Diploma Engineering

Laboratory Manual

(Microprocessor and Microcontroller) (4341101)

[branch / branches with sem]

Enrolment No	
Name	
Branch	
Academic Term	
Institute	

Directorate Of Technical Education
Gandhinagar - Gujarat

DTE's Vision:

- To provide globally competitive technical education;
- Remove geographical imbalances and inconsistencies;
- Develop student friendly resources with a special focus on girls' education and support to weaker sections;
- Develop programs relevant to industry and create a vibrant pool of technical professionals.

DTE's Mission:

Institute's Vision:

Student should write

Institute's Mission:

Student should write

Department's Vision:

Student should write

Department's Mission:

Student should write

Certificate

This is to certify that Mr./Ms ………………………………………………………………. Enrollment No. ………………………. of ……………. Semester of *Diploma in*……………………………………………………………………………………………………….of ……………………………………………………………………… (GTU Code) has satisfactorily completed the term work in course ………………………………………………………………………………for the academic year: …………………… Term: Odd/Evenprescribed in the GTU curriculum.

Place:…………………..

Date: …………………..

Signature of Course Faculty **Head of the Department**

Preface

The primary aim of any laboratory/Practical/field work is enhancement of required skills as well as creative ability amongst students to solve real time problems by developing relevant competencies in psychomotor domain. Keeping in view, GTU has designed competency focused outcome-based curriculum -2021 (COGC-2021) for Diploma engineering programmes. In this more time is allotted to practical work than theory. It shows importance of enhancement of skills amongst students and it pays attention to utilize every second of time allotted for practical amongst Students, Instructors and Lecturers to achieve relevant outcomes by performing rather than writing practice in study type. It is essential for effective implementation of competency focused outcome- based Green curriculum-2021. Every practical has been keenly designed to serve as a tool to develop & enhance relevant industry needed competency in each and every student. These psychomotor skills are very difficult to develop through traditional chalk and board content delivery method in the classroom. Accordingly, this lab manual has been designed to focus on the industry defined relevant outcomes, rather than old practice of conducting practical to prove concept and theory.

By using this lab manual, students can read procedure one day in advance to actual performance day of practical experiment which generates interest and also, they can have idea of judgement of magnitude prior to performance. This in turn enhances predetermined outcomes amongst students. Each and every Experiment /Practical in this manual begins by competency, industry relevant skills, course outcomes as well as practical outcomes which serve as a key role for doing the practical. The students will also have a clear idea of safety and necessary precautions to be taken while performing experiment.

This manual also provides guidelines to lecturers to facilitate student-centered lab activities for each practical/experiment by arranging and managing necessary resources in order that the students follow the procedures with required safety and necessary precautions to achieve outcomes. It also gives an idea that how students will be assessed by providing Rubrics.

Microcontroller is used in almost all the domestic, industrial, consumer goods and other high end products. Automation is used in every field of engineering and microcontroller is inbuilt element of these systems and devices. Diploma engineers have to deal with various microcontroller based systems and maintain them. This course is intended to develop the skills to maintain and solve the application problems related to microcontrollers.

Although we try our level best to design this lab manual, but always there are chances of improvement. We welcome any suggestions for improvement.

Programme Outcomes (POs) :

1. **Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the *engineering* problems.

2. **Problem analysis**: Identify and analyse well-defined *engineering* problems using codified standard methods.

3. **Design/ development of solutions:** Design solutions for *engineering* well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

4. **Engineering Tools, Experimentation and Testing:** Apply modern *engineering* tools and appropriate technique to conduct standard tests and measurements.

5. **Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.

6. **Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

7. **Life-long learning:** Ability to analyze individual needs and engage in updating in the context of technological changes *in field of engineering.*

Practical Outcome - Course Outcome matrix

Course Outcomes (COs):

a. *Identify basic features of microprocessor*
b. *Explain architecture and working of microprocessor*
c. *Illustrate microcontroller internal architecture*
d. *Write and execute assembly language programs(software) for given application*
e. *Interface microcontroller with hardware for given application*

S. No.	Practical Outcome/Title of experiment	CO1	CO2	CO3	CO4	CO5
1.	Explore various blocks of Microprocessor System.	√				
2.	Learn architecture and pin diagram of Microprocessor chip 8085.		√			
3.	Learn architecture and pin diagram of Microcontroller chip 8051.			√		
4.	Use 8051 Simulation tool / Trainer kit for running ASM programs.				√	
5.	Write and execute assembly language programs based on Data transfer Instruction				√	
6.	Develop assembly language programs based on Arithmetic Instructions (e.g. 8 bit Addition, Subtraction, Multiplication, Division)				√	
7.	Develop Assembly Language Programs based on Logical Instructions (And, Or etc.)				√	
8.	Develop Assembly Language Programs based on Branch Instructions				√	
9.	Develop Assembly Language Programs to introduce delay (e.g.1ms Delay) using Timer/Counter				√	
10.	Develop Programs for serial communication				√	
11.	Develop a program to interface LED with 8051					√
12.	Develop a program to interface 7 segment Display with 8051					√
13.	Develop a program to Interface 8 bit DAC and ADC with 8051					√
14.	Develop a program to interface a DC Motor with 8051					√
15.	Develop a program to interface LCD Module with 8051					√
16.	Develop a program to interface a Stepper Motor with 8051					√

Industry Relevant Skills

The following industry relevant skills are expected to be developed in the students by performance of experiments of this course.

a. Identify the relevant microcontroller.
b. Interface various I/O devices with microcontroller.
c. Interpret the program.

Guidelines to Course Faculty

1. Couse faculty should demonstrate experiment with all necessary implementation strategies described in curriculum.
2. Couse faculty should explain industrial relevance before starting of each experiment.
3. Course faculty should Involve & give opportunity to all students for hands on experience.
4. Course faculty should ensure mentioned skills are developed in the students by asking.
5. Utilise 2 hrs of lab hours effectively and ensure completion of write up with quiz also.
6. Encourage peer to peer learning by doing same experiment through fast learners.

Instructions for Students

1. Organize the work in the group and make record of all observations.
2. Students shall develop maintenance skill as expected by industries.
3. Student shall attempt to develop related hand-on skills and build confidence.
4. Student shall develop the habits of evolving more ideas, innovations, skills etc.
5. Student shall refer technical magazines and data books.
6. Student should develop habit to submit the practical on date and time.
7. Student should well prepare while submitting write-up of exercise.

Continuous Assessment Sheet

Enrolment No:

Name: **Term:**

Sr no	Practical Outcome/Title of experiment	Page	Date	Marks (25)	Sign
1	Explore various blocks of Microprocessor System.				
2	Learn architecture and pin diagram of Microprocessor chip 8085.				
3	Learn architecture and pin diagram of Microcontroller chip 8051.				
4	Use 8051 Simulation tool / Trainer kit for running ASM programs.				
5	Write and execute assembly language programs based on Data transfer Instruction				
6	Develop assembly language programs based on Arithmetic Instructions (e.g. 8 bit Addition, Subtraction, Multiplication, Division)				
7	Develop Assembly Language Programs based on Logical Instructions (And, Or etc.)				
8	Develop Assembly Language Programs based on Branch Instructions				
9	Develop Assembly Language Programs to introduce delay (e.g.1ms Delay) using Timer/Counter				
10	Develop Programs for serial communication				
11	Develop a program to interface LED with 8051				
12	Develop a program to interface 7 segment Display with 8051				
13	Develop a program to Interface 8 bit DAC and ADC with 8051				
14	Develop a program to interface a DC Motor with 8051				
15	Develop a program to interface LCD Module with 8051				
16	Develop a program to interface a Stepper Motor with 8051				

Date: ……………

Practical No.1: Explore various blocks of Microprocessor System.

A. Objective:

Microprocessor is the heart of the computer system. It is a small computation unit that is fabricated on a single chip. The components used in building up the chip are transistors, registers, diodes, etc which work together to perform the assigned operation. It accepts the input in binary form, processes them as per the instruction stored in the memory, and performs the arithmetic logic and sequential digital logic operation. From this practical students are able to understand functioning of different blocks in microprocessor.

B. Expected Program Outcomes (POs):

1. Basic & Discipline specific knowledge
7. Life-long learning

C. Expected Skills to be developed based on competency:

This practical is expected to develop the following skills for the industry-recognize competency: **'Demonstrate microprocessor-based system'**

1. Identify the function of various blocks in microprocessor.

D. Expected Course Outcomes(Cos)

Identify basic features of microprocessor.

E. Practical Outcome(PRo)

Explore various blocks of Microprocessor System.

F. Expected Affective domain Outcome(ADos)

1. Follow precautionary measures.
2. Demonstrate working as a leader/ a team member.
3. Follow ethical practices

G. Prerequisite Theory:

Microprocessor is a kind of integrated circuit (IC) unit which combines all the basic functions of a central processing unit (CPU) of the computer. It is a programmable unit that is fabricated on the silicon chip and it consists of an ALU unit, clock, control unit, and register array which accepts the input in binary form (0's and 1's) and delivers the output after processing the input data as per the instructions fetched into the memory unit.

The basic building blocks of this processor are an ALU, register array, and the main control processing unit. The function of the arithmetic logical unit (ALU) is to perform mathematical and logical operations based on the data fetched from the input units or the memory device. The register array is a combination of register and accumulator. The control unit handles the overall processing and flow of data in the computer.

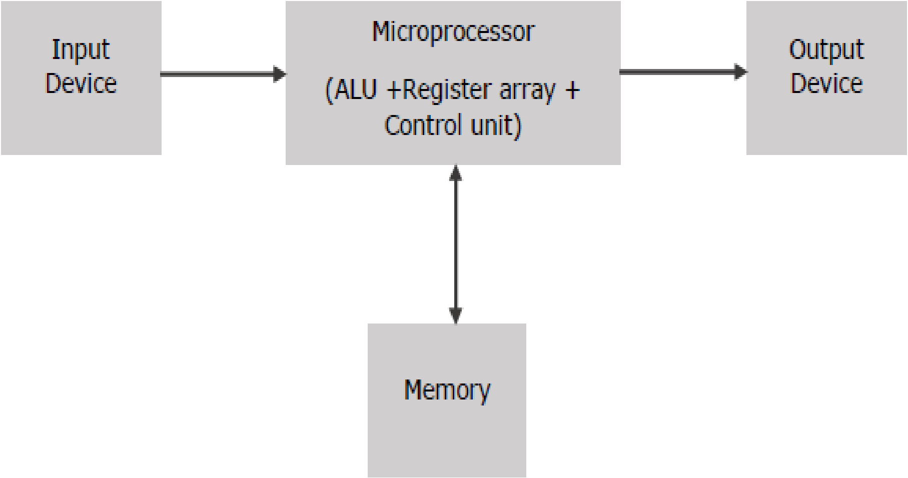

Figure 1 Block Diagram of Microprocessor system

Microprocessor consists of three types of buses: a Databus, a control bus, and an address bus. It is a combination of conductors proposed for the transmission of data containing address and control information to various elements in it. The data bus is bidirectional and carries to and from the memory. The address bus is the unidirectional bus that carries the address of the input or output port from the CPU towards the memory or I/O port. The control bus carries the clock signal, interrupt signal and ready signal and these are bidirectional and denote the state of the process.

H. Experimental set up/ Program Logic-Flow chart:

Faculty will demonstrate the use and function of various blocks in microprocessor system using chart or presentations.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Chart	Block diagram of Microprocessor system	1 No.

J. Safety and necessary Precautions followed:

1. Handle computer system with care.
2. Start and shutdown system with proper procedure.

K. Conclusion:

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L. Practical related Quiz.

1. Write function of ALU.

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2. List types of buses in microprocessor system.

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3. Write the function of Register.

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M. References:

https://www.tutorialspoint.com/microprocessor/index.htm

N. Assessment-Rubrics

Experiment No 1 Explore various blocks of Microprocessor System.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.2: Learn architecture and pin diagram of Microprocessor chip 8085.

A. **Objective:**

8085 is the 8 bit microprocessor available in 40-pin DIP (Dual Inline Package) chip. Microprocessors are applicable to wide range of information processing tasks, ranging from general computing to real time monitoring systems. From this practical students are able to understand different blocks in 8085 architecture, also identify various pins and their functions.

B. **Expected Program Outcomes (POs):**

1. Basic & Discipline specific knowledge
7. Life-long learning

C. **Expected Skills to be developed based on competency:**

This practical is expected to develop the following skills for the industry-recognize competency: **'Demonstrate microprocessor-based system'**

1. Identify the function of given pins.

D. **Expected Course Outcomes(Cos)**

Explain architecture and working of microprocessor.

E. **Practical Outcome(PRo)**

Learn architecture and pin diagram of Microprocessor chip 8085

F. **Expected Affective domain Outcome(ADos)**

1. Follow precautionary measures.
2. Demonstrate working as a leader/ a team member.
3. Follow ethical practices

G. **Prerequisite Theory:**

8085 Architecture

Architecture of 8085 microprocessor is as shown in Fig. 1. In addition to the arithmetic & logic circuits, the ALU includes the accumulator, which is part of every arithmetic & logic operation. General purpose 8 bit registers B, C, D, E, H & L can be used singly or can be used as 16 bit register pairs BC, DE, HL. 8085 has 8 bit flag register which contains S (sign flag), Z (zero flag), AC (auxillary carry flag), P (parity flag) & CY (carry flag). These flags are used to show the status of the microprocessor before/after an operation. The Program Counter is a 16 bit register that is used to control the sequencing of the execution of instructions. This register always holds the address of the next instruction. The Stack Pointer (SP) is also a 16-bit register that is used to point into memory.

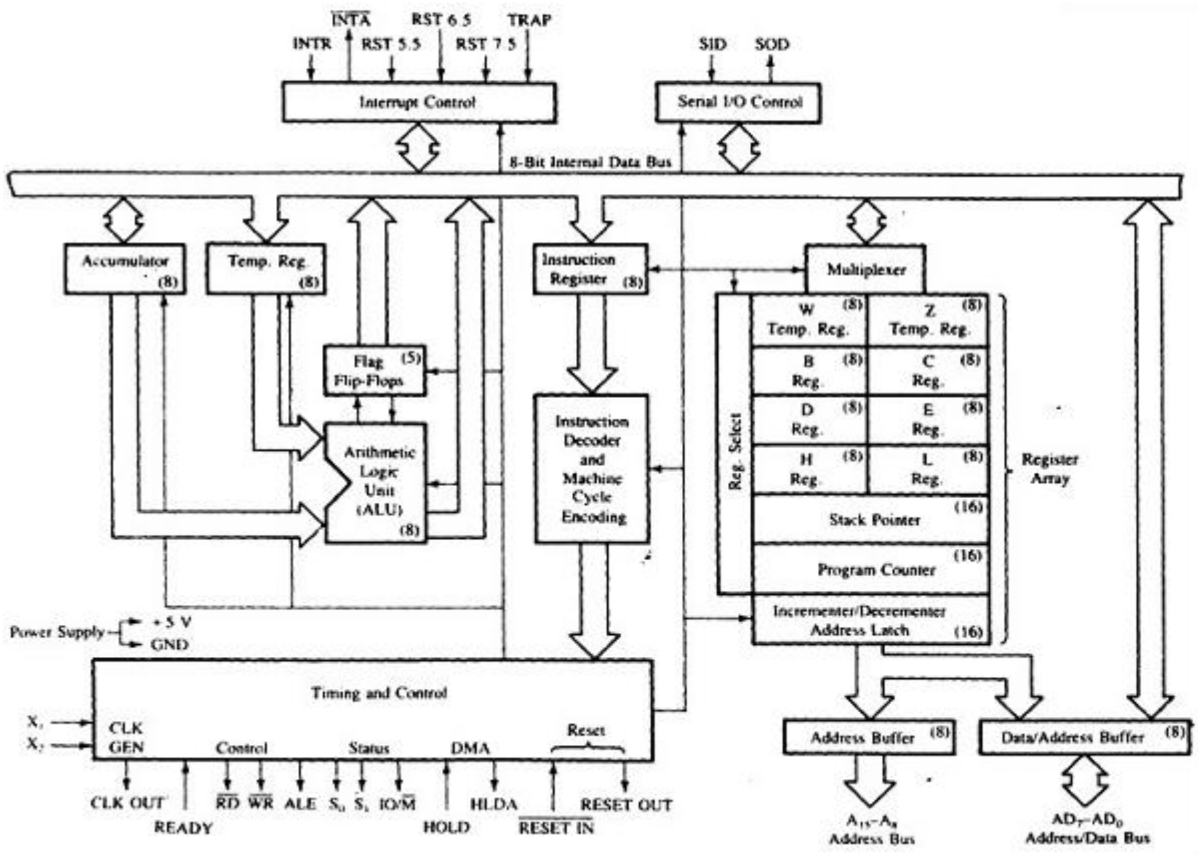

Figure 2 8085 Microprocessor Architecture

Pin diagram of 8085 is shown in fig. 2. The pins of an 8085 microprocessor can be classified into seven groups.

Address bus (A15-A8): It carries the most significant 8-bits of memory or I/O address.

Data bus (AD7-AD0): It carries the least significant 8-bit address and data bus.

Control and status signals: These signals are used to identify the nature of operation. There are 3 control signal and 3 status signals. Three control signals are RD, WR & ALE. RD signal indicates that the selected I/O or memory device is to be read and is ready for accepting data available on the data bus. WR signal indicates that the data on the data bus is to be written into a selected memory or I/O location. ALE is a positive going pulse generated when a new operation is started by the microprocessor. When the pulse goes high, it indicates address. When the pulse goes down it indicates data. Three status signals are IO/M, S0 & S1. IO/M signal is used to differentiate between I/O and Memory operations, i.e. when it is high indicates I/O operation and when it is low then it indicates memory operation. S1 & S0 signals are used to identify the type of current operation.

Power Supply: There are 2 power supply signals − VCC & VSS. VCC indicates +5v power supply and VSS indicates ground signal.

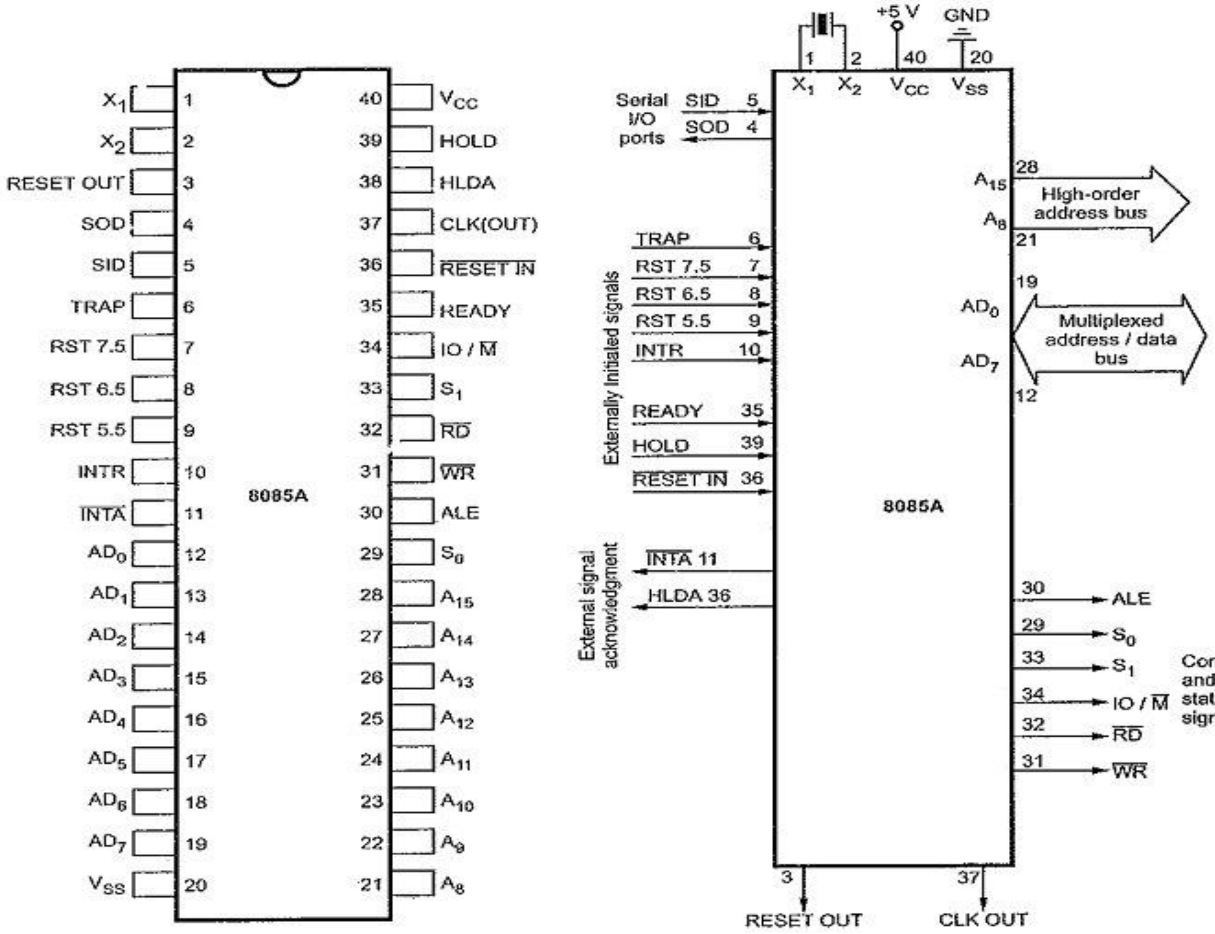

Figure 3 80805 microprocessor pin diagram

Clock Signals: There are 3 clock signals, i.e. X1, X2, CLK OUT. A crystal is connected at X1 and X2 pins and is used to set frequency of the internal clock generator. This frequency is internally divided by 2. CLK OUT is used as the system clock for devices connected with the microprocessor.

Interrupts & externally initiated signals: Interrupts are the signals generated by external devices to request the microprocessor to perform a task. There are 5 interrupt signals, i.e. TRAP, RST 7.5, RST 6.5, RST 5.5, and INTR. INTA is an interrupt acknowledgment signal. RESET IN is used to reset the microprocessor by setting the program counter to zero. RESET OUT is used to reset all the connected devices when the microprocessor is reset. READY signal indicates that the device is ready to send or receive data. If READY is low, then the CPU has to wait for READY to go high. HOLD signal indicates that another master is requesting the use of the address and data buses. HLDA (HOLD Acknowledge) indicates that the CPU has received the HOLD request and it will relinquish the bus in the next clock cycle. HLDA is set to low after the HOLD signal is removed.

Serial I/O signals: There are 2 serial signals, i.e. SID and SOD used for serial communication. The output SOD (Serial output data line) is set/reset as specified by the SIM instruction. The data on SID (Serial input data line) is loaded into accumulator whenever a RIM instruction is executed.

H. Experimental set up/ Program Logic-Flow chart:

Faculty will demonstrate the use and function of pins of 8085 using chart or presentations.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Chart	8085 Microprocessor pin diagram and Block diagram	1 No.

J. Safety and necessary Precautions followed:

1. Handle computer system with care.
2. Start and shutdown system with proper procedure.

K. Conclusion:

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L. Practical related Quiz.

1. List general purpose registers of 8085 microprocessor.

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2. What operation is performed during first T -state of every machine cycle in 8085?

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3. 8085 microprocessor had ……… data lines and ………. Address lines.

4. List hardware interrupts of 8085.

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5. What is TRAP?

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M. References:
https://www.tutorialspoint.com/microprocessor/index.htm

N. Assessment-Rubrics

Experiment No 2 Learn architecture and pin diagram of Microprocessor chip 8085.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.3: Learn architecture and pin diagram of Microcontroller chip 8051.

A. **Objective:**

Microcontroller had wide range of applications in electronic system needing real time processing/control, starting from domestic applications such as washing machine, TV and air conditioners. Microcontrollers are also used in automobiles, process control industries, cell phones, robotics and in space applications. From this practical students are able to understand different blocks in 8051 architecture, also identify various pins and their functions.

B. **Expected Program Outcomes (POs):**

1. Basic & Discipline specific knowledge
7. Life-long learning

C. **Expected Skills to be developed based on competency:**

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Identify the function of given pins.

D. **Expected Course Outcomes(Cos)**

Illustrate microcontroller internal architecture.

E. **Practical Outcome(PRo)**

Learn architecture and pin diagram of Microcontroller chip 8051.

F. **Expected Affective domain Outcome(ADos)**

1. Follow precautionary measures.
2. Demonstrate working as a leader/ a team member.
3. Follow ethical practices

G. **Prerequisite Theory:**

8051 Architecture

8051 is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package) having 4KB of ROM storage and 128 bytes of RAM storage, two 16-bit timers. It consists of four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the microcontroller. In the 8051 microcontroller architecture, the system bus plays a key role to connect all the devices to the central processing unit. This bus includes an 8-bit data bus, a 16-bit address bus & bus control signals. Other devices can also be interfaced throughout the system bus like ports, memory, interrupt control, serial interface, the CPU, timers.

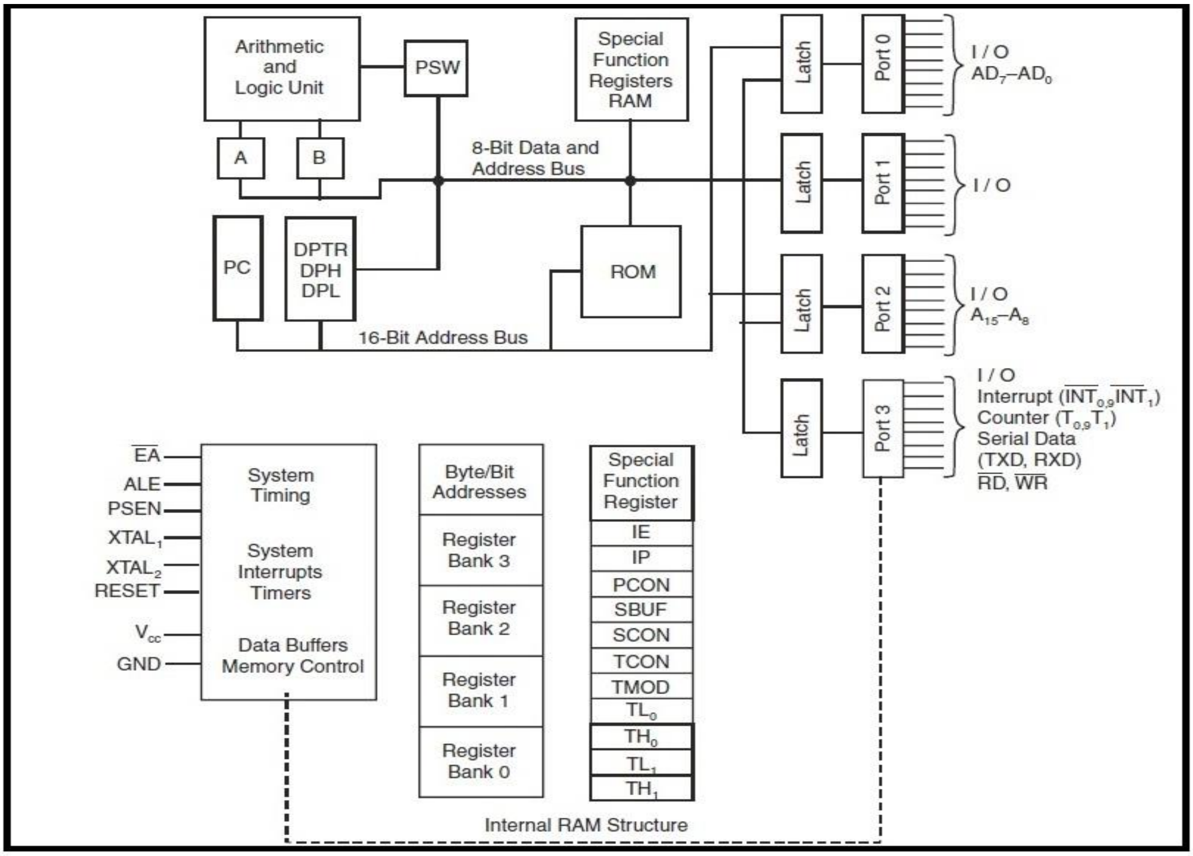

Figure 4 8051 Microcontroller Architecture

8051 Pin diagram

Pin diagram of 8051 is shown in fig. 2.

Pins 1 to 8(Port 1): The Pins 1.0 to 1.7 are 8 Pins of port 1. Each of them can be configured as input or output pin.

Pin 9: It is used to Reset Microcontroller 8051. A positive pulse is given on this Pin to reset Microcontroller.

Pin 10 to 17(Port 3): These Pins are similar to Pins of Port 1. These Pins can be used as universal Input or output. These are dual function Pins. Function of each Pin is given as

Pin 10 It is Serial Data Receive.

Pin 11 It is Serial Data Transmit.

Pin 12 Interrupt 0 input.

Pin 13 Interrupt 1 input.

Pin 14 Counter 0 clock input.

Pin 15 Counter 1 clock input.

Pin 16 Writing Signal for Writing content on external RAM.

Pin 17 Reading Signal to read contents of external RAM.

Pin 18 and 19: These are input output PINS for oscillator. An internal oscillator is connected to Micro controller through these PINS.

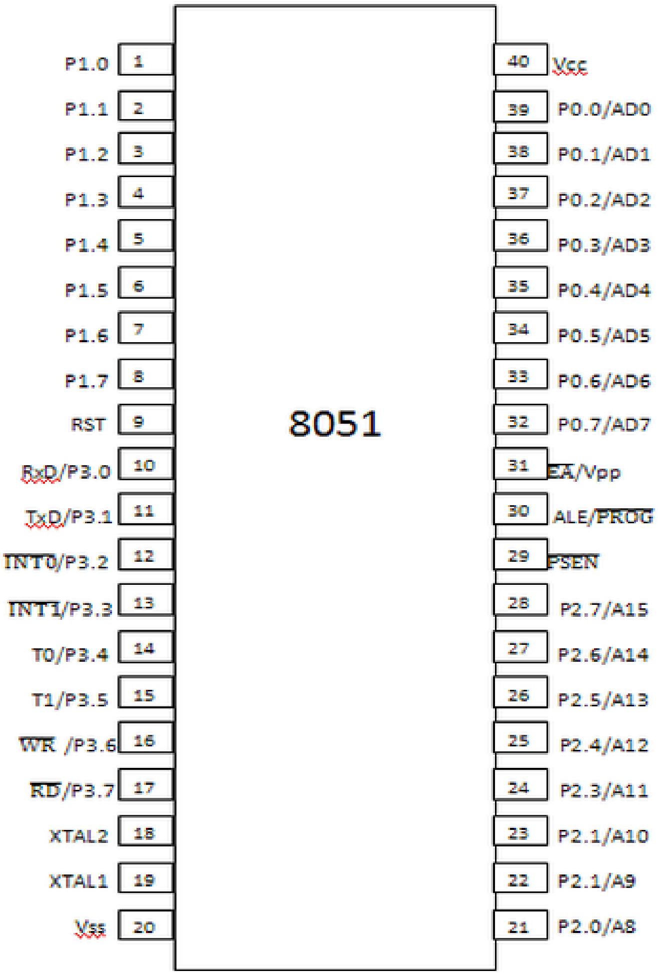

Figure 5 8051 microprocessor pin diagram

Pin 20: Pin 20 is grounded.

Pin 21 to 28 (Port 2): These Pins can be configured as Input Output Pins. But this is only possible in case when we don't use any external memory. If we use external memory then these pins will work as high order address bus (A8 to A15).

Pin 29: If we use an external ROM then it should has a logic 0 which indicates Micro controller to read data from memory.

Pin 30: This Pin is used for ALE that is Address Latch Enable. If we use multiple memory chips then this pin is used to distinguish between them. This Pin also gives program pulse input during programming of EPROM.

Pin 31: If we have to use multiple memories then by applying logic 1 to this pin instructs Micro controller to read data from both memories first internal and afterwards external.

Pin 32 to 39(Port 0): Similar to port 2 and 3, these pins can be used as input output pins when we don't use any external memory. When ALE or Pin 30 is at 1 then this port is used as data bus, when ALE pin at 0, then this port is used as lower order address bus (A0 to A7).

Pin 40: VCC +5V power supply.

H. Experimental set up/ Program Logic-Flow chart:

Faculty will demonstrate the use and function of pins of 8051 using chart or presentations.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Chart	8051 Microcontroller pin diagram and Block diagram	1 No.

J. Safety and necessary Precautions followed:

1. Handle computer system with care.
2. Start and shutdown system with proper procedure.

K. Conclusion:

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L. Practical related Quiz.

1. List special function registers of 8051 Microcontroller.

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2. Internal RAM ………….. bytes and Internal ROM …………. bytes in 8051.
3. Higher order address bus is connected to port ……….. and Lower order address bus is connected to port ………… for external memory interfacing.
4. List interrupts of 8051.

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5. How many address lines need to interface 512 byte memory with 8051?

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M. **References:**

https://www.tutorialspoint.com/microprocessor/index.htm

N. **Assessment-Rubrics**

Experiment No 3 Learn architecture and pin diagram of Microcontroller chip 8051.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
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Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.4: Use 8051 Simulation tool / Trainer kit for running ASM programs.

A. Objective:

Simulator is software which will execute the program and show the results exactly to the program running on the hardware, if the programmer found any errors in the program at the time of simulation, he can change the program and re-simulate the code and get the expected result, before going to the hardware testing. Students are able to build and validate their program very easily and in an interactive way using simulators.

B. Expected Program Outcomes (POs):

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. Expected Skills to be developed based on competency:

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Test and validate program using simulator/trainer kit.

D. Expected Course Outcomes(Cos)

Write and execute assembly language programs(software) for given application.

E. Practical Outcome(PRo)

Use 8051 Simulation tool / Trainer kit for running ASM programs.

F. Expected Affective domain Outcome(ADos)

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. Prerequisite Theory:

MCU 8051 is an 8051 simulator which is very simple to use and have an interactive IDE (Integrated Development Environment). It is developed by Martin Osmera. There are many features for this IDE they are:

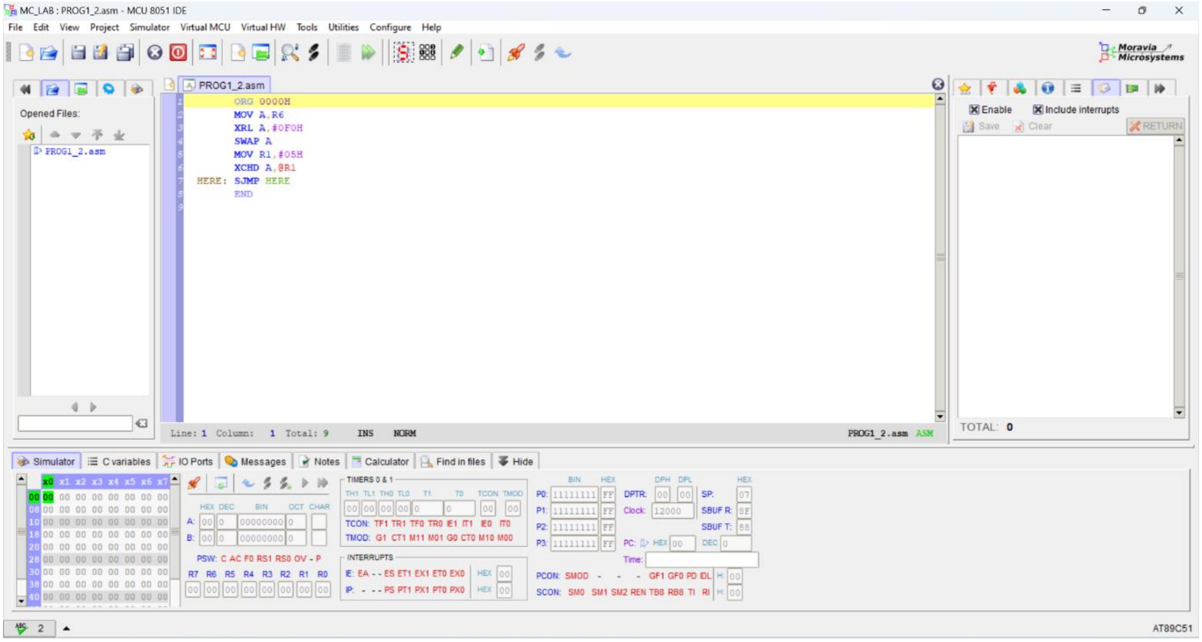
It supports both C and assembly language for compilation and simulation.

It has in-built source code editor, graphical note pad, ASCII charts, Assembly symbol viewer etc. Also supports number of 8051 IC's like at89c51, A89S52, 8051, 8052, etc.

It will support the certain electronic simulation like LED, 7segment display, LCD display etc. which will help in giving the output when you interface these things to the hardware directly.

It has tools like hex decimal editors, base converters, special calculator, file converter, inbuilt hardware programmer etc.

It has syntax validation, pop base auto completion etc.



```
        ORG 0000H
        MOV A,R6
        XRL A,#0F0H
        SWAP A
        MOV R1,#05H
        XCHD A,@R1
HERE:   SJMP HERE
        END
```

Figure 6 MCU 8051 Simulator

H. Experimental set up/ Program Logic-Flow chart:

Faculty will demonstrate the user interface of 8051 simulator.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	

J. Safety and necessary Precautions followed:

1. Handle computer system/Trainer Kit with care.
2. Start and shutdown system with proper procedure.

K. Conclusion:

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L. Practical related Quiz.

1. List different open source 8051 Simulators.

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M. References:

http://sourceforge.net/projects/mcu8051ide/files/

N. Assessment-Rubrics

Experiment No 4 Use 8051 Simulation tool / Trainer kit for running ASM programs.

Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.5: Write and execute assembly language programs based on Data transfer Instruction.

A. Objective:

The Data Transfer Instructions are associated with transfer of data between registers or external program memory or external data memory. Students are able to transfer data between registers, internal program and data memory as well as external program and data memory.

B. Expected Program Outcomes (POs):

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. Expected Skills to be developed based on competency:

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Transfer data in various ways using data transfer instructions.

D. Expected Course Outcomes(Cos)

Write and execute assembly language programs(software) for given application.

E. Practical Outcome(PRo)

Write and execute assembly language programs based on Data transfer Instruction.

F. Expected Affective domain Outcome(ADos)

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. Prerequisite Theory:

The Data Transfer Instructions are associated with transfer of data between registers or external program memory or external data memory.

MOV instruction copies data from one location to another. It has following format:

```
MOV destination, source; copy source to dest.
```

The instruction tells the CPU to move the source operand to the destination operand.

MOVC instruction moves a byte of data located in program ROM into register A. This allows us to put strings of data, such as look-up table elements, in the code space and read them into CPU.

`MOVC A,@A+DPTR;` The address of the desired Byte is formed by adding the content of the accumulator to the 16-bit DPTR register.

MOVX instruction (X stands for external data memory) is widely used to access external data memory space. To bring externally stored data into the CPU, we use the instruction `MOVX A,@DPTR`. In writing data to external data RAM, we use the instruction `MOVX @DPTR,A`. In both cases DPTR hold the address of external RAM that we want to access.

XCH instruction actually move data in two directions: from source to destination and from destination to source. It supports all addressing mode except immediate.

`XCH A,Source;` It swaps the contents of register A and the source byte.

`XCHD A,@Ri;` It exchanges only the lower nibble of A with the lower nibble of the RAM location pointed to by Ri while leaving upper nibbles in both places unchanged.

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	

J. Safety and necessary Precautions followed:

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Start and shutdown system with proper procedure.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Copy the contents of R0 of Bank 0 to the R1 of Bank 3.

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Sample Program 2: Exchange low nibbles of register R5 and R6: put the low Nibble of R5 into R6, and the low nibble of R6 into R5.

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Sample Program 3: Copy the data from external RAM Location 0123h to TL0 and Data external RAM location 0234h to TH0.

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L. **Observations (Input-Output):**

Sample Program 1			
Before Execution		After Execution	
Register	Data	Register	Data
R0 of Bank 0		R1 of Bank 3	

Sample Program 2			
Before Execution		After Execution	
Register	Data	Register	Data
R5		R5	
R6		R6	
Sample Program 3			
Before Execution		After Execution	
External RAM addr.	Data	Register	Data
0123h		TL0	
0234h		TH0	

M. Conclusion:

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N. Practical related Quiz.

1. Data of R7=30H after MOV A, 07H data of A= ……… H & memory location 07H has data ………. H.
2. If A = 15h and R0 = 30h then after execution of MOV @R0,A content of Accumulator is stored at ……………. RAM location.
3. If R1= 33h , A=30h then after XCH A, R1 value of A= ………….
4. List different addressing modes of 8051.

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5. Which data transfer instruction is used to take data from program memory?

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O. References:

https://nptel.ac.in/courses/108105102

P. Assessment-Rubrics

Experiment No 5 Write and execute assembly language programs based on Data transfer Instruction.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.6: Develop assembly language programs based on Arithmetic Instructions.

A. Objective:

8051 microcontrollers contain an Arithmetic Logic Unit, which is responsible for performing mathematical operations at lightning-fast speeds. A set of registers input data into the ALU on which the ALU performs operations based on the instructions it receives. Applications such as BCD and ASCII conversions and checksum byte testing require arithmetic operations. This practical will help the students to develop skills to write assembly program for arithmetic operations.

B. Expected Program Outcomes (POs):

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. Expected Skills to be developed based on competency:

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Perform mathematical operations using various arithmetic instructions.

D. Expected Course Outcomes(Cos)

Write and execute assembly language programs(software) for given application.

E. Practical Outcome(PRo)

Write and execute assembly language programs based on Arithmetic Instruction.

F. Expected Affective domain Outcome(ADos)

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. Prerequisite Theory:

Using Arithmetic Instructions, you can perform addition, subtraction, multiplication and division. The arithmetic instructions also include increment by one, decrement by one and a special instruction called Decimal Adjust Accumulator.

In addition operation, the accumulator register A must be involved. The form of the ADD instruction is

ADD A, source; ADD the source operand to the accumulator

It tells the CPU to add the source byte to register A and put the result in register A. Source operand can be either a register or immediate data, but the destination must always be register A. `ADD R4,A` and `ADD R2,#12H` are invalid since A must be the destination of any arithmetic operation. This instruction will affect CY, AC and OV flags.

ADDC instruction will add the source byte to A, in addition to the CY flag. It has the form: *ADDC A, source; A=A+Source+CY*

This instruction is used in multibyte addition. This instruction will affect CY, AC and OV flags.

DA A (decimal adjust accumulator) instruction is used after addition of BCD numbers to convert the result back to BCD. It adds 6 to the lower 4 bits of A if it is greater than 9 or if AC=1. It also adds 6 to upper 4 bits of A if it is greater than 9 or if CY=1.

In many microprocessor there are two different instructions for subtraction: SUB and SUBB (subtract with borrow). But in the 8051 we have only SUBB. To make SUB out of SUBB, we have to make CY=0 prior to the execution of the instruction. Notice that we use the CY flag for the borrow.

SUBB A,source; A=A-source-CY

The 8051 uses adder circuitry to perform the subtraction. For this reason, it uses 2's complement method. Assuming that the CY=0 prior to the execution of subtraction instruction, hardware of the CPU will perform following steps to execute SUBB instruction for unsigned numbers.

Take the 2's complement of the subtrahend (source operand)

Add it to the minuend (A)

Invert the carry

After these three steps the result is obtained in the accumulator register and the flags are set. If CY=0 after the execution of SUBB, the result is positive; if CY=1, the result is negative and the destination has the 2's complement of the result. CPL (complement) and INC (increment) instructions can be used to change it.

INC instruction adds 1 to the 16-bit DPTR register, 8-bit register or memory location specified by the operand. Note that CY is not affected even if value FF is incremented to 00.

DEC instruction subtracts 1 from 8-bit register or memory location specified by the operand. Note that CY is not affected even if value 00 is decremented to FF. This instruction can not be used to decrement 16-bit DPTR.

The 8051 supports byte by byte multiplication only. The bytes are assumed to be unsigned data. The syntax is as follows:

MUL AB; AxB, 16-bit result in B and A

In byte-by-byte multiplication, one of the operands must be in register A, and the second operand must be in register B. After multiplication, the result is in the A and B registers; the lower byte is in A, and the upper byte is in B.

The 8051 supports byte over byte division only. The bytes are assumed to be unsigned data. The syntax is as follows:

```
DIV AB; divide A by B, A/B
```

When dividing a byte by a byte, the numerator must be in register A, and the denominator must be in register B. After division, the quotient is in the A and the remainders is in B.

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	

J. Safety and necessary Precautions followed:

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Start and shutdown system with proper procedure.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Add the byte in register R0 and R1, put the result in external RAM 2050h (LSB) and 2051h (MSB).

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Sample Program 2: Subtract the content of RAM location 13h from RAM location 2Bh; put result in RAM location 3Ch.

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Sample Program 3: Multiply the using number in register R3 by the unsigned number on port 2 and put the result in external RAM location 10h(MSB) and 11h(LSB).

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L. Observations (Input-Output):

Sample Program 1			
Before Execution		After Execution	
REGISTERS	DATA	EXT. RAM ADDR.	DATA
R0		2050h(LSB)	
R1		2051h(MSB)	
Sample Program 2			
Before Execution		After Execution	
INT. RAM ADDR.	DATA	INT. RAM ADDR.	DATA
2Bh		3Ch	
13h		CY	
Sample Program 3			
Before Execution		After Execution	
Register/Port	DATA	EXT. RAM ADDR.	DATA
R3		10h(MSB)	
P2		11h(LSB)	

M. Conclusion:

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N. Practical related Quiz.

1. If content of A is FFh, then after execution of INC A content of A is ………..
2. Data of A=15H , B=02H after MUL AB data of A= ……….. H &B= …………… H.
3. Data of A=09H , B=02H after DIV AB data of A= ……….. H &B= …………… H.
4. Draw PSW register.

5. ………………………………. flag will get set, when carry is generated from D3 to D4.

O. References:

https://nptel.ac.in/courses/108105102
http://what-when-how.com/8051-microcontroller/arithmetic-instructions/

P. Assessment-Rubrics

Experiment No 6 Develop assembly language programs based on Arithmetic Instructions.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.7: Develop Assembly Language Programs based on Logical Instructions.

A. Objective:

Logical Instructions perform logical operations like AND, OR, XOR, NOT, Rotate, Clear and Swap. Logical Instruction are performed on Bytes of data on a bit-by-bit basis. This practical will help the students to develop skills to write assembly program for logical operations.

B. Expected Program Outcomes (POs):

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. Expected Skills to be developed based on competency:

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Perform logical operations using various logical instructions.

D. Expected Course Outcomes(Cos)

Write and execute assembly language programs(software) for given application.

E. Practical Outcome(PRo)

Develop Assembly Language Programs based on Logical Instructions.

F. Expected Affective domain Outcome(ADos)

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. Prerequisite Theory:

ANL instruction will perform a logic AND on the two operands and place the result in the destination. It has the following form:

ANL destination,source; dest = dest AND source

The destination is normally the accumulator. The source operand can be a register, in memory, or immediate. This instruction has no effect on any of flags. The ANL instruction is often used to mask (set to 0) certain bits of an operand.

ORL instruction will perform a logic OR on the two operands and place the result in the destination. It has the following form:

ORL destination,source; dest = dest OR source

The destination is normally the accumulator. The source operand can be a register, in memory, or immediate. This instruction has no effect on any of flags. The ORL instruction is often used to set certain bits of an operand to 1.

XRL instruction will perform XOR operation on the two operands and place the result in the destination. It has the following form:

`XRL destination,source; dest = dest XOR source`

The destination is normally the accumulator. The source operand can be a register, in memory, or immediate. This instruction has no effect on any of flags. The XRL can be used to check whether two registers have the same value or not. XRL instruction can be used to toggle certain bits of an operand. The XRL instruction can be used to clear the contents of a register by XORing it with itself.

CLR instruction clears register A. All bits of the accumulator are set to 0. This instruction can also be used to clear a single bit. The bit can be Carry flag, or any bit-addressable location in the 8051.

CPL A instruction complements the contents of register A. The complement action changes the 0s to 1s and the 1s to 0s. This is also called 1’s complement. To get the 2’s complement, all we have to do is to add 1 to the 1’s complement.

RL rotate left instruction performs bitwise rotation of an accumulator (A). This instruction does not affect any flag. `RL A ;rotate left A`

In rotate left 8 bits of the accumulator are rotated left one bit, and bit D7 exits from the MSB and enters into LSB, D0.

RR rotate right instruction performs bitwise rotation of an accumulator (A). This instruction does not affect any flag. `RR A ;rotate right A`

In rotate right 8 bits of the accumulator are rotated right one bit, and bit D7 exits from the MSB and enters into LSB, D0.

RLC rotate left through carry instruction also performs bitwise rotation of an accumulator (A). But it involves the carry flag.

`RLC A ;rotate left through carry`

In RLC A, Bits are shifted from right to left one bit. They exit the MSB and enter the carry flag, and the carry flag enters the LSB.

RRC rotate right through carry instruction also performs bitwise rotation of an accumulator (A). But it involves the carry flag.

`RRC A; rotate right through carry`

In RRC A, bits are rotated from left to right. They exit the LSB to the carry flag, and the carry flag enters the MSB.

Another useful instruction is the SWAP instruction. It works only on the accumulator (A) `SWAP A.` It swaps the lower nibble and the higher nibble. In other words, the lower 4 bits are put into the higher 4 bits and the higher 4 bits are put into the lower 4 bits.

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	

J. Safety and necessary Precautions followed:

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Start and shutdown system with proper procedure.

K. Source code: (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Find 2’s complement of a value stored at memory location 65H. Put the result on same location.

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Sample Program 2: Make the low nibble of R5 the complement of the high nibble of R6

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Sample Program 3: Rotate DPTR 1-bit left.

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L. Observations (Input-Output):

Sample Program 1			
Before Execution		After Execution	
RAM ADDR.	DATA	RAM ADDR.	DATA
65H		65H	
Sample Program 2			
Before Execution		After Execution	
REGISTERS	DATA	REGISTERS	DATA
R5		R5	
R6		R6	
Sample Program 3			
Before Execution		After Execution	
REGISTERS	DATA	REGISTERS	DATA
DPTR		DPTR	

M. Conclusion:

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N. Practical related Quiz.

1. If A=39h value of A after CPL A = …………….
2. If A = AAh and R3 = F0h then A = ……………. after execution of ANL A,R3.
3. If A = 32h and R3 = 50h then A = ……………. after execution of ORL A,R3.
4. Content of A is 08h. Content of A after execution of RL A is ………….. H.
5. If A = 2Ah then A = ……………. after execution of SWAP A.

O. References:

https://nptel.ac.in/courses/108105102

P. Assessment-Rubrics

Experiment No 7 Develop Assembly Language Programs based on Logical Instructions.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.8: Develop Assembly Language Programs based on Branch Instructions.

A. Objective:

A microcontroller sequentially executes instructions but in some cases, transferring this control to another block of code becomes essential. The branching instructions in the 8051 microcontroller are responsible for performing this operation. Tasks like looping, calling delays, and conditional execution of code can be performed using these branching instructions. This practical will help the students to develop skills to write assembly program for looping techniques.

B. Expected Program Outcomes (POs):

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. Expected Skills to be developed based on competency:

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Execute looping techniques using branch instructions.

D. Expected Course Outcomes(Cos)

Write and execute assembly language programs(software) for given application.

E. Practical Outcome(PRo)

Develop Assembly Language Programs based on Branch Instructions.

F. Expected Affective domain Outcome(ADos)

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. Prerequisite Theory:

Repeating a sequence of instructions, a certain number of times is called a loop. The loop is one of the most widely used action that any microprocessor performs. In the 8051, the loop action is performed by the instruction

```
DJNZ reg, Label
```

In this instruction, the register is decremented; If it is not zero, it jumps to the target address referred to by the label. Prior to the start of loop the register is loaded with the counter for the number of repetitions. Counter can be R0 – R7 or

RAM location. Notice that in this instruction both the register decrement and the decision to jump are combined into a single instruction. If we want to repeat an action more times than 256, we use a loop inside a loop, which is called nested loop. In nested loop, we use multiple registers to hold the count.

Conditional jumps for 8051 are listed in Table 1. These conditional jump instructions jump only if a certain condition is met.

Table 1 The 8051 Conditional Jump Instructions

Instructions	**Actions**
JZ	Jump if A = 0
JNZ	Jump if A ≠ 0
DJNZ	Decrement and Jump if A ≠ 0
CJNE A,byte	Jump if A ≠ byte
CJNE reg,#data	Jump if byte ≠ #data
JC	Jump if CY = 1
JNC	Jump if CY = 0
JB	Jump if bit = 1
JNB	Jump if bit = 0
JBC	Jump if bit = 1 and clear bit

The unconditional jump is a jump in which control is transferred unconditionally to the target location. In the 8051 there are two unconditional jumps: LJMP long jump and SJMP short jump

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	**Instrument/Equipment /Components/Trainer kit**	**Specification**	**Quantity**
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	

J. **Safety and necessary Precautions followed:**

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Start and shutdown system with proper procedure.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Multiply the content of R2 by the content of R3 without using MUL instruction. Store the result in R5 (MSB) and R4 (LSB).

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Sample Program 2: Ten hex numbers are stored in RAM location 50h onwards. Write a program to find the biggest number in the set. The biggest number should finally save in 60h.

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Sample Program 3: For an 89C51 with a crystal frequency of 24 MHz, generate a delay of 5ms.

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L. Observations (Input-Output):

Sample Program 1			
Before Execution		After Execution	
REGISTERS	DATA	REGISTERS	DATA
R2		R5	
R3		R4	
Sample Program 2			
Before Execution		After Execution	
INT. RAM ADDR.	DATA	EXT. RAM ADDR.	DATA
50h		60h	
51h			
52h			
53h			
54h			
55h			
56h			
57h			
58h			
59h			

M. Conclusion:

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N. Practical related Quiz.

1. List conditional jump instructions.

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2. How many Machine cycles are required to generate a delay of 5ms with a crystal frequency of 24 MHz?

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O. References:

https://nptel.ac.in/courses/108105102

P. Assessment-Rubrics

Experiment No 8 Develop Assembly Language Programs based on Branch Instructions.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.9: Develop Assembly Language Programs to introduce delay using Timer/Counter.

A. Objective:

In 8051 timers are used to generate delays or as counters to count events happening outside the microcontroller. 8051 has two 16 bit timers which can be operated in different modes to generate specific delay. This practical will help the students to develop skills to program timers and generate delays.

B. Expected Program Outcomes (POs):

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. Expected Skills to be developed based on competency:

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Generate delay by programming appropriate mode of timer.

D. Expected Course Outcomes(Cos)

Write and execute assembly language programs(software) for given application.

E. Practical Outcome(PRo)

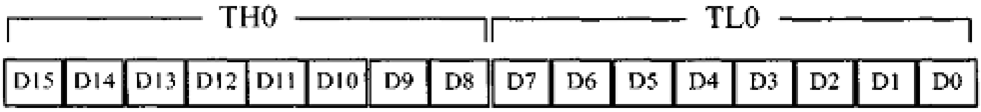
Develop Assembly Language Programs to introduce delay using Timer/Counter.

F. Expected Affective domain Outcome(ADos)

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

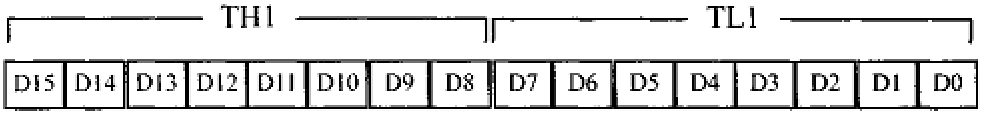
G. Prerequisite Theory:

The 8051 has two timers: Timer 0 and Timer 1. They can be used either as timers or as event counters. Both Timer 0 and Timer 1 are 16 bits wide. Since the 8051 has an 8-bit architecture, each 16-bit timer is accessed as two separate registers of low byte and high byte. The 16-bit register of Timer 0 is accessed as the low byte register called TL0 (Timer 0 low byte) and the high byte register called TH0 (Timer 0 high byte). Similarly for Timer 1 accessed as TL1 and TH1. These registers can be accessed like any other register, such as A, B, RO, Rl, R2, etc.



TH0								TL0							
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Figure 7 Timer 0 Register

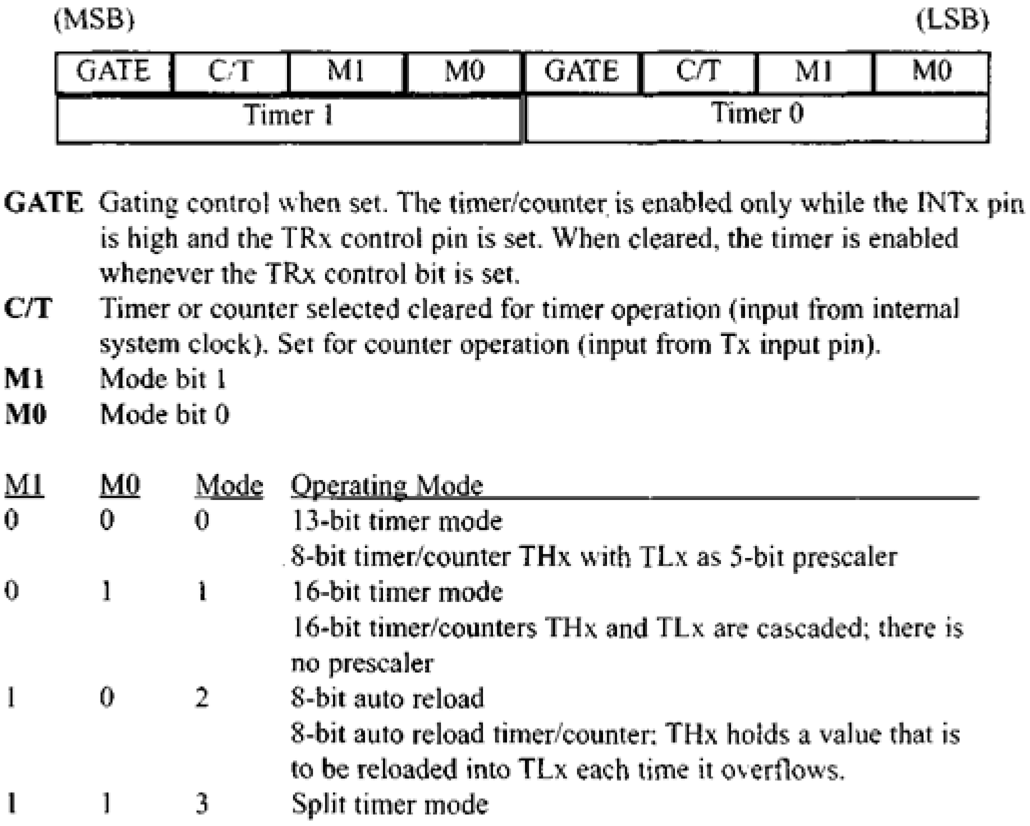


TH1								TL1							
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Figure 8 Timer 1 Register

TMOD (timer mode) register

Both timers 0 and 1 use the same register, called TMOD, to set the various timer operation modes. TMOD is an 8-bit register in which the lower 4 bits are set aside for Timer 0 and the upper 4 bits for Timer 1. In each case, the lower 2 bits are used to set the timer mode and the upper 2 bits to specify the operation.



(MSB) (LSB)

GATE	C/T	M1	M0	GATE	C/T	M1	M0
Timer 1				Timer 0			

GATE Gating control when set. The timer/counter is enabled only while the INTx pin is high and the TRx control pin is set. When cleared, the timer is enabled whenever the TRx control bit is set.

C/T Timer or counter selected cleared for timer operation (input from internal system clock). Set for counter operation (input from Tx input pin).

M1 Mode bit 1

M0 Mode bit 0

M1	M0	Mode	Operating Mode
0	0	0	13-bit timer mode 8-bit timer/counter THx with TLx as 5-bit prescaler
0	1	1	16-bit timer mode 16-bit timer/counters THx and TLx are cascaded; there is no prescaler
1	0	2	8-bit auto reload 8-bit auto reload timer/counter: THx holds a value that is to be reloaded into TLx each time it overflows.
1	1	3	Split timer mode

Note: The 8051 timers use 1/12 of crystal frequency, regardless of machine cycle time.

Mode 1 programming

It is a 16-bit timer; therefore, it allows values of 0000 to FFFFH to be loaded

into the timer's registers TL and TH. After TH and TL are loaded with a 16-bit initial value, the timer must be started. This is done by "SETB TR0" for Timer 0 and "SETB TR1" for Timer 1.

After the timer is started, it starts to count up. It counts up until it reaches its limit of FFFFH. When it rolls over from FFFFH to 0000, it sets high a flag bit called TF (timer flag). This timer flag can be monitored. When this timer flag is raised, one option would be to stop the timer with the instructions "CLR TR0" or "CLR TR1", for Timer 0 and Timer 1, respectively. Again, it must be noted that each timer has its own timer flag: TF0 for Timer 0, and TF1 for Timer 1.

After the timer reaches its limit and rolls over, in order to repeat the process the registers TH and TL must be reloaded with the original value and TF must be reset to 0.

Steps to program in mode 1

1. Load the TMOD value register indicating which timer (Timer 0 or Timer 1) is to be used and which timer mode (0 or 1) is selected.
2. Load registers TL and TH with initial count values.
3. Start the timer. Keep monitoring the timer flag (TF) with the "JNB TFx, target" instruction to see if it is raised. Get out of the loop when TF becomes high.
4. Stop the timer.
5. Clear the TF flag for the next round.
6. Go back to Step 2 to load TH and TL again.

Mode 2 programming

It is an 8-bit timer; therefore, it allows only values of 00 to FFH to be loaded into the timer's register TH. The 8051 gives a copy of it to TL. Then the timer must be started just like we done in mode 1.

After the timer is started, it starts to count up by incrementing the TL register. It counts up until it reaches its limit of FFH. When it rolls over from FFH to 00, it sets high the TF (timer flag). When the TL register rolls from FFH to 0 and TF is set to 1, TL is reloaded automatically with the original value kept by the TH register. To repeat the process, we must simply clear TF the programmer does not need to reload the original value. This makes mode 2 an auto-reload in contrast with mode 1 in which the programmer has to reload TH and TL.

Steps to program in mode 2

1. Load the TMOD value register indicating which timer (Timer 0 or Timer 1) is to be used, and select the timer mode (mode 2).
2. Load the TH registers with the initial count value.

3. Start the timer. Keep monitoring the timer flag (TF) with the “JNB TFx, target” instruction to see whether it is raised. Get out of the loop when TF goes high.
4. Clear the TF flag.
5. Go back to Step 4, since mode 2 is auto-reload.

COUNTER PROGRAMMING

As far as the use of a timer as an event counter is concerned, everything that we have talked about in programming the timer previously also applies to programming it as a counter, except the source of the frequency. When the timer/counter is used as a timer, the 8051’s crystal is used as the source of the frequency. When it is used as a counter, however, it is a pulse outside the 8051 that increments the TH, TL register. The timer’s modes are the same as well.

If C/T = 0, the timer gets pulses from the crystal. In contrast, when C/T = 1, the timer is used as a counter and gets its pulses from outside the 8051. Therefore, when C/T = 1, the counter counts up as pulses are fed from pins 14 and 15. These pins are called T0 (Timer 0 input) and Tl (Timer 1 input). Notice that these two pins belong to port 3 i.e. T0= P3.4 and T1=P3.5.

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	

J. Safety and necessary Precautions followed:

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Start and shutdown system with proper procedure.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Write a program to generate a square wave of 50% duty cycle on bit 3 of Port 1 using Timer 0 in Mode 1.

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L. **Conclusion:**

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M. **Practical related Quiz.**

1. Draw TMOD Register.

2. Draw TCON Register

3. Which timer and mode are selected for MOV TMOD, #20h?

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4. Which timer and mode are selected for MOV TMOD, #04h?

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N. References:

https://nptel.ac.in/courses/108105102

O. Assessment-Rubrics

Experiment No 9 Develop Assembly Language Programs to introduce delay using Timer/Counter.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: …………..

Practical No.10: Develop Programs for serial communication.

A. **Objective:**

In many applications, microcontrollers have to either accept the data in serial form or output the data in serial form. Serial communication is commonly used in applications such as industrial automation systems, scientific analysis and certain consumer products. This practical will help the students to develop skills to understand the concepts of serial port and how they are interfaced with microcontroller.

B. **Expected Program Outcomes (POs):**

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. **Expected Skills to be developed based on competency:**

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Transmit and receive data serially in microcontroller.

D. **Expected Course Outcomes(Cos)**

Write and execute assembly language programs(software) for given application.

E. **Practical Outcome(PRo)**

Develop Programs for serial communication.

F. **Expected Affective domain Outcome(ADos)**

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. **Prerequisite Theory:**

Baud rate in the 8051

The 8051 transfers and receives data serially at many different baud rates. The baud rate in the 8051 is programmable. This is done with the help of Timer 1. Before we discuss how to do that, we will look at the relationship between the crystal frequency and the baud rate in the 8051.

The 8051 divides the crystal frequency by 12 to get the machine cycle frequency. In the case of XTAL = 11.0592 MHz, the machine cycle frequency is

921.6 kHz (11.0592 MHz / 12 = 921.6 kHz). The 8051 's serial communication UART circuitry divides the machine cycle frequency of 921.6 kHz by 32 once more before it is used by Timer 1 to set the baud rate. Therefore, 921.6 kHz divided by 32 gives 28,800 Hz. This is the number we will use throughout this section to find the Timer 1 value to set the baud rate. When Timer 1 is used to set the baud rate it must be programmed in mode 2. To get baud rates compatible with the PC, we must load TH1 with the values shown in Table.

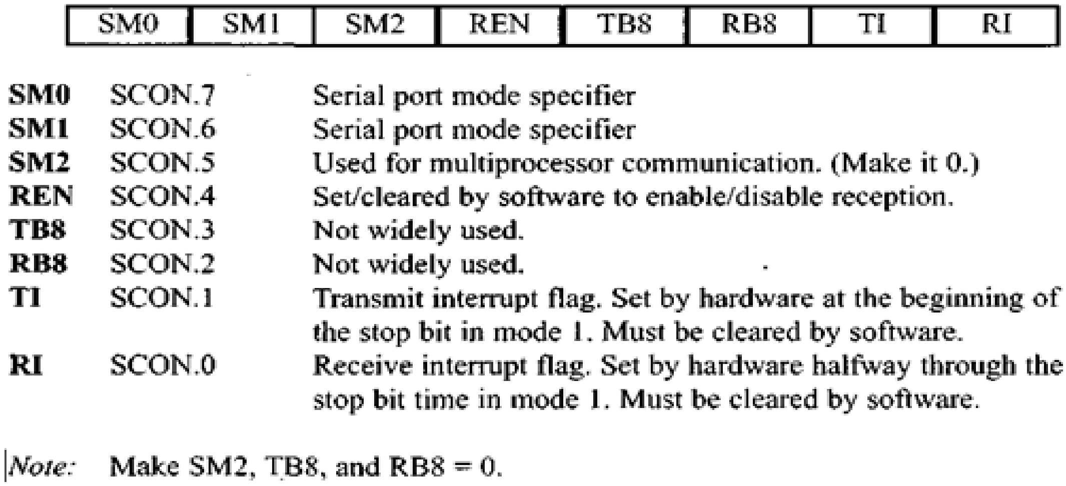
Baud Rate	TH1 (Decimal)	TH1 (Hex)
9600	-3	FD
4800	-6	FA
2400	-12	F4
1200	-24	E8
Note: XTAL = 11.0592 MHz.		

SBUF register

SBUF is an 8-bit register used solely for serial communication in the 8051. For a byte of data to be transferred via the TxD line, it must be placed in the SBUF register. Similarly, SBUF holds the byte of data when it is received by the 8051 's RxD line. SBUF can be accessed like any other register in the 8051.

The moment a byte is written into SBUF, it is framed with the start and stop bits and transferred serially via the TxD pin. Similarly, when the bits are received serially via RxD, the 8051 deframes it by eliminating the stop and start bits, making a byte out of the data received, and then placing it in the SBUF.

SCON (serial control) register



SM0	SM1	SM2	REN	TB8	RB8	TI	RI

SM0	SCON.7	Serial port mode specifier
SM1	SCON.6	Serial port mode specifier
SM2	SCON.5	Used for multiprocessor communication. (Make it 0.)
REN	SCON.4	Set/cleared by software to enable/disable reception.
TB8	SCON.3	Not widely used.
RB8	SCON.2	Not widely used.
TI	SCON.1	Transmit interrupt flag. Set by hardware at the beginning of the stop bit in mode 1. Must be cleared by software.
RI	SCON.0	Receive interrupt flag. Set by hardware halfway through the stop bit time in mode 1. Must be cleared by software.

Note: Make SM2, TB8, and RB8 = 0.

The SCON register is an 8-bit register used to program the start bit, stop bit, and data bits of data framing, among other things. The following describes various bits of the SCON register.

<u>Programming the 8051 to transfer data serially</u>

In programming the 8051 to transfer character bytes serially, the following steps must be taken.

1. The TMOD register is loaded with the value 20H, indicating the use of Timer 1 in mode 2 to set the baud rate.
2. The TH1 is loaded with one of the values in above Table to set the baud rate for serial data transfer (assuming XTAL = 11.0592 MHz).
3. The SCON register is loaded with the value 50H, indicating serial mode 1 where an 8-bit data is framed with start and stop bits.
4. TR1 is set to 1 to start Timer 1.
5. TI is cleared by the "CLR TI" instruction.
6. The character byte to be transferred serially is written into the SBUF register.
7. The TI flag bit is monitored with the use of the instruction "JNB TI, xx" to see if the character has been transferred completely.
8. To transfer the next character, go to Step 5.

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type "AT89C51".
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	

J. Safety and necessary Precautions followed:

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Start and shutdown system with proper procedure.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Write a program for 8051 to send letter 'A' serially at baud rate 4800 continuously.

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L. **Observations (Input-Output):**

M. **Conclusion:**

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N. **Practical related Quiz.**

1. Draw SCON Register.

2. Why crystal frequency used in microcontroller is 11.0592MHz?

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3. Write full name of SCON and SBUF.

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O. References:

https://nptel.ac.in/courses/108105102

P. Assessment-Rubrics

Experiment No 10 Develop Programs for serial communication.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.11: Develop a program to interface LED with 8051.

A. **Objective:**

Display devices are interfaced with the microcontroller to indicate the results of the operation performed. LED, seven segment displays and LCDs can be interfaced to display the output in form of single digit, single character or alphanumeric character. LEDs are by far the most widely used means of taking output. They find huge application as indicators during experimentations to check the validity of results at different stages. They are very cheap and easily available in a variety of shape, size and colors. This practical will help the students to develop skills to interface LED with microcontroller.

B. **Expected Program Outcomes (POs):**

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. **Expected Skills to be developed based on competency:**

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Turn on and off LEDs using port pins.

D. **Expected Course Outcomes(Cos)**

Interface microcontroller with hardware for given application.

E. **Practical Outcome(PRo)**

Develop a program to interface LED with 8051.

F. **Expected Affective domain Outcome(ADos)**

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. **Prerequisite Theory:**

8051 has 4 bidirectional I/O ports which can be used as input or output ports. LEDs can be used as output devices to display the result obtained from the operation. Even the LED can be turned on /off by some switch or delay. Interfacing of LED with port pin of microcontroller is shown in the fig. below.

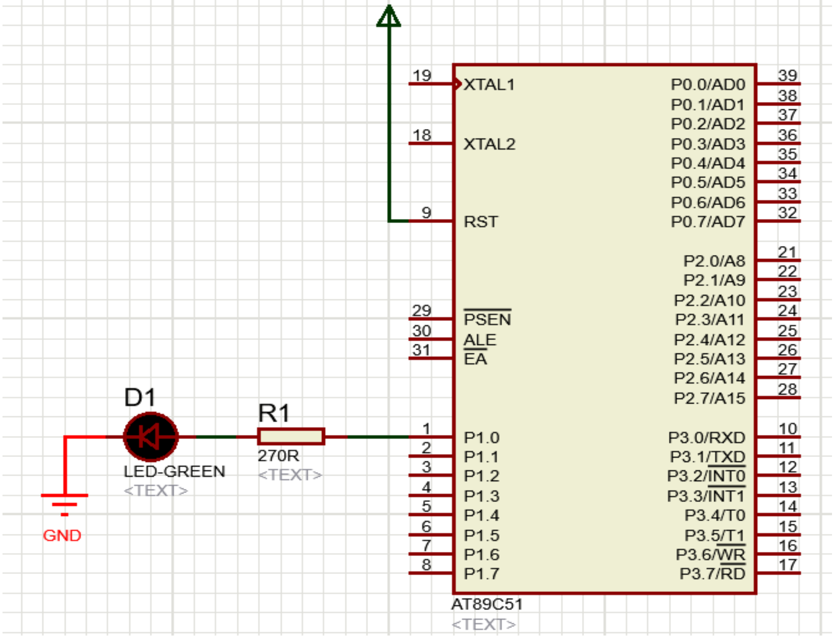

Figure 9 Interfacing of LED with Microcontroller

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	
Note: For Hardware simulation you can also use Proteus 8 Professional			

J. Safety and necessary Precautions followed:

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Use always current limiting resistor before interfacing 7-segment display to microcontroller.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Write a to blink LED interfaced at port P1.0 at time interval of 5ms.

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L. **Conclusion:**

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M. **Practical related Quiz.**

1. How many LEDs can be interfaced at Port 1.

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2. Write the Full name of LED.

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N. **References:**
https://nptel.ac.in/courses/108105102

O. Assessment-Rubrics

Experiment No 11 Develop a program to interface LED with 8051.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.12: Develop a program to interface 7 segment Display with 8051.

A. **Objective:**

In electronic displays like pricing menu at petrol pump, in metros, digital clocks and in many electronics appliances most commonly used display device is a 7-segment display (SSD). Seven segment displays are used to display decimal numbers from 0 to 9 and in some cases, basic characters also. This practical will help the students to develop skills to interface 7-segment display to microcontroller and display number from 0 to 9.

B. **Expected Program Outcomes (POs):**

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. **Expected Skills to be developed based on competency:**

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Display numbers and characters on 7 segment display.

D. **Expected Course Outcomes(Cos)**

Interface microcontroller with hardware for given application.

E. **Practical Outcome(PRo)**

Develop a program to interface 7 segment Display with 8051.

F. **Expected Affective domain Outcome(ADos)**

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. **Prerequisite Theory:**

Seven Segment are available in two configuration - (1) Common Anode (2) Common Cathode. The circuit diagram shows the connections of seven segment to the controller.

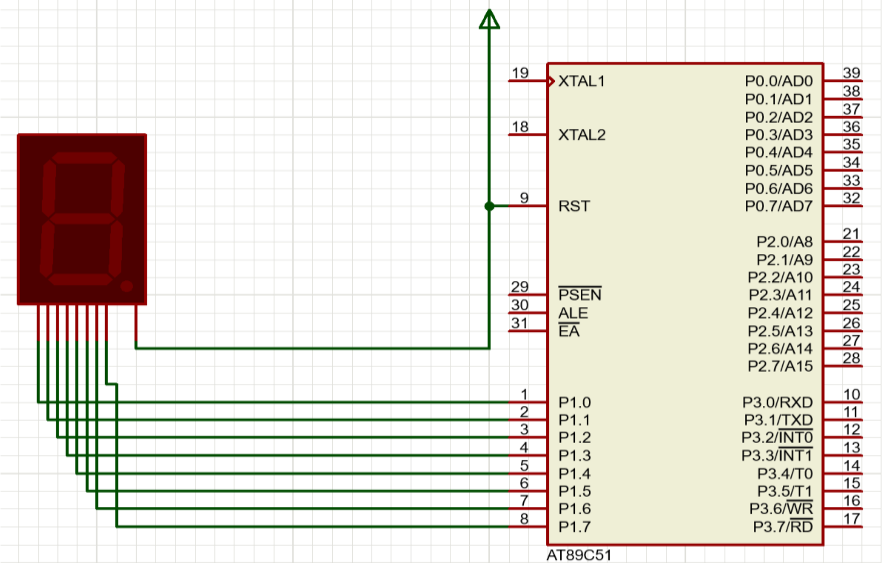

Figure 10 Interfacing of 7 segment display (common anode) with 8051

The pins a to h of the Seven Segment are connected to the Port P1 of the microcontroller. The common pin of the seven segment is connected to Vcc. Since the seven segment display works on negative logic, we will have to provide logic 0 to the corresponding pin to make an LED glow.

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	
Note: For Hardware simulation you can also use Proteus 8 Professional			

J. **Safety and necessary Precautions followed:**

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Use always current limiting resistor before interfacing 7-segment display to microcontroller.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Write a program to display 0 to 9 digits on common anode seven segment display at an interval of 1 second.

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L. Conclusion:

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M. Practical related Quiz.

1. Which type of seven segment display is used in this practical?

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N. References:

https://nptel.ac.in/courses/108105102

O. Assessment-Rubrics

Experiment No 12 Develop a program to interface 7 segment Display with 8051.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.13: Develop a program to Interface 8 bit DAC and ADC with 8051.

A. **Objective:**

In the real world most of the signals sensed and processed by humans are analog signals. Analog-to-digital conversion is the primary means by which analog signals are converted into digital data that can be processed by computers for various purposes. The digital to analog converter (DAC) is a device widely used to convert digital pulses to analog signals. This practical will help the students to develop skills to interface ADC and DAC to the microcontroller and convert analog data from various sensors into digital number that can be interpret and process by the microcontroller.

B. **Expected Program Outcomes (POs):**

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. **Expected Skills to be developed based on competency:**

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Convert analog data into digital number using ADC.
2. Convert digital number into analog signal using DAC.

D. **Expected Course Outcomes(Cos)**

Interface microcontroller with hardware for given application.

E. **Practical Outcome(PRo)**

Develop a program to Interface 8 bit DAC and ADC with 8051.

F. **Expected Affective domain Outcome(ADos)**

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. **Prerequisite Theory:**

An analog-to-digital converter, or simply ADC, is a semiconductor device that is used to convert an analog signal into a digital code. An analog signal is a signal that may assume any value within a continuous range. Examples of analog signals commonly encountered every day are sound, light, temperature, and pressure, all of which may be represented electrically by an analog voltage or current. Interfacing of ADC0804 with 8051 is shown below in the figure.

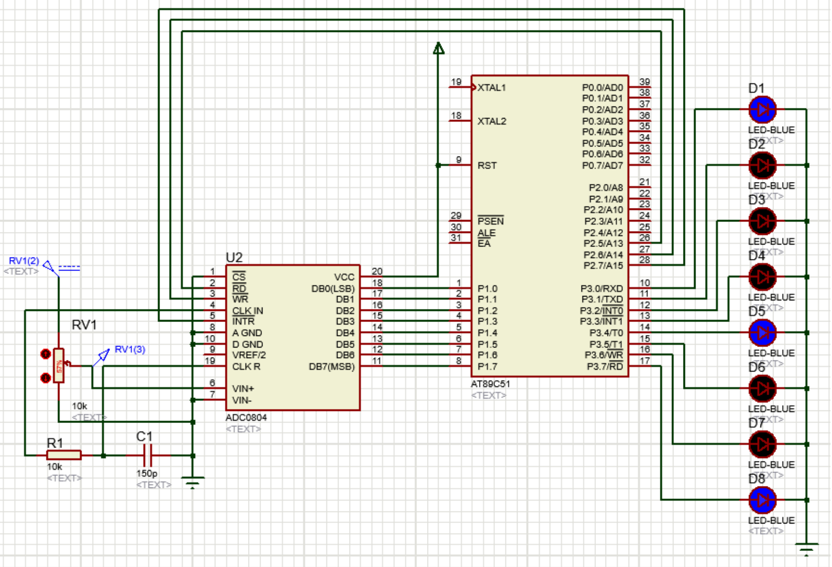

Figure 11 Interfacing of ADC 0804 with 8051

In DAC the number of data bit input decides the resolution since the number of analog output levels is equal to 2^n, where n is the number of data bit inputs. An 8 input DAC provides 256 discrete voltage (or current). The most commonly used, 8-bit, R/2R method followed DAC is DAC 0808

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type "AT89C51".
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	
Note: For Hardware simulation you can also use Proteus 8 Professional			

J. **Safety and necessary Precautions followed:**

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Use always current limiting resistor before interfacing 7-segment display to microcontroller.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Write a program to convert 10k POT value from port 1 into digital and send it to port 3.

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L. **Conclusion:**

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M. Practical related Quiz.

1. If V_{ref} pin is connected to 2.56V then what will be the step size of ADC0808?

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N. References:

https://nptel.ac.in/courses/108105102

O. Assessment-Rubrics

Experiment No 13 Develop a program to Interface 8 bit DAC and ADC with 8051.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.14: Develop a program to interface a DC Motor with 8051.

A. **Objective:**

When we talk about controlling the robot, the first thing comes into the mind is controlling DC motors. Interfacing DC motor to the microcontroller is very important concept in Robotic applications. By interfacing DC motor to the microcontroller, we can do many things like controlling the direction of the motor, controlling the speed of the motor. This practical will help the students to develop skills to control the DC motor using microcontroller.

B. **Expected Program Outcomes (POs):**

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. **Expected Skills to be developed based on competency:**

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Control direction and speed of DC motor.

D. **Expected Course Outcomes(Cos)**

Interface microcontroller with hardware for given application.

E. **Practical Outcome(PRo)**

Develop a program to interface a DC Motor with 8051.

F. **Expected Affective domain Outcome(ADos)**

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. **Prerequisite Theory:**

The maximum output current of microcontroller pin is 15mA at 5V. But the power requirements of most of DC motors is out of reach of the microcontroller and even the back emf which is produced by the motor may damage the microcontroller. Hence, we need motor driver circuit in between a DC motor and the microcontroller. L293D is such motor driver ICs which can drive two DC motors at a time. For L293D Motor Driver, the motor supply is variable between 4.5 to 36V and it provides maximum current of 600mA. An analog-to-digital converter, or simply ADC, is a semiconductor device that is used to convert an analog signal into a digital code. There are 4 input pins for L293D. Motors directions depends on the logic inputs applied at these pins. EN1 and EN2 must be high to drive the 2 DC motors.

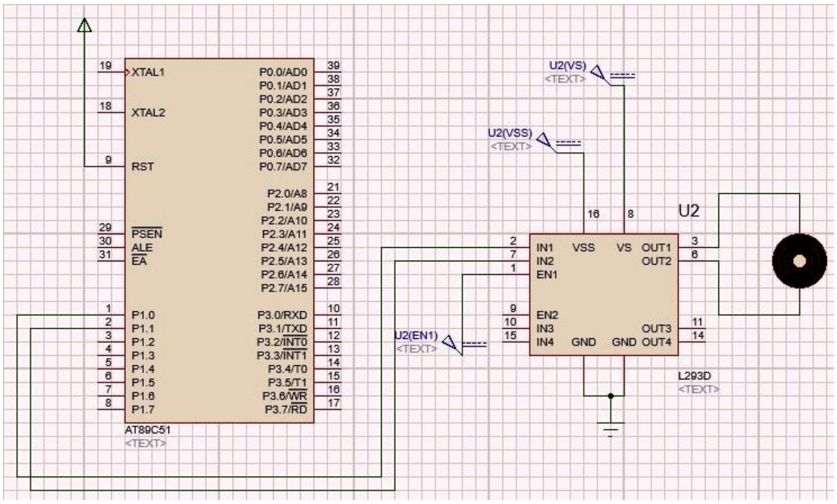

Figure 12 Interfacing of DC Motor with 8051

H. **Procedure:**

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. **Resources/Equipment Required**

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	
Note: For Hardware simulation you can also use Proteus 8 Professional			

J. **Safety and necessary Precautions followed:**

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Use always current limiting resistor before interfacing 7-segment display to microcontroller.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Write a program to rotate DC motor in forward and reverse direction.

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L. Observations (Input-Output):

M. Conclusion:

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N. Practical related Quiz.

1. Why we need motor driver circuit to interface DC motor with 8051 microcontroller?

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O. References:

https://nptel.ac.in/courses/108105102

P. Assessment-Rubrics

Experiment No 14 Develop a program to interface a DC Motor with 8051.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.15: Develop a program to interface LCD Module with 8051.

A. **Objective:**

LCD (Liquid Crystal Display) is an alphanumeric display. It is available in various sizes. We use LCD display for displaying the messages in a more interactive way to operate the system or displaying error messages etc. The selection of LCD is based on application. Generally 16 X 2 LCD is widely used. This practical will help the students to develop skills to display messages on LCD.

B. **Expected Program Outcomes (POs):**

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. **Expected Skills to be developed based on competency:**

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Display different messages on LCD.

D. **Expected Course Outcomes(Cos)**

Interface microcontroller with hardware for given application.

E. **Practical Outcome(PRo)**

Develop a program to interface LCD Module with 8051.

F. **Expected Affective domain Outcome(ADos)**

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. **Prerequisite Theory:**

Liquid Crystal Display also called as LCD is very helpful in providing user interface as well as for debugging purpose. These LCD's are very simple to interface with the controller as well as are cost effective. The LCD requires 3 control lines (RS, R/W & EN) & 8 (or 4) data lines i.e. total 11 lines are required and if operated in 4-bit mode then 4 data lines plus 3 control lines are required.

PIN DISCRIPTION:

Pin No.	Symbol	Function
1	Vss	Ground
2	Vdd	Supply Voltage
3	V0	Contrast Setting
4	RS	Register Select
5	R/W	Read/Write Select
6	En	Chip Enable Signal
7 to 14	DB0-DB7	Data Line
15	A/Vee	GND for the backlight
16	K	Vcc for backlight

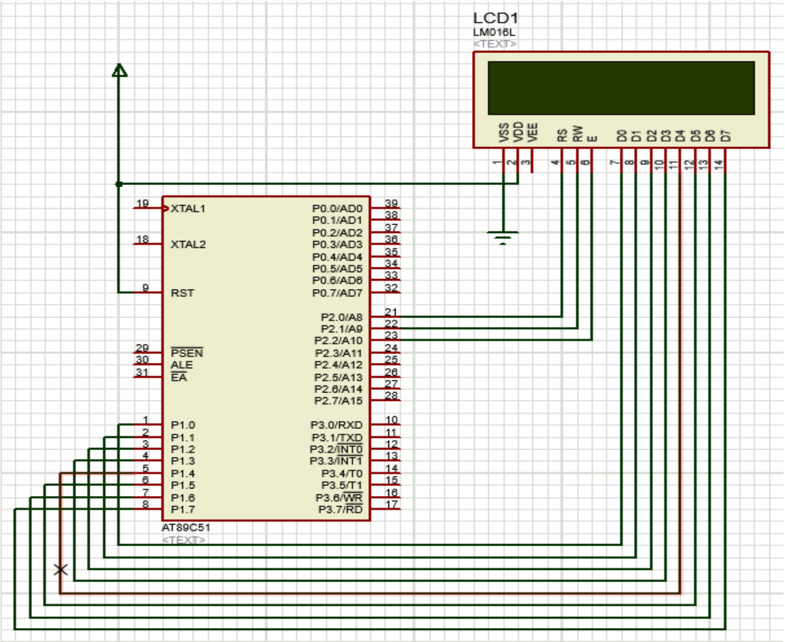

Figure 13 Interfacing of LCD with 8051

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	
Note: For Hardware simulation you can also use Proteus 8 Professional			

J. **Safety and necessary Precautions followed:**

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Use always current limiting resistor before interfacing 7-segment display to microcontroller.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Write a program to display “Hello Word” on LCD.

L. Conclusion:

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M. Practical related Quiz.

1. Write full name of LCD.

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2. State the functions of RS, RW and E Pins in LCD

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N. References:

https://nptel.ac.in/courses/108105102

O. Assessment-Rubrics

Experiment No 15 Develop a program to interface LCD Module with 8051.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date

Date: ……………

Practical No.16: Develop a program to interface a Stepper Motor with 8051.

A. Objective:

Different field applications require precise positioning, repeatability of movement in clockwise and anticlockwise direction with good accuracy. Stepper motors are controlled by microcontrollers in such areas like in computer peripherals, Business machines, process control and for making robots. This practical will help the students to develop skills to interface stepper motor to 8051 and rotate in clockwise and anticlockwise direction.

B. Expected Program Outcomes (POs):

1. Basic & Discipline specific knowledge
2. Problem Analysis
3. Design/ Development of Solution
4. Engineering Tools, Experimentation and Testing
5. Engineering practices for Society, Environment and sustainability
6. Project Management
7. Life-long learning

C. Expected Skills to be developed based on competency:

This practical is expected to develop the following skills for the industry-recognize competency: **'Implement microcontroller-based system/equipment'**

1. Interface stepper motor to microcontroller and rotate in clockwise and anti-clockwise direction at the given angles.

D. Expected Course Outcomes(Cos)

Interface microcontroller with hardware for given application.

E. Practical Outcome(PRo)

Develop a program to interface a Stepper Motor with 8051.

F. Expected Affective domain Outcome(ADos)

1. Operate Computer system/trainer kit carefully with safety and necessary precaution.
2. Follow precautionary measures.
3. Demonstrate working as a leader/ a team member.
4. Follow ethical practices

G. Prerequisite Theory:

A stepper motor is brushless DC motor, which can be rotated in small angles, the angles are called steps. Generally, stepper motors use 200 steps to complete 360-degree rotation, meaning it rotates 1.8 degree per step. Stepper motor used in many devices which needs precise rotational movement like robots, antennas, hard drives etc. We can rotate the stepper motor to any particular angle by giving it proper instructions.

A Stepper motor comes in two types: Unipolar and Bipolar. Unipolar stepper motor generally has five or six wires, in which four wires are one end of four stator coils, and the other end of the four coils is tied together that makes the fifth wire, this is called common wire. Bipolar stepper motor there is just four wires coming out from two sets of coils, meaning there are no common wires.

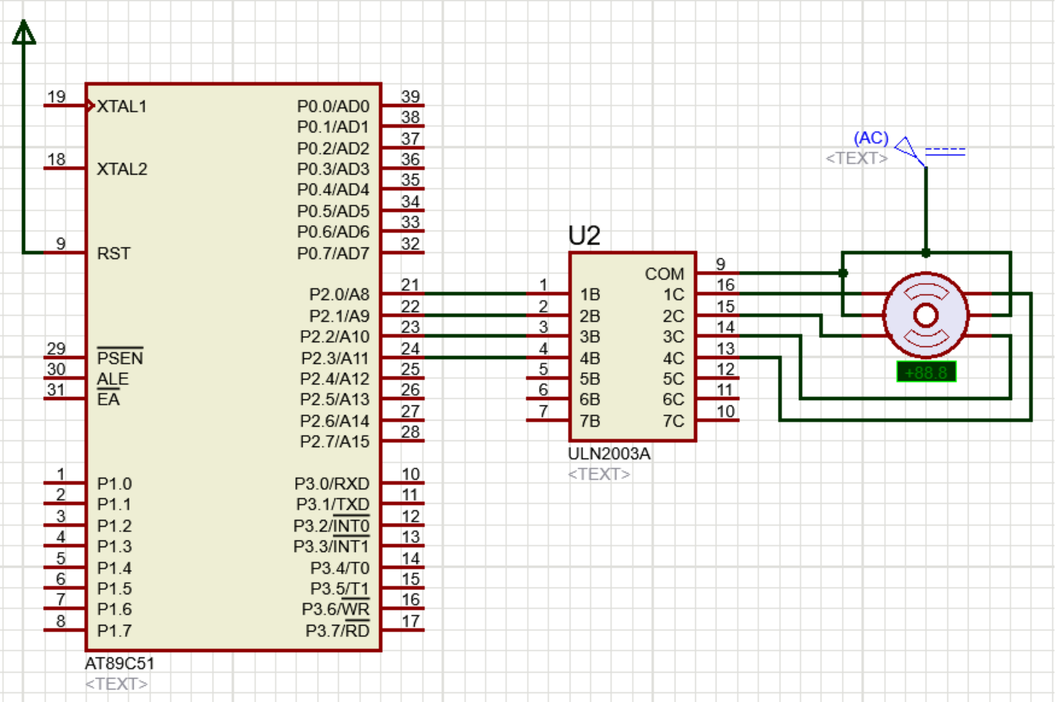

Figure 14 Interfacing of Stepper motor with 8051

Here we are going to interface 6 wires Unipolar Stepper Motor with an 8051 controller. Only four wires are required to control the stepper motor. Two common wires of the stepper motor are connected to the 5V supply. ULN2003 driver is used to driving the stepper motor. Note that to know the winding coil and their center tap leads measure resistance in between leads. From center leads, we will get half the resistance value of that winding.

H. Procedure:

1. Start MCU 8051 IDE by double clicking on its icon.
2. Create a new project.
3. Select processor type “AT89C51”.
4. Enable external RAM and ROM as per requirement.
5. Type the program in text editor and save as filename.asm extension.
6. Compile the program.
7. Start simulation.
8. Run the program step by step.
9. Observe the output on the project window.
10. Note the values of the result of various operations in the observation table.

I. Resources/Equipment Required

Sr. No.	Instrument/Equipment /Components/Trainer kit	Specification	Quantity
1.	Hardware	Computer System with basic configuration	As per Batch Size
2.	Software	Open Source MCU 8051 Simulator	
Note: For Hardware simulation you can also use Proteus 8 Professional			

J. **Safety and necessary Precautions followed:**

1. Handle computer system/Trainer Kit with care.
2. Check rules / syntax of assembly programming
3. Use always current limiting resistor before interfacing 7-segment display to microcontroller.

K. **Source code:** (Programs given below are sample programs faculty can assign similar programs to students)

Sample Program 1: Write a program to rotate stepper motor in clockwise direction by 180^0.

L. **Conclusion:**

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M. **Practical related Quiz.**

1. If a motor takes 90 steps to make one complete revolution, what is the step angle for this motor?

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N. References:

https://nptel.ac.in/courses/108105102

O. Assessment-Rubrics

Experiment No 16 Develop a program to interface a Stepper Motor with 8051.			
Criteria	**M**	**Rubrics**	**Marks**
Procedure Writing/ Developing Logic/ Writing Code	3	Low (0 marks): Student does not write the procedure/ Develop logic/not write code and not know syntax.	
		Medium (1-2 marks): Student writes incomplete procedure/ incomplete program code.	
		High (3 marks): Student writes complete procedure/ complete program code.	
Execution/ Conduction	4	Low (0 marks): Student not able to conduct experiment/ not able to execute program/ not knowing procedure of execution.	
		Medium (1-3 marks): Student incompletes the execution of program with errors	
		High (4 marks): Student completes the connection of circuit/build setup/conduct experiment with safety/execute program without errors showing correct result.	
Observation/Graph/Record Submission	3	Low (0 marks): Student does not submit program and result in time in record book.	
		Medium (1-2 marks): Student submits written program question answers incompletely in record book.	
		High (3 marks): student submits executed program with result noted in record book with all practical related question answers.	
		Marks for Experiment	

Sign with Date