Table of Contents

User Requirements & Technical Specifications

Design a System that waters a garden. The sprinkler system is turned on at 11am and 6pm and will stay on until the moisture content of the soil is greater than the moisture content desired by the user.

A series of 12 moisture sensors are placed in 6 rows, 2 in each row, and the moisture content of each row is increased independently using the different sprinklers in that particular row only.

Moisture content of the soil is checked every 2 minutes. Depending on the moisture content of the soil, the valves are turned ON or OFF. Moisture sensors are spaced evenly within rows to get the most accurate reading of moisture content.

The Technical Specifications are as follows

- The Soil moisture sensors will take values from 0 - 5V.
- The User provides a required value, the value upto which he wants to water his garden i.e. required value for Soil moisture level.
- The Ultrasonic Water Level Sensor 12ft Model provides an industry standard 4-20 mA output. This output is passed through a conversion circuit (which convert to Volt Range 0-5V) before being passed to ADC0808 - 2
- Since resolution of 8 bit ADC with 5V Vref is 19.53mV, a reading of 1V corresponds to 59h in Digital Value
- The range of Water Level allowed, above which Irrigation System works is 30% of Range of Water Level Sensor (Here, 12ft). Irrigation System does not switch ON below a ready of 30% of the Range (Here, 12ft)
- 100-ASVF RainBird - 1inch Electric Solenoid Valve With Flow Control and Backflow Prevention, is supplied with a 24V AC Source (Frequency 50/60 Hz) for its working.
- 2-2 Way Direct Acting Solenoid Valve works on multiple input configuration. In our implementation, Solenoid Valve is supplied with a 24V AC Source (Frequency 50/60 Hz) for its working.

Placement of Sprinkler and Sensors in Lawn

Legend

- Position of Rotors
- Range of Rotors
- Position of Impact Sprinkler
- Range of Impact Sprinkler
- Position of Drip Emitter
- Range of Drip Emitter
- Position of Rotors
- Range of Rotors
- Position of Impact Sprinkler
- Range of Impact Sprinkler
- Position of Bubbler
- Range of Bubbler
- Range of Soil Moisture Sensor
- Position of Soil Moisture Sensor

Assumptions

- We start the system at 00:00 hours for the first time
- Water pressure is assumed to be enough to water the garden without the use of a pump.
- Power Supply to all hardware components is uninterrupted
- Moisture content is read, and valves are opened/closed after every 2 mins, we assume no damage is done to the lawn during this time.
- Average value is taken to open/close the valves, we assume that the average will not be heavily skewed
- Slight overlapping of the sprinklers of 2 adjacent rows will not lead to over watering.

Components Used

- 8086 Intel Microprocessor
- 8284 Clock Generator

  Used to provide a Clock Frequency of 5 Mhz. We have used this Clock frequency for 8086 and Counter of 8254.

  Used to provide RESET and READY Signals to 8086

- ITead Soil Moisture Sensor (Manual Attached) – 12 Nos.

  The ITead Soil Moisture Sensor is a simple device used for measuring the moisture in soil and similar materials. The two large exposed pads function as probes for the sensor, together acting as a variable resistor. A higher water content in the soil implies better conductivity between the pads, which further implies a lower resistance between the pads and a higher Analog Output Voltage.

  Working Voltage (Vcc) : 3.3V - 5V

  Analog Output Voltage (Vout) : 0V - 5V

  Four –pin connector – V_{cc}, GND, D and A

PIN	SIGNAL	INPUT/OUTPUT	DESCRIPTION
1	Vcc	Input	Input Voltage
2	GND	Input	Ground Signal
3	A	Output	Analog output interface
4	D	Output	Digital output interface

- ADC0808 - 1 & ADC0808 - 2

  12 Soil Moisture Sensors Analog Input, 1 Water Level Sensor Analog Input, 1 User Entered Required Moisture Level DC Source Input, all with voltage varying from 0 – 5 V can be directly connected to IN0-7 Pins of the ADC. These analog inputs are directly compatible with a 8-bit resolution digital output. (ADC0808 Manual Attached)

- 8255 Programmable Peripheral Interface Device - 1

Interfaces ADC0808 - 1 and is responsible for Switching ON/OFF Individual Lane Valves / Backflow Valve / Master Valve via relay mechanism

- 8255 Programmable Peripheral Interface Device - 2

  Interfaces ADC0808 - 2

- 8254 Programmable Interval Timer

  To generate ADC Clock (1Mhz) and 2 Minute TIMER INT – to read the value of 12 Soil Moisture Sensor and 1 Water Level Sensor

- 8259 Programmable Interrupt Controller

  Interrupts from EOC from ADC and TIMER INT from 8254 every 2 Minute. TIMER INT is given higher priority as the timer is the one that enables the ADC0808 for conversion.

- 2716 ROM

  4 nos. Smallest ROM chip available is 2K and as we need to have even and odd bank and ROM is required at reset address which is at $FFFF0_H$ and 00000_H - where there is the IVT

- 6116 RAM

  The smallest available RAM Chip is 2K. We need 4K, owing due to odd and even banks. Hence, 2 nos of 6116 RAM is used stack and temporary storage of data

- LS138 3:8 Decoder - 1 for Memory Decoding
- LS138 3:8 Decoder - 2 for I/O Device Decoding
- LS 373, LS 245, LS 244 and required gates
- WL705 Ultrasonic Water level Sensor (Manual Attached)

  The WL705 uses the latest ultrasonic distance measuring technology for accurate non-contact water level monitoring. The sensors contain a rugged transducer in a stainless steel sealed housing for long life and provide an industry standard 4-20 mA output. This output is passed through a conversion circuit (which convert to Volt Range 0-5V) before being passed to ADC0808 - 2

  Ranges: 0.33 to 3 ft; 0.33 to 12 ft; and 1 to 48 ft

  Resolution: 0.009 in, 0.035 in, and 0.141 in

Power: 3 and 12 ft range: 10 to 30 VDC @70 mA max; 48 ft range: 10 to 30 VDC @40 mA max

Output: 4-20 mA (4 mA is minimum water level and 20 mA is maximum water level)

Operating Temperature: -40 to 158°F (-40 to 70°C)

Connections:
Brown +15-30V DC
Blue Ground
Green 4-20mA output (WL705-048)
Black 4-20mA output (WL705-012 & WL705-003)

PIN	SIGNAL	I/O	Pin Color	DESCRIPTION
1	Vcc	Input	Brown	Input Voltage
2	GND	Input	Blue	Ground Signal
3	Vout	Output	Green	Output in Current (4-20mA), from WL705-048, 48ft Model
4	Vout	Output	Black	Output in Current (4-20mA), from WL705-012, 12ft Model

- Conversion Circuit from 4-20mA to 0-5V

  The Ultrasonic Water Level Sensor provides an output ranging 4-20mA. This output current is proportionally converted to a voltage output ranging 0-5V using a Conversion Circuit

- 6 Nos. 2-2 Way direct acting Solenoid Valves, 1 for each row (Manual Attached)
- 100-ASVF RainBird - 1" Electric Solenoid Valve With Flow Control and Backflow Prevention (Manual Attached)
- Sprinklers

  a. 32SA Pop-up Gear Driven Rotors (Range: 10m)
  b. Adjustable Full-Circle Bubbler (Range 0.6m)
  c. Drip Irrigation Emitters- 8Ltr/hour (Point Impact)
  d. In-Ground Impact Sprinkler (Range: 15m)

Address Map

Memory Map

ROM 1 – 00000_H – $01FFF_H$

RAM 1– 02000_H – $02FFF_H$

I/O Map

8255 #1 – 00_H – 06_H

8255 #2 – 08_H – $1E_H$

8259 – 20_H – 22_H

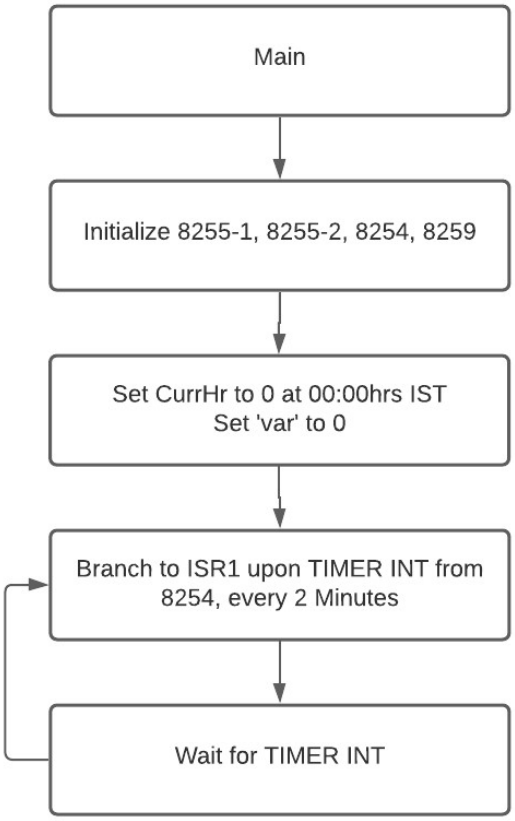
8254 – 24_H – $2A_H$

Design

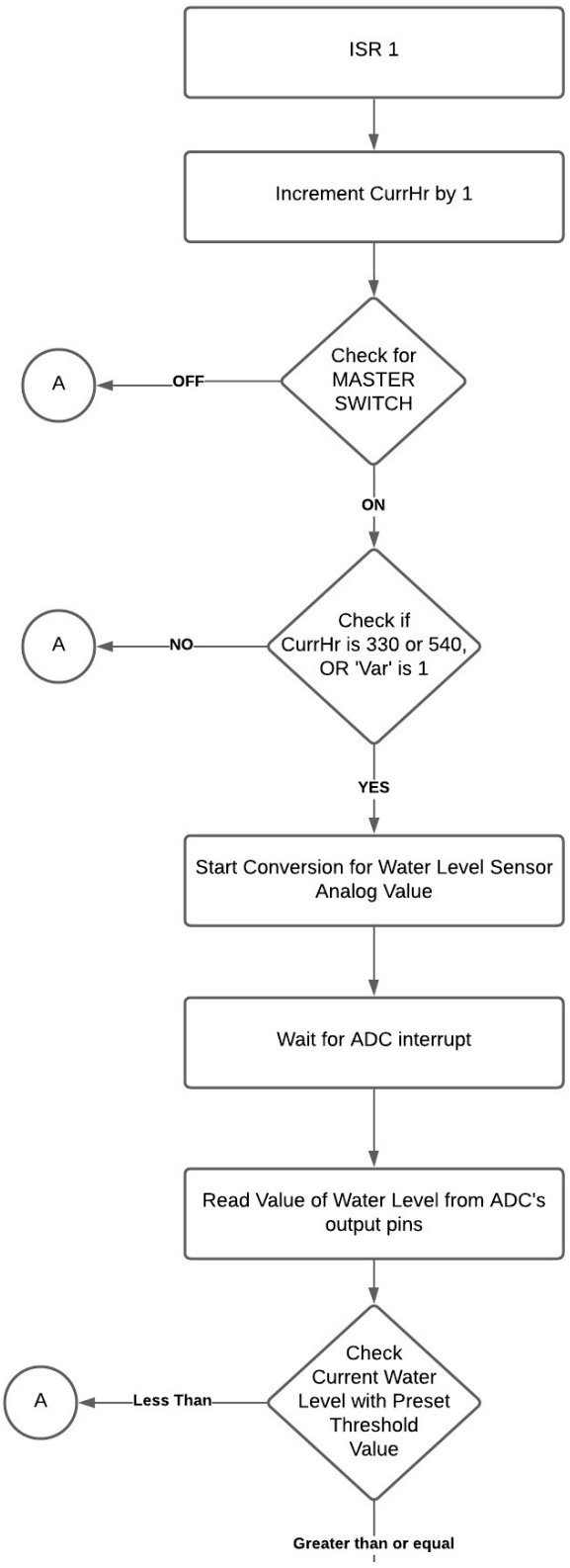
Complete Proteus Design File (.DSN Extension) with Proper Labelling is attached as part of submission.

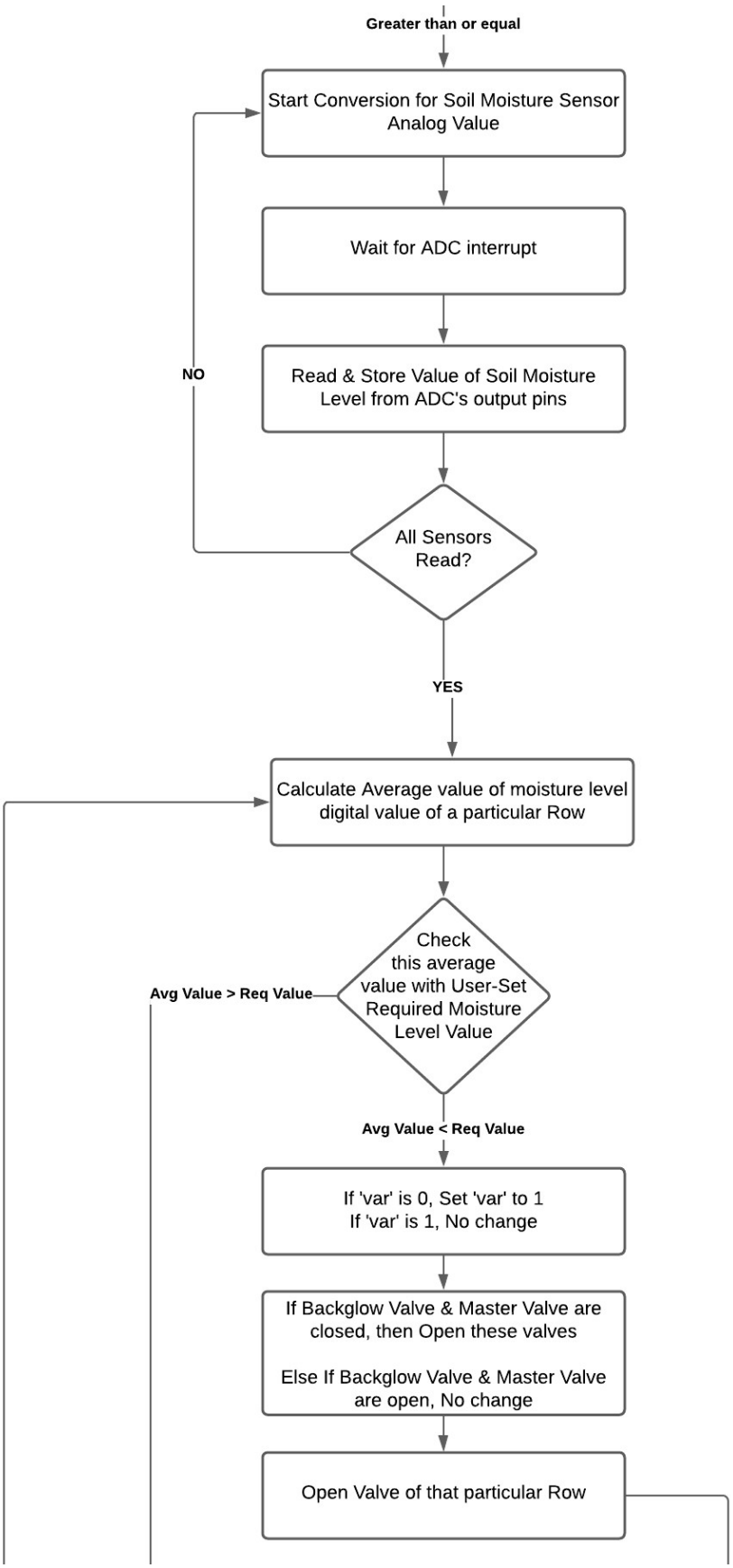
Flow Chart

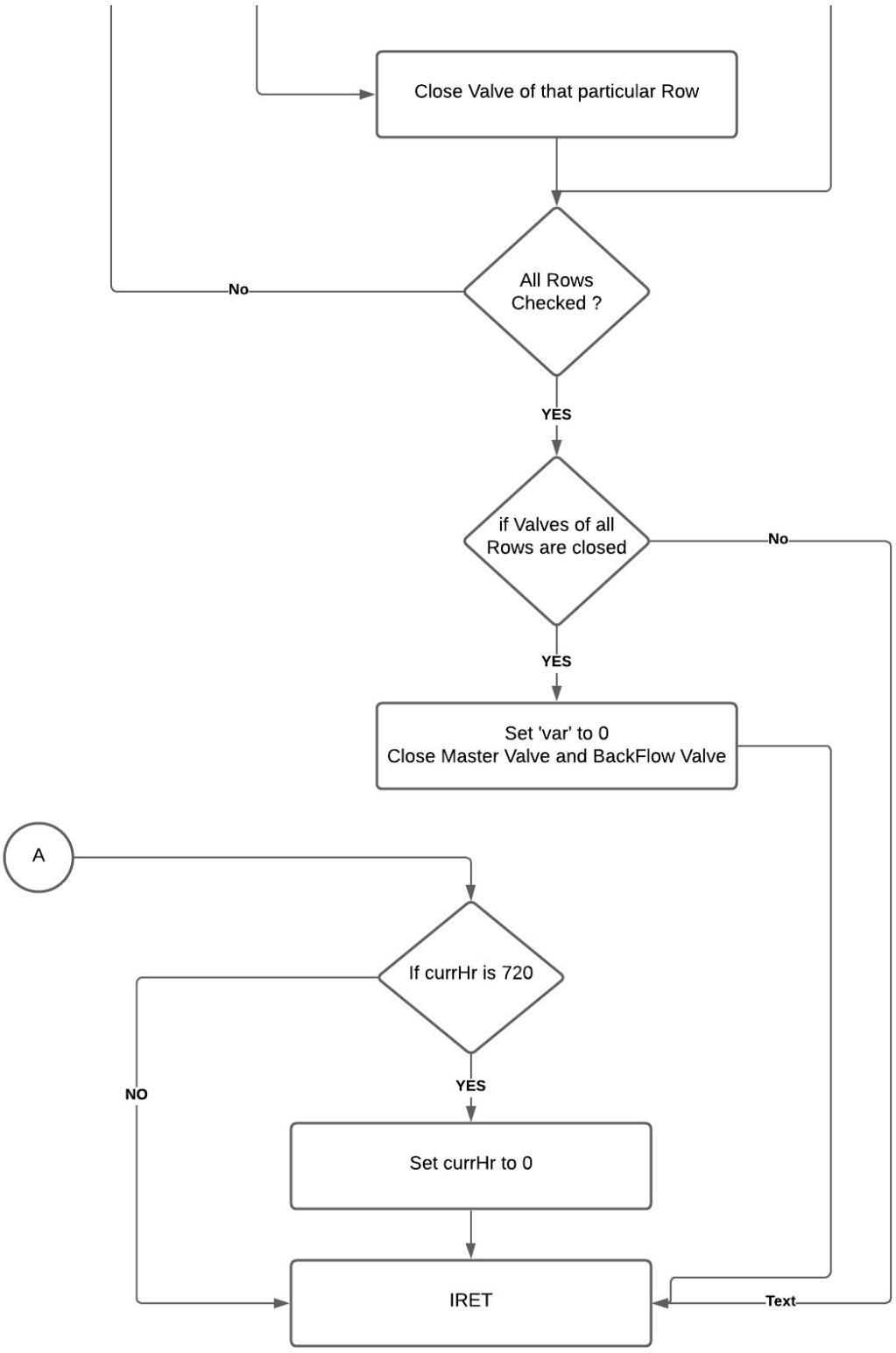
Main Program



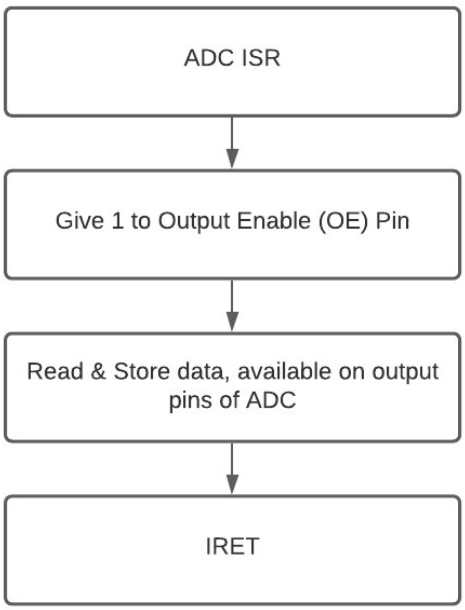
Flow Chart of ISR1



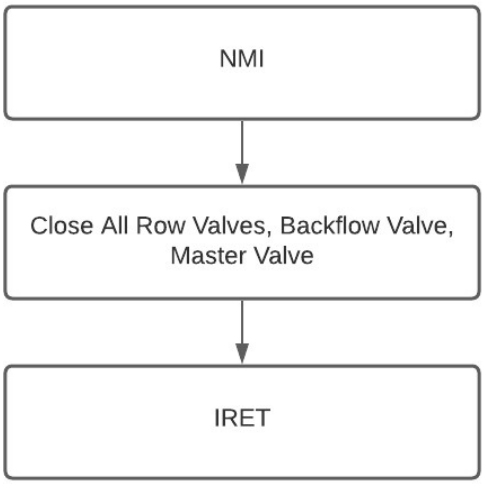

Greater than or equal
Start Conversion for Soil Moisture Sensor Analog Value
Wait for ADC interrupt
Read & Store Value of Soil Moisture Level from ADC's output pins
NO
All Sensors Read?
YES
Calculate Average value of moisture level digital value of a particular Row
Check this average value with User-Set Required Moisture Level Value
Avg Value > Req Value
Avg Value < Req Value
If 'var' is 0, Set 'var' to 1
If 'var' is 1, No change
If Backglow Valve & Master Valve are closed, then Open these valves
Else If Backglow Valve & Master Valve are open, No change
Open Valve of that particular Row


Close Valve of that particular Row
All Rows Checked ?
No
YES
if Valves of all Rows are closed
No
YES
Set 'var' to 0
Close Master Valve and BackFlow Valve
A
If currHr is 720
NO
YES
Set currHr to 0
IRET
Text

Flow Chart of ADC ISR



Flow Chart of NMI



Variations in Proteus Implementation with Justification

1. 8253 Programmable Interval Timer is used in Proteus Design inplace of 8254 Programmable Interval Timer, as 8254 Programmable Interval Timer is not available in Proteus
2. Since 8259 Programmable Interrupt Controller does not work in proteus – 2 minute TIMER INT from 8253 is used as NMI and the EOC INT (which branches to ADC ISR) is replaced by software delay/polling. 8259 is thus not used in Proteus Design File
3. ROM is in 00000h only – as proteus allows to change reset address.
4. Clock is at 2 MHz as the clock generated for 8086 requires a long rise and fall time of clock.
5. ADC has been given a clock of frequency 1MHz, which is less than the max 1.28Mhz it can withstand
6. 2732 ROM is used as 2716 ROM is not available in Proteus.
7. Using a gate-based circuit for memory – does the same as LS138 (For Memory Decoder) here
8. Water Level Sensor – replaced by a potentiometer, whose resistance can be changed from 0 - 1000 Ohm. Voltage Supplied to this Potentiometer is 5V. Hence every 1% change in resistance is equal to a change of 0.05V across the potentiometer. Voltage Output across the potentiometer, which is fed into the ADC Input, varies from 0-5V.
9. Soil Moisture Sensor – replaced by a potentiometer, whose resistance can be changed from 0 - 1000 Ohm. Voltage Supplied to this Potentiometer is 5V. Hence every 1% change in resistance is equal to a change of 0.05V across the potentiometer. Voltage Output across the potentiometer, which is fed into the ADC Input, varies from 0-5V.
10. For Proteus Simulation, 8253 gives an TIMER INT, every 0.09 Seconds.
11. For Time of the Day Check: Instead of 11:00 hrs or 18:00 hrs, which were corresponding to 330d and 540d respectively to be compared with CurrHr, we have compared CurrHr with 2d and 10d
12. A 12V DC Source is supplied to the Relay Mechanism, to trigger the Solenoid of the Valves (Backflow Valve, Master Valve, 6 Row Valves)