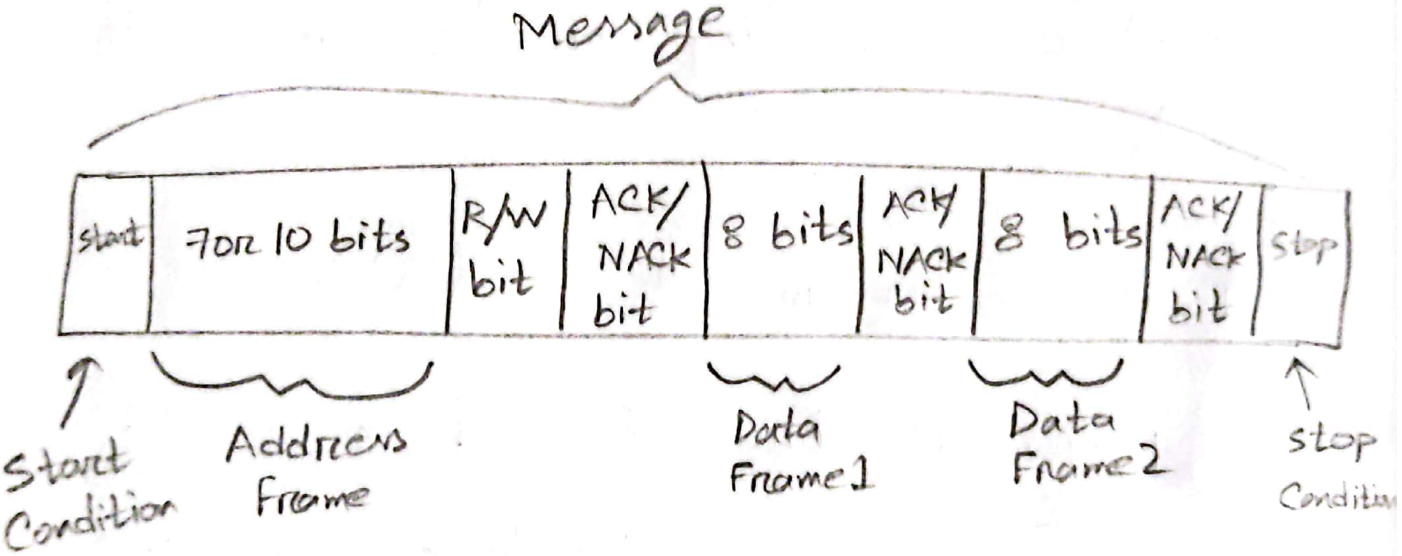

Fig: I2C message

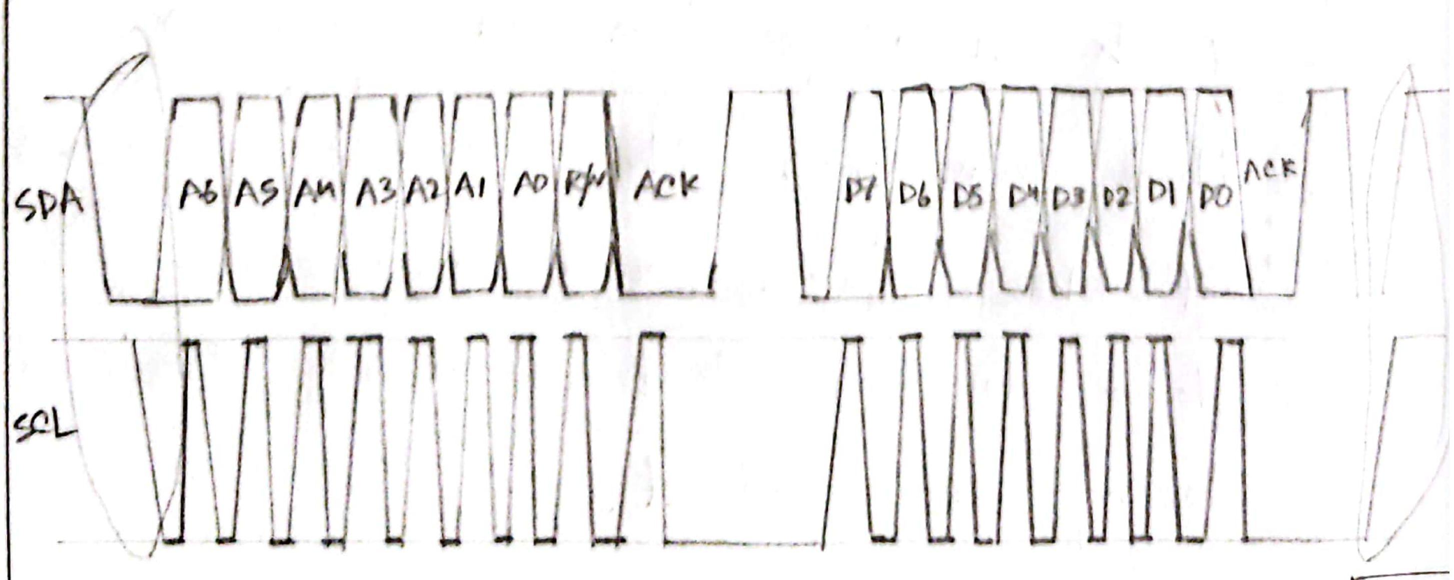

Fig: Diagram of I2C

Start Condition - To initiate the address frame, the master device leaves SCL High and SDA Low. This puts all slave devices on notice that a transmission is about to start.

Stop Condition - Once all data frames have been sent, the master will generate a stop condition. Stop conditions : 0 → 1 (low to high) on SDA after 0 → 1 on SCL.

Address Frame - A 7 or 10 bit sequence unique to each slave that identifies the slave when master wants to talk to it.

Data Frame - After the master detects ACK bit from the slave, the first ~~da~~ frame is ready to be sent. The data frame is always 8 bits long and sent with the MSB first. Each data frame is immediately followed by an ACK/NACK bit to verify that the frame has been received.

Read/Write Bit - The address frame includes a single bit at the end that informes the slave whether the master wants to write data or to receive data from it. Receive data→ R/W is low, Request data → R/W high.

ACK/NACK bit - Acknowladegement bit.

I2C notices slaves to sent data, by addressing.

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Steps of I2C Data Transmission -

1. Master sends start condition to every connected slave by switching SDA 1→0 before SCL 1→0.

2. Master sends each slave the 7 or 10 bit address of the slave.

3. Each slaves compares the address from the master. If address matches, ACK bit is sent by SDA line low for 1 bit.

4. Master sends / receives data frames.

5. After each data frame has been transferred, slaves returns ACK bit.

6. To stop data transmission, master sends stop condition, SCL 0→1 before SDA 0→1.

(b) A watchdog timer is an electronic or software timer that is used to detect and recover from ~~an~~ a system malfunctions. It monitors microcontrollers (MCU) programs to see if they are out of control or stopped operating. Should a MCU program, for some reason, run out of control or stop running, the device may behave erratically, which can cause damage.

To ~~proa~~ proactively prevent such incidents, it falls to the role of the watchdog timer to constantly watch over the MCU to ensure it is operating normally.

The watchdog timer communicates with the MCU at a set of interval. If the MCU does not output accordingly or behave strange, the timer determines that the MCU is malfunctioning and sends a reset signal to MCU.

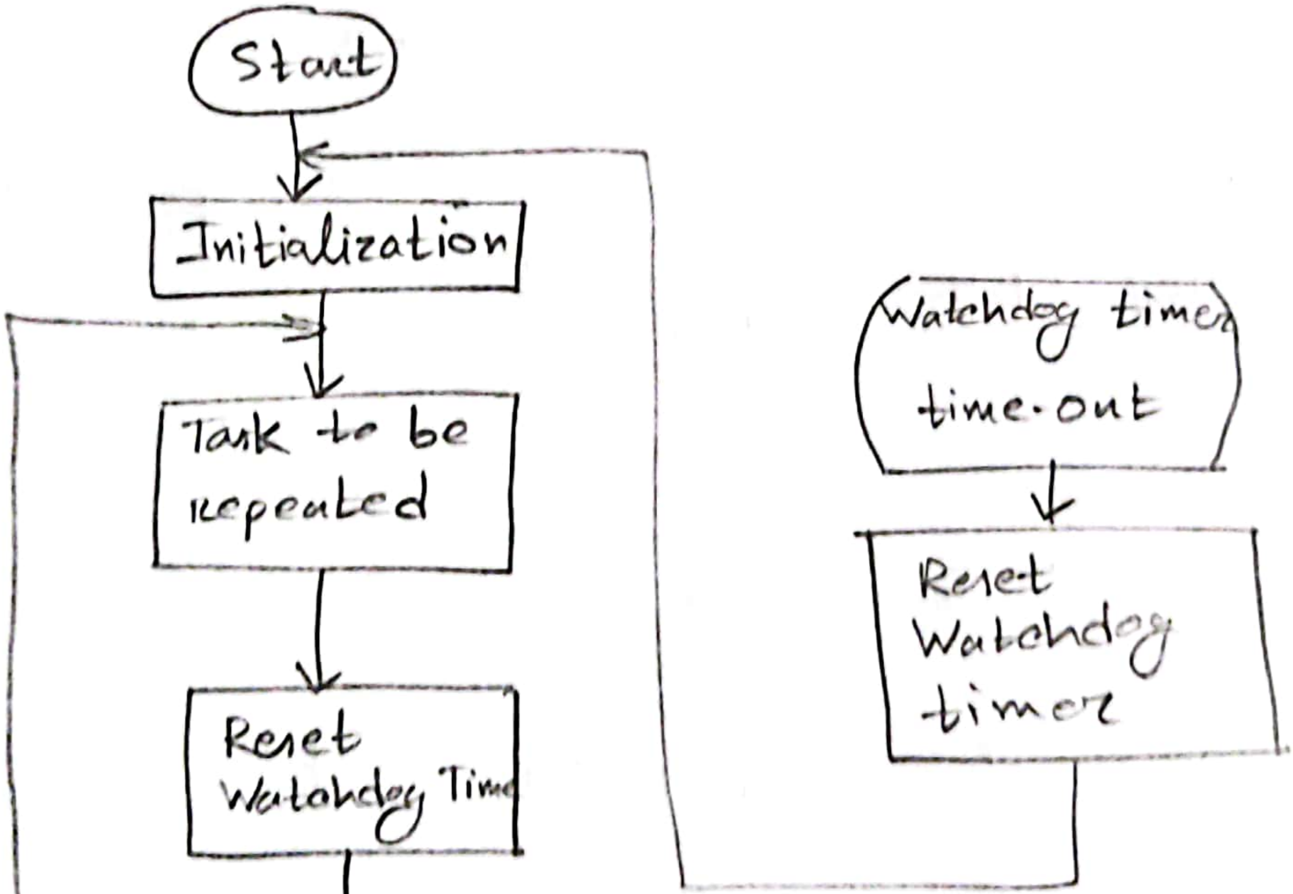

Fig: Flowchart of watchdog timer

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(c)

A DAC is showing 4.5 V output for the input code 1010101

$$\overset{6543210}{\text{Binary Input} = 1010101}$$

$$\therefore V_{out} = V_{ref} \times \sum_{i=1}^{n} \frac{b_{n-i}}{2^i}$$

$$\text{or, } 4.5 = V_{ref} \times \left[\frac{b_{7-1}}{2^1} + \frac{b_{7-2}}{2^2} + \frac{b_{7-3}}{2^3} + \frac{b_{7-4}}{2^4} + \frac{b_{7-5}}{2^5} + \frac{b_{7-6}}{2^6} + \frac{b_{7-7}}{2^7} \right]$$

$$\text{or, } 4.5 = V_{ref} \times \left[\frac{b_6}{2} + \frac{b_5}{4} + \frac{b_4}{8} + \frac{b_3}{16} + \frac{b_2}{32} + \frac{b_1}{64} + \frac{b_0}{128} \right]$$

$$\text{or, } 4.5 = V_{ref} \times \left[\frac{1}{2} + \frac{1}{8} + \frac{1}{32} + \frac{1}{128} \right]$$

$$\text{or, } 4.5 = V_{ref} \times 0.664$$

$$\therefore V_{ref} = 6.77 \text{ V.}$$

FS range $= 12 - 2 = 10V$

$\therefore LSB = \frac{FS\ Range}{2^n} = \frac{10}{2^7} = 0.078\ V.$

(Ans).

Ans. to the Ques. No. 5

(a) Assembly Code:

```
CLR   PSW4
SETB  PSW3      ; Selecting Bank 1
MOV   R1, #50H
MOV   R2, #60H
MOV   R3, #70H

SETB  PSW4      ; Selecting Bank3
MOV   R0, #2H
MOV   R2, #4H
```

After the execution of the program,
then contents of RAM Location :

Bank 1

Address	Content
F	
E	
D	
C	
B	70H
A	60H
9	50H
8	

Bank 3

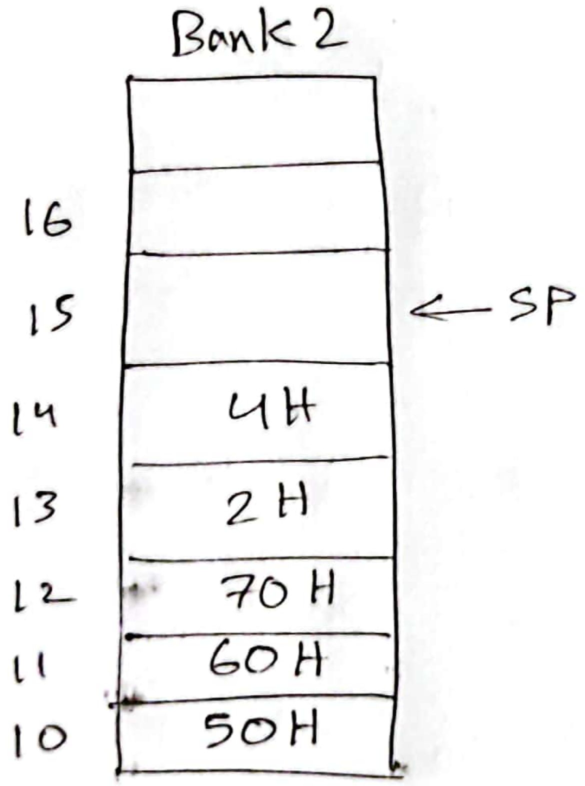
Address	Content
1F	
1E	
1D	
1C	
1B	
1A	4H
19	
18	2H

PUSH instructions -

PUSH 9
PUSH A
PUSH B
PUSH 18
PUSH 1A

Stack Contents:

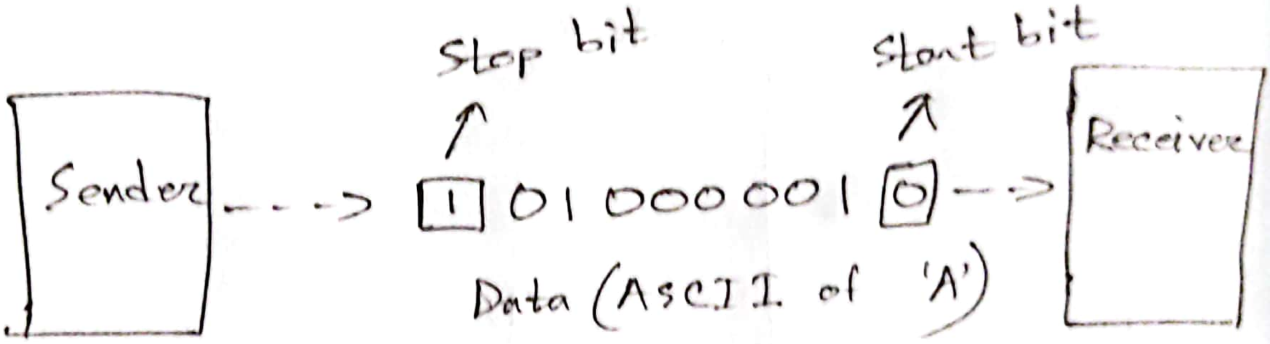
Bank-2 is used for stack memory as Bank-1 is already filled up with data. SP is set to OFH address of the main memory.



(b)

Frame format of sending 'A':

As we are using Asynchronous Serial Mode, the frame format is given below:

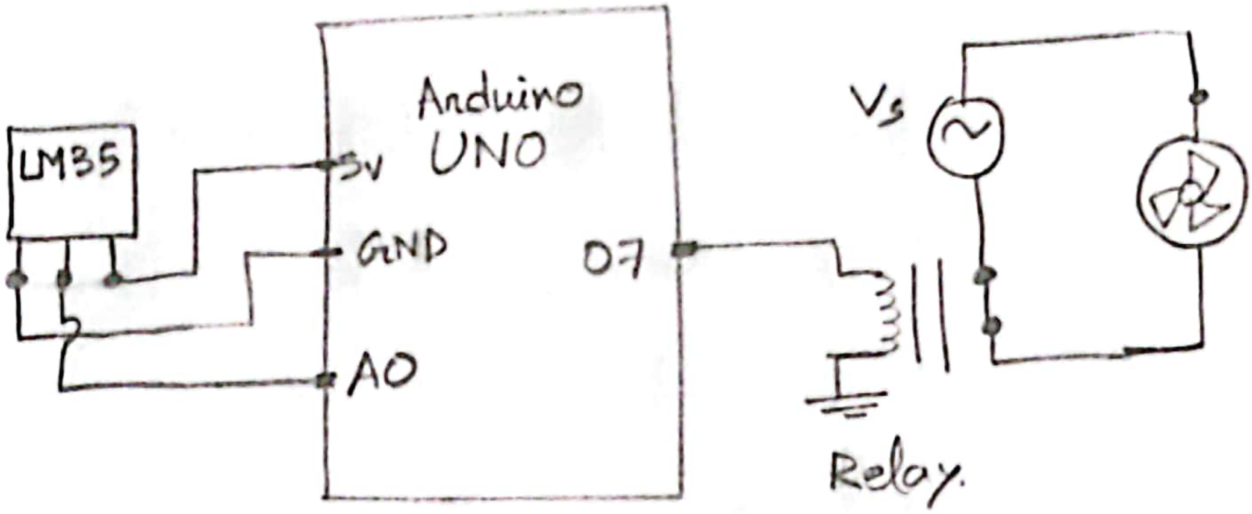


In the format, start and stop bits are used for synchronization. Start bit (0) to alert receiver to the arrival of new data ('A'); Stop bit (1) to let receiver know that the byte is finished.

(a)

Automatic Garden System:

Design:



Code:

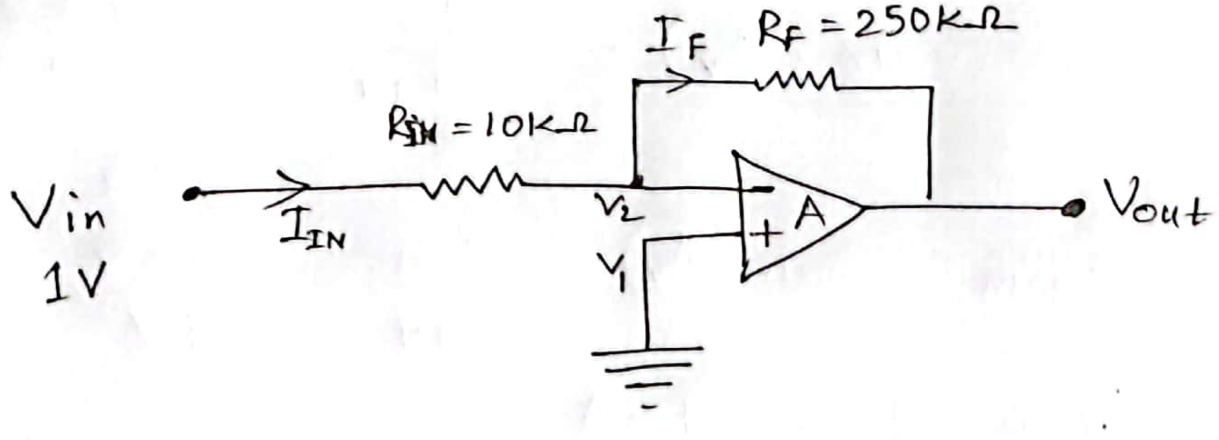
```
~~#include <servo.h>~~
# include <servo.h>
int val;
int LM35Pin = A0;
int RelayPin = 7;
int flag = 0;
```

```
void setup ()
{
    Serial.begin(9600);
}

Void loop ()
{
    val = analogRead (LM35Pin);
    float MV = (val/1024.0)*5000;
    float Cel = MV/10;

    if (Cel >35.0)
    {
        flag =1;
    }
    if (flag)
    {
        digitalWrite (RelayPin, ~~High~~ HIGH);
        delay (2000);
        flag =0;
    }
```

```
else if (flag==0)
{
    digitalWrite(Relaypin, LOW);
}

}
```

Ans. to the Ques. No. 4

(a)



Given,

$R_F = 250K\Omega$, $R_{IN} = 10K\Omega$, $V_{IN} = 1V$

V_2 = Virtual Earth Summing Point
= 0V.

$\therefore I_{IN} = \frac{V_{IN}}{R_{IN}} = \frac{1}{10K\Omega} = 0.1mA$

Since this is an Inverting Amplifier, so no current flows through input terminals.

$\therefore I_F = I_{IN} = I$

$$\therefore V_{out} = -\frac{R_F}{R_{IN}} \times V_{IN}$$

$$= -\frac{250K\Omega}{10K\Omega} \times 1V$$

$$= -25V$$

$$\therefore \text{Gain}(A_v) = -\frac{R_F}{R_{IN}} = -\frac{250K\Omega}{10K\Omega}$$

$$= -25$$

Again, $\text{Gain}(A_v) = \frac{V_{out}}{V_{IN}} = \frac{-25V}{1V} = -25$

Now, $I = 0.1mA$

So, $\frac{V_{IN} - V_2}{R_{IN}}$

$$= \frac{1-0}{10\times10^3}$$

$$= 0.1mA$$

and $\dfrac{V_2 - V_{out}}{R_F}$

$= \dfrac{0-(-25)}{250\times10^3}$

$= 0.1 mA$

So, $I = \dfrac{V_{IN} - V_2}{R_{IN}} = \dfrac{V_2 - V_{out}}{R_F}$

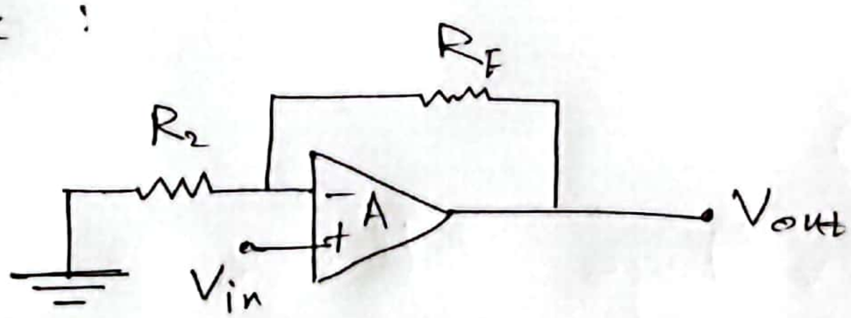
[Proved].

(b)

A voltage follower is an OP-AMP which has a voltage gain of 1. That means the OP-AMP dosen't provide any amplification to the signal. Since the output voltage directly follows the input voltage, it is called the Voltage Follower Circuit.

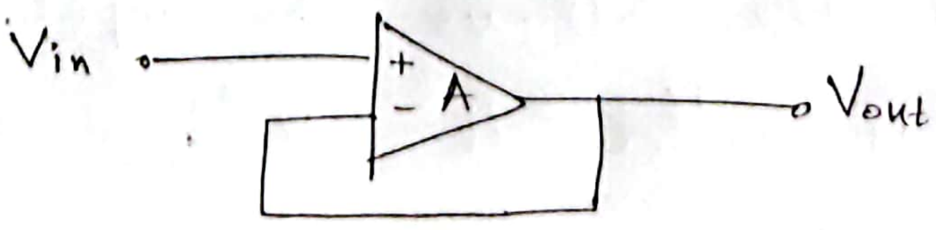
For example, if 105 V goes into OP-AMP as input, the same 105 V comes as output in the other end. The voltage follower act like a buffer, providing no amplification or attenuation to the signal.

Following is the circuit of a voltage follower :



If we put $R_f = 0$ and $R_2 = \infty$, the circuit will have a fixed gain ~~of to~~ of 1.

Thus the circuit becomes:



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Purpose of using a voltage follower in circuits are :

⇒ It is important in voltage divider circuits since it uses the concept of voltage follower circuit.

⇒ It draws a very little current.

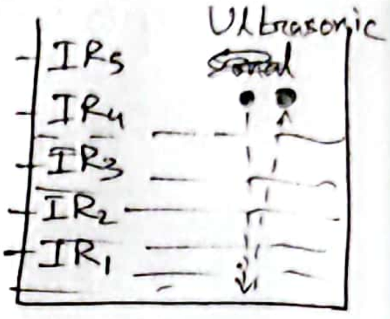
⇒ When voltage input ~~as~~ is needed at ~~ob~~ output result.

(c)

(i) Water Level Measurement in Tank :

I would ~~have~~ utilized the sensors with a setup in the tank, pictured in fig-1. 5 IR's placed in 5 different heights of the tank would help measuring the water level.

If the water level ~~near~~ reaches any particular IR, it will detect water surface as obstacle.



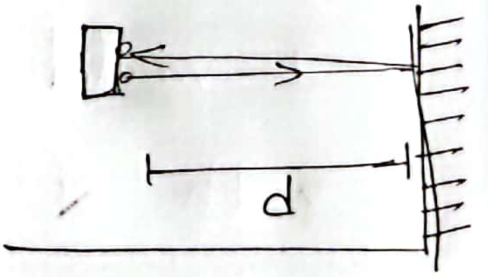
Tank

fig-1

And if we want to know the depth of the tank pricisely, we can use the Ultrasonic sensor. Though it works better only measuring big distances.

(ii) Recognizing Objects in Distance.

Ultrasonic sensors are used to measure distance and recognizing object in distance. It sends an ultrasonic sound which is supposed to travel towards an object.



If any object exists in its path, the sound wave will be reflected. The reflected wave will be caught by the sensor.

If the distance between the surface and sensor is 'd' and it takes 't' time to travel back after reflection and forth. then,

$$2d = vt \ ; \ v = \text{velocity of sound.}$$

$$\text{or, } d = \frac{vt}{2}.$$

If the sensor dosen't get any reflected wave, $t = \infty$ so, $d = \infty$

so, there is no object in front of the sensors.

This mechanism of ultrasonic sensor will help to recognize objects ~~that~~ in a distance as well as measuring the distance.

Ans. to the Ques. No. 1

(a) A microcontroller is a compact integrated circular designed to govern a specific operation in an embedded system.

- It is basically a computer on a chip.
- It includes a processor, memory, I/O and other peripherals on a single chip.

8051 and AVR microcontroller comes under the family of microcontroller

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Difference between AVR and 8051.

8051	AVR
1. It has 8 bit bus width.	1. It has 8 bit bus but some are 32 bit bus width.
2. It is based on Von-neuman architecture.	2. It is based on Modified Harvard architecture.
3. Uses CICS instruction set architecture.	3. Uses RISC instruction based architecture.
4. Uses SPI, I2C, UART, USART communication protocol	4. Uses UART, USART, LIN, CAN, Ethernet, SPI, I2S, communication protocol.
5. Uses ROM, SRAM, Flash memory	5. Uses Flash, SRAM, EEPROM memory.

8051	AVR
6. Speed is 12 clock per instruction cycle	6. Speed is 1 clock per instruction cycle.
7. Its family includes 8051 variants.	7. Its family includes Atmega, Tiny, Xmega, Special purpose AVR.
8. Consumes average power.	8. Consumes low power

(b)

$+7 = 0000\ 0111$

$1\text{'s comp} = 1111\ 1000$

$+1$

$2\text{'s comp} = 1111\ 1001$

$\therefore (-7) = 11111001$

Again, $+4 = 0000\ 0100$

$1\text{'s comp} = 1111\ 1011$

$+1$

$2\text{'s comp} = 1111\ 1100$

$\therefore (-4) = 1111\ 1100$

Now, $(-7) = 1111\ 1001$

$+ (-4) = 11111100$

$(-11) = \boxed{1}\ 11110101$

Value of the status flags are:

* V (Overflow) = 1 (Occurred)

* N (Negative) = 1 (Negative)

* S (sign bit) = 0 ~~(S⊕N)~~ ($S = N \oplus V$)

* P (Parity bit) = 0 (odd no. of 1)

(c) (ii) Here,

ROM memory = 2K bytes
= 2048 bytes

We know,
Each address location in AVR is 2 bytes.

$\therefore$ Total Mem address $= \frac{2048}{2} = 1024$

$\therefore$ Address range = 0000 to 03FF (Hex).

(ii) ROM memory = 64K bytes

= ~~655~~ 65536 bytes

$\therefore$ Total Memory address $= \frac{65536}{2}$

$= 32768$

$\therefore$ Address range = 0000 to 7FFF (Hex).

(Ans).