Subject Name Solutions

4341101 – Summer 2025

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

Define Microprocessor and draw its block diagram.

Solution

A **microprocessor** is a programmable digital device that performs arithmetic and logical operations on data according to stored instructions.
Block Diagram:

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph LR
    A[Input Device] {-{-}{} B[CPU]}
    B {-{-}{} C[Output Device]}
    B {{-}{-}{} D[Memory Unit]}
    B {-{-}{} E[Control Unit]}
    B {-{-}{} F[ALU]}
    E {-{-}{} G[Control Signals]}
    F {-{-}{} H[Arithmetic \& Logic Operations]}
{Highlighting}
{Shaded}
```

- **CPU**: Central Processing Unit performs all operations
- **Memory**: Stores programs and data
- **Control Unit**: Controls instruction execution sequence

Mnemonic

"My Computer Processes Instructions" (Memory-CPU-Program-Instructions)

Question 1(b) [4 marks]

Explain operand and opcode with proper instruction example.

Solution

Opcode specifies the operation to be performed. **Operand** specifies the data on which operation is performed.
Example Table:

Instruction	Opcode	Operand	Function
MOV A,B	MOV	A,B	Move B to A
ADD A,#05H	ADD	A,#05H	Add 05H to A

- **Opcode**: Operation code (MOV, ADD, SUB)
- **Operand**: Data or address (A, B, #05H)
- **Format**: Opcode + Operand = Complete Instruction

Mnemonic

"Operation On Data" (Opcode-Operand-Data)

Question 1(c) [7 marks]

Compare Microprocessor and Microcontroller.

Solution

Parameter	Microprocessor	Microcontroller
Definition	CPU only	CPU + Memory + I/O
Memory	External RAM/ROM	Internal RAM/ROM
I/O Ports	External interface	Built-in ports
Cost	Higher system cost	Lower system cost
Power	Higher consumption	Lower consumption
Speed	Faster processing	Moderate speed
Applications	Computers, laptops	Washing machine, microwave

- **Microprocessor**: General purpose computing
- **Microcontroller**: Specific embedded applications
- **Integration**: Microcontroller has everything on single chip

Mnemonic

"Micro Means More Integration" (Microcontroller-Memory-More-Integration)

Question 1(c OR) [7 marks]

Compare RISC and CISC.

Solution

Parameter	RISC	CISC
Instructions	Simple, few	Complex, many
Instruction Size	Fixed length	Variable length
Execution Time	Single cycle	Multiple cycles
Memory Access	Load/Store only	Any instruction
Registers	More registers	Fewer registers
Pipeline	Efficient pipelining	Complex pipelining
Examples	ARM, MIPS	x86, 8085

- **RISC**: Reduced Instruction Set Computer
- **CISC**: Complex Instruction Set Computer
- **Performance**: RISC faster, CISC more flexible

Mnemonic

"Reduced Instructions Speed Computing" (RISC-Instructions-Speed-Computing)

Question 2(a) [3 marks]

Explain Bus Organization of 8085 microprocessor.

Solution

8085 has **three types** of buses for communication with external devices.
Bus Organization Table:

Bus Type	Lines	Function
Address Bus	16 lines (A0-A15)	Memory addressing
Data Bus	8 lines (D0-D7)	Data transfer
Control Bus	Multiple lines	Control signals

- **Address Bus**: Unidirectional, 64KB memory addressing
- **Data Bus**: Bidirectional, 8-bit data transfer
- **Control Bus**: Read, Write, IO/M signals

Mnemonic

"Address Data Control" (ADC)

Question 2(b) [4 marks]

Explain function of ALE signal with diagram.

Solution

ALE (Address Latch Enable) separates address and data on multiplexed bus.
ALE Timing Diagram:

```
    ALE  \_\_\_\_       \_\_\_\_
        |    |\_\_\_\_|    |\_\_\_\_

  AD7{-0 ADDR |   DATA  | ADDR}
       \_\_\_\_\_|\_\_\_\_\_\_\_\_\_\_|\_\_\_\_\_
```

- **High ALE**: Address is available on AD0-AD7
- **Low ALE**: Data is available on AD0-AD7
- **Function**: Latches lower address byte
- **Frequency**: ALE = Clock frequency ÷2

Mnemonic

"Address Latch Enable" (ALE)

Question 2(c) [7 marks]

Describe architecture of 8085 microprocessor with the help of neat diagram.

Solution

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[Accumulator A] {-{-}{} B[ALU]}
    C[Temp Register] {-{-}{} B}
    B {-{-}{} D[Flag Register]}
    E[B,C,D,E,H,L Registers] {-{-}{} F[Address Buffer]}
    G[Program Counter] {-{-}{} F}
    H[Stack Pointer] {-{-}{} F}
    F {-{-}{} I[Address Bus A0{-}A15]}
    J[Data/Address Buffer] {-{-}{} K[Data Bus AD0{-}AD7]}
    L[Instruction Register] {-{-}{} M[Instruction Decoder]}
    M {-{-}{} N[Control Unit]}
    N {-{-}{} O[Control Signals]}
{Highlighting}
```

{Shaded}

Key Components:
- **ALU**: Performs arithmetic and logical operations
- **Registers**: Store temporary data (A, B, C, D, E, H, L)
- **Program Counter**: Points to next instruction
- **Stack Pointer**: Points to stack top
- **Control Unit**: Generates control signals

Mnemonic

"All Registers Program Stack Control" (A-R-P-S-C)

Question 2(a OR) [3 marks]

Draw Flag Register of 8085 microprocessor & explain it.

Solution

Flag Register Format:

```
 D7  D6  D5  D4  D3  D2  D1  D0
+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+
| S | Z | 0 |AC | 0 | P | 1 | C |
+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+
```

Flag Functions:
- **S (Sign)**: Set if result is negative
- **Z (Zero)**: Set if result is zero
- **AC (Auxiliary Carry)**: Set for BCD operations
- **P (Parity)**: Set for even parity
- **C (Carry)**: Set when carry/borrow occurs

Mnemonic

"Some Zero Auxiliary Parity Carry" (SZAPC)

Question 2(b OR) [4 marks]

Explain De-multiplexing of Address and Data buses for 8085 Microprocessor.

Solution

De-multiplexing separates address and data signals from AD0-AD7 lines.
De-multiplexing Circuit:

```
AD0{-AD7 {-}{-}{-}{-}+{-}{-}{-}{-} D{-}Latch {-}{-}{-}{-} A0{-}A7 (Address)}
            |          \^{}
            |          |
            |        ALE
            |
            +{-{-}{-}{-} Data Buffer {-}{-}{-}{-} D0{-}D7 (Data)}
```

- **ALE High**: Address latched in external latch
- **ALE Low**: Data flows through buffer
- **74LS373**: Common latch IC used
- **Benefit**: Separate address and data buses

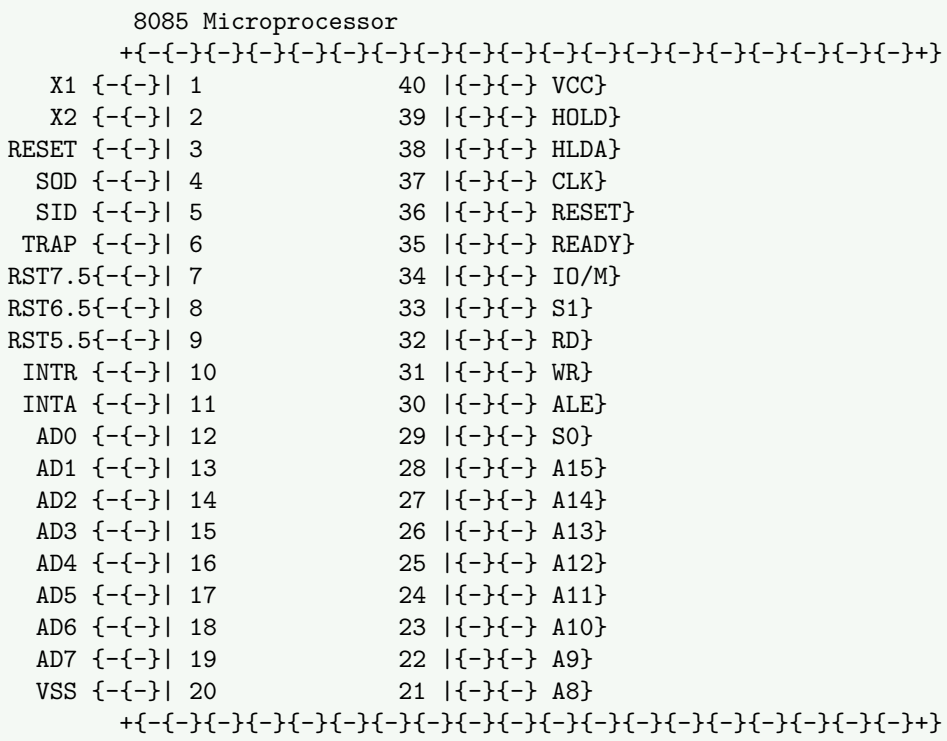
Mnemonic

"Address Latch External Demultiplex" (ALED)

Question 2(c OR) [7 marks]

Describe Pin diagram of 8085 microprocessor with the help of neat diagram.

Solution



Pin Categories:

- **Power**: VCC, VSS
- **Clock**: X1, X2, CLK
- **Address/Data**: AD0-AD7, A8-A15
- **Control**: ALE, RD, WR, IO/M
- **Interrupt**: INTR, INTA, RST7.5, RST6.5, RST5.5, TRAP

Mnemonic

"Power Clock Address Control Interrupt" (PCACI)

Question 3(a) [3 marks]

Write a function of DPTR and PC.

Solution

Functions Table:

Register	Function	Size
DPTR	Data Pointer	16-bit
PC	Program Counter	16-bit

DPTR Functions:

- **External Memory**: Access external data memory
- **Addressing**: 16-bit address for MOVX instructions

PC Functions:

- **Instruction Pointer**: Points to next instruction
- **Auto Increment**: Increments after each instruction fetch

Mnemonic

"Data Program Counter" (DPC)

Question 3(b) [4 marks]

Draw PCON SFR of 8051and Explain function of each bit.

Solution

PCON Register (87H):

```
 D7  D6  D5  D4  D3  D2  D1  D0
+{-{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+}
|SMOD| {- | {-} | {-} |GF1|GF0|PD |IDL|}
+{-{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+{-}{-}{-}+}
```

Bit Functions:

- **SMOD**: Serial port baud rate doubler
- **GF1, GF0**: General purpose flags
- **PD**: Power Down mode control

- **IDL**: Idle mode control

Power Management:

- **IDL = 1**: CPU stops, peripherals run
- **PD = 1**: Complete power down

Mnemonic

"Serial General Power Idle" (SGPI)

Question 3(c) [7 marks]

Explain architecture of 8051 microcontroller with the help of neat diagram.

Solution

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[CPU Core] {-{-}{} B[ALU]}
    A {-{-}{} C[Accumulator A]}
    A {-{-}{} D[B Register]}
    A {-{-}{} E[PSW]}
    F[Program Memory ROM] {-{-}{} G[Program Counter PC]}
    H[Data Memory RAM] {-{-}{} I[Data Pointer DPTR]}
    J[Timer 0] {-{-}{} K[Timer Control]}
    L[Timer 1] {-{-}{} K}
    M[Serial Port] {-{-}{} N[Serial Control]}
    O[Port 0] {-{-}{} P[I/O Control]}
    Q[Port 1] {-{-}{} P}
    R[Port 2] {-{-}{} P}
    S[Port 3] {-{-}{} P}
    T[Interrupt System] {-{-}{} U[Interrupt Control]}
{Highlighting}
{Shaded}
```

Major Blocks:

- **CPU**: 8-bit processor with ALU
- **Memory**: 4KB ROM, 128B RAM
- **Timers**: Two 16-bit timers

- **Serial Port**: Full duplex UART
- **I/O Ports**: Four 8-bit ports
- **Interrupts**: 5 interrupt sources

Mnemonic

"CPU Memory Timer Serial IO Interrupt" (CMTSII)

Question 3(a OR) [3 marks]

List common features of 8051 microcontroller.

Solution

Common Features:

- **CPU**: 8-bit microcontroller
- **Memory**: 4KB ROM, 128B RAM
- **I/O Ports**: 32 I/O lines (4 ports)
- **Timers**: Two 16-bit timers/counters
- **Serial Port**: Full duplex UART
- **Interrupts**: 5 interrupt sources
- **Clock**: 12MHz maximum frequency

Mnemonic

"CPU Memory IO Timer Serial Interrupt Clock" (CMITSIC)

Question 3(b OR) [4 marks]

Draw IP SFR of 8051 and Explain function of each bit.

Solution

IP Register (B8H):

```
 D7  D6  D5  D4  D3  D2  D1  D0
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| -  |  -  |  -  | PS | PT1| PX1| PT0| PX0|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Bit Functions:

- **PS**: Serial port interrupt priority
- **PT1**: Timer 1 interrupt priority
- **PX1**: External interrupt 1 priority
- **PT0**: Timer 0 interrupt priority
- **PX0**: External interrupt 0 priority

Priority Levels:

- **1**: High priority
- **0**: Low priority

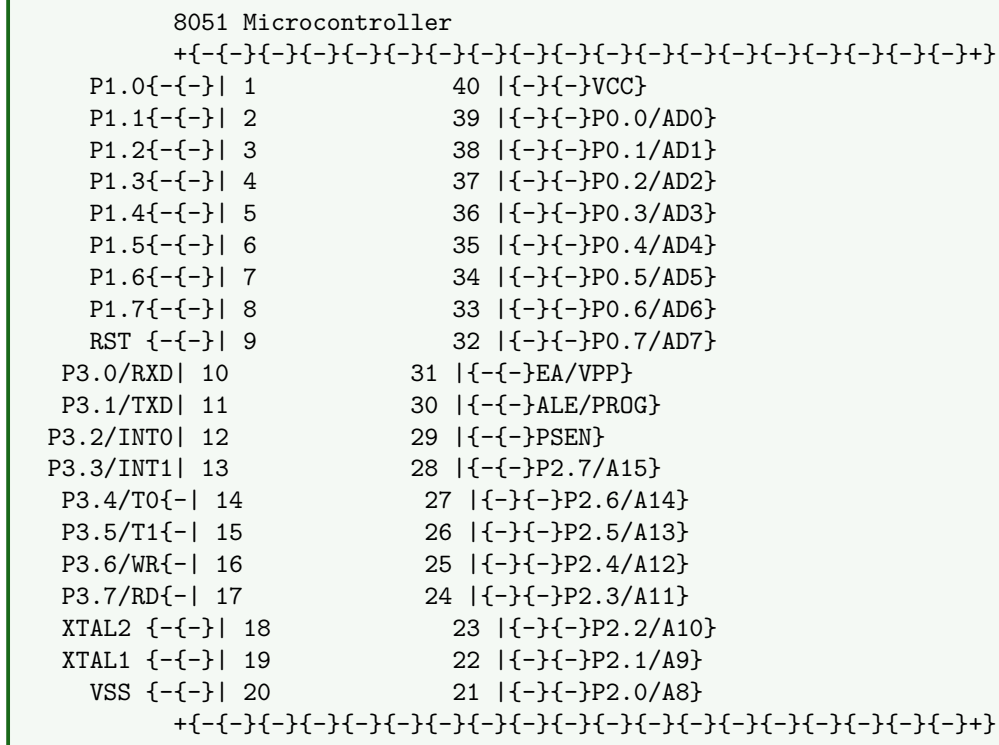
Mnemonic

"Priority Serial Timer External" (PSTE)

Question 3(c OR) [7 marks]

With the help of neat diagram explain Pin diagram of 8051 microcontroller.

Solution



Pin Groups:

- **Power**: VCC (40), VSS (20)
- **Clock**: XTAL1 (19), XTAL2 (18)
- **Reset**: RST (9)
- **Ports**: P0, P1, P2, P3
- **Control**: ALE, PSEN, EA

Mnemonic

"Power Clock Reset Ports Control" (PCRPC)

Question 4(a) [3 marks]

Explain arithmetic instructions with example.

Solution

Arithmetic Instructions:

Instruction	Function	Example
ADD	Addition	ADD A,#10H
SUBB	Subtraction	SUBB A,R0
MUL	Multiplication	MUL AB
DIV	Division	DIV AB
INC	Increment	INC A
DEC	Decrement	DEC R1

- **ADD A,#10H**: Add 10H to accumulator
- **Flags**: Affected by arithmetic operations

Mnemonic

"Add Subtract Multiply Divide Increment Decrement" (ASMIDI)

Question 4(b) [4 marks]

Write an 8051 Assembly Language Program to Find 2's complement of a value stored at memory location 65H. Put the result on same location.

Solution

```
ORG 0000H            ; Program start address
MOV A,65H            ; Load value from location 65H
CPL A                ; Complement the value (1{s complement)}
ADD A,\#01H           ; Add 1 to get 2{s complement}
MOV 65H,A            ; Store result back to 65H
SJMP $               ; Stop program
END
```

Program Steps:

- **Load**: Get value from memory location 65H
- **Complement**: Generate 1's complement using CPL
- **Add 1**: Convert to 2's complement
- **Store**: Put result back to same location

Mnemonic

"Load Complement Add Store" (LCAS)

Question 4(c) [7 marks]

List Addressing Modes of 8051 Microcontroller and explain them with example.

Solution

Addressing Modes Table:

Mode	Description	Example	Usage
Immediate	Data in instruction	MOV A,#25H	Constant data
Register	Data in register	MOV A,R0	Fast access
Direct	Memory address	MOV A,30H	RAM access
Indirect	Address in register	MOV A,@R0	Pointer access
Indexed	Base + offset	MOVC A,@A+DPTR	Table access
Relative	PC + offset	SJMP LOOP	Branch instructions
Bit	Bit address	SETB P1.0	Bit operations

Examples:

- **MOV A,#25H**: Load immediate value 25H
- **MOV A,@R0**: Load from address in R0
- **SJMP LOOP**: Jump relative to current PC

Mnemonic

"Immediate Register Direct Indirect Indexed Relative Bit" (IRDIIRB)

Question 4(a OR) [3 marks]

Explain logical instruction with example.

Solution

Logical Instructions:

Instruction	Function	Example
ANL	AND operation	ANL A,#0FH

ORL	OR operation	ORL A,R1
XRL	XOR operation	XRL A,#55H
CPL	Complement	CPL A
RL	Rotate left	RL A
RR	Rotate right	RR A

- **ANL A,#0FH**: AND accumulator with 0FH (mask operation)
- **Applications**: Bit masking, data manipulation

Mnemonic

"AND OR XOR Complement Rotate" (AOXCR)

Question 4(b OR) [4 marks]

Write an 8051 Assembly Language Program to Multiply the number in register R3 by the number in register R0 and put the result in internal RAM location 10h(MSB) and 11h(LSB).

Solution

```
ORG 0000H           ; Program start address
MOV A,R3            ; Move R3 to accumulator
MOV B,R0            ; Move R0 to B register
MUL AB              ; Multiply A and B
MOV 10H,B           ; Store MSB (B) to location 10H
MOV 11H,A           ; Store LSB (A) to location 11H
SJMP $              ; Stop program
END
```

Program Flow:

- **Load**: Move multiplicand and multiplier to A and B
- **Multiply**: Use MUL AB instruction
- **Store**: MSB in B register, LSB in A register
- **Result**: 16-bit result stored in two locations

Mnemonic

"Load Multiply Store Result" (LMSR)

Question 4(c OR) [7 marks]

Explain data transfer instruction with example.

Solution

Data Transfer Instructions:

Category	Instruction	Example	Function
Register	MOV	MOV A,R0	Register to register
Immediate	MOV	MOV A,#25H	Immediate to register
Direct	MOV	MOV A,30H	Memory to register
Indirect	MOV	MOV A,@R0	Indirect addressing
External	MOVX	MOVX A,@DPTR	External memory
Code	MOVC	MOVC A,@A+DPTR	Code memory
Stack	PUSH/POP	PUSH ACC	Stack operations

Examples:
- **MOV A,R0**: Move R0 content to accumulator
- **MOVX A,@DPTR**: Read from external data memory
- **PUSH ACC**: Push accumulator to stack

Data Movement:
- **Internal**: Within 8051 memory space
- **External**: To/from external memory
- **Code**: From program memory

Mnemonic

"Move Data Between Locations" (MDBL)

Question 5(a) [3 marks]

Explain the 8051 flags with the help of PSW format.

Solution

PSW Register (D0H):

```
 D7  D6  D5  D4  D3  D2  D1  D0
+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+
| C |AC | F0|RS1|RS0| OV| {- | P |}
+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+{-}{-}+
```

Flag Functions:
- **C (Carry)**: Set when carry/borrow occurs
- **AC (Auxiliary Carry)**: For BCD arithmetic
- **OV (Overflow)**: Set when signed overflow
- **P (Parity)**: Even parity of accumulator
- **RS1, RS0**: Register bank select bits

Mnemonic

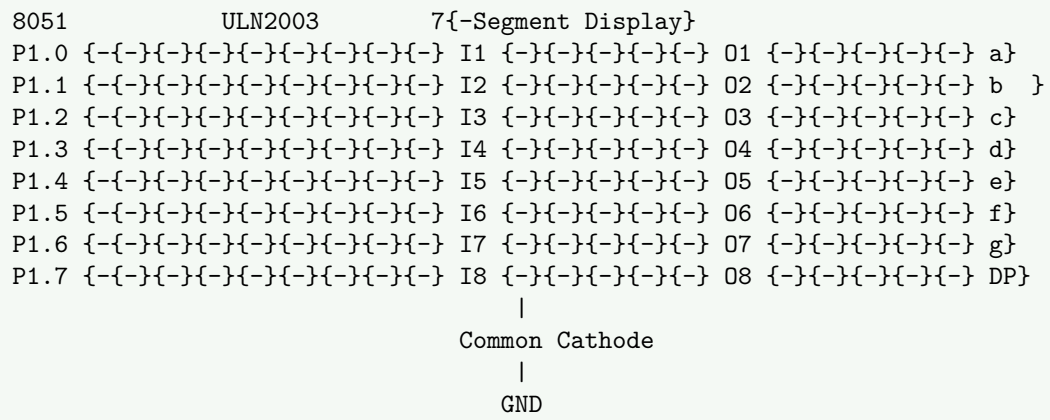
"Carry Auxiliary Overflow Parity Register" (CAOPR)

Question 5(b) [4 marks]

Draw and explain diagram Interfacing 7 segment with microcontroller.

Solution

7-Segment Interface Circuit:



Components:
- **ULN2003**: Current driver IC

- **Resistors**: Current limiting (330Ω)
- **Display**: Common cathode type

Working: Port data drives display segments through current driver

Mnemonic

"Port Driver Display Ground" (PDDG)

Question 5(c) [7 marks]

Interface 8 LEDs with microcontroller and write a program to turn on and off.

Solution

LED Interface Circuit:

```
    8051            Current Limiting      LEDs
    P1.0 {-}{-}{-}{-}{-}{-}{-}{-} 330Ω {-}{-}{-}{-}{-}{-}{-}{-} LED0 {-}{-}{-}{-}{-} +5V}
    P1.1 {-}{-}{-}{-}{-}{-}{-}{-} 330Ω {-}{-}{-}{-}{-}{-}{-}{-} LED1 {-}{-}{-}{-}{-} +5V}
    P1.2 {-}{-}{-}{-}{-}{-}{-}{-} 330Ω {-}{-}{-}{-}{-}{-}{-}{-} LED2 {-}{-}{-}{-}{-} +5V}
    P1.3 {-}{-}{-}{-}{-}{-}{-}{-} 330Ω {-}{-}{-}{-}{-}{-}{-}{-} LED3 {-}{-}{-}{-}{-} +5V}
    P1.4 {-}{-}{-}{-}{-}{-}{-}{-} 330Ω {-}{-}{-}{-}{-}{-}{-}{-} LED4 {-}{-}{-}{-}{-} +5V}
    P1.5 {-}{-}{-}{-}{-}{-}{-}{-} 330Ω {-}{-}{-}{-}{-}{-}{-}{-} LED5 {-}{-}{-}{-}{-} +5V}
    P1.6 {-}{-}{-}{-}{-}{-}{-}{-} 330Ω {-}{-}{-}{-}{-}{-}{-}{-} LED6 {-}{-}{-}{-}{-} +5V}
    P1.7 {-}{-}{-}{-}{-}{-}{-}{-} 330Ω {-}{-}{-}{-}{-}{-}{-}{-} LED7 {-}{-}{-}{-}{-} +5V}
```

Assembly Program:

```
ORG 0000H           ; Start address
MAIN:
    MOV P1,\#0FFH    ; Turn on all LEDs (logic 0)
    CALL DELAY      ; Call delay subroutine
    MOV P1,\#00H     ; Turn off all LEDs (logic 1)
    CALL DELAY      ; Call delay subroutine
    SJMP MAIN       ; Repeat continuously

DELAY:
    MOV R2,\#250     ; Outer loop counter
D1: MOV R3,\#250     ; Inner loop counter
D2: DJNZ R3,D2      ; Decrement R3 until zero
    DJNZ R2,D1      ; Decrement R2 until zero
    RET             ; Return from subroutine
END
```

Mnemonic

"Light Emitting Display Interface" (LEDI)

Question 5(a OR) [3 marks]

List Applications of microcontroller in various fields.

Solution

Applications by Field:

Field	Applications
Home	Washing machine, Microwave, AC
Automotive	Engine control, ABS, Airbag
Industrial	Process control, Robotics

Medical	Pacemaker, Blood pressure monitor
Communication	Mobile phones, Modems
Security	Access control, Burglar alarm
Entertainment	Gaming consoles, Remote control

Mnemonic

"Home Auto Industrial Medical Communication Security Entertainment" (HAIMCSE)

Question 5(b OR) [4 marks]

Draw and explain diagram interfacing of DC motor with 8051.

Solution

DC Motor Interface:

```
    8051       L293D Motor Driver         DC Motor
    P1.0 {-{-}{-}{-}{-}{-}{-} Enable Pin                 |}
    P1.1 {-{-}{-}{-}{-}{-}{-} Input 1  {-}{-}{-}{-}{-} Output 1 {-}{-}+}
    P1.2 {-{-}{-}{-}{-}{-}{-} Input 2  {-}{-}{-}{-}{-} Output 2 {-}{-}+}
                    |              |
                   VCC            GND
                    |              |
                  +12V           Motor
```

Components:

- **L293D**: Dual H-bridge driver IC
- **Motor**: 12V DC motor
- **Control**: Direction and speed control

Control Logic:

- **Forward**: P1.1=1, P1.2=0
- **Reverse**: P1.1=0, P1.2=1
- **Stop**: P1.1=0, P1.2=0

Mnemonic

"Driver Control Motor Direction" (DCMD)

Question 5(c OR) [7 marks]

Interface LCD with microcontroller and write a program to display "Microprocessor and Microcontroller".

Solution

LCD Interface:

```
    8051                16x2 LCD
    P2.0 {-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-} RS (Register Select)}
    P2.1 {-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-} EN (Enable)  }
    P1.0{-P1.7 {-}{-}{-}{-}{-}{-}{-}{-} D0{-}D7 (Data lines)}
    GND {-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-} VSS, RW}
    +5V {-{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-} VDD, VEE (via 10kΩ pot)}
```

Assembly Program:

```
ORG 0000H
    CALL LCD\_INIT       ; Initialize LCD
    MOV DPTR,\#MSG1     ; Point to message
    CALL DISPLAY\_MSG    ; Display message
```

```
    SJMP $              ; Stop

LCD\_INIT:
    MOV P1,\#38H         ; Function set: 8{-bit, 2{-}line}
    CLR P2.0            ; RS=0 (command)
    SETB P2.1           ; EN=1
    CLR P2.1            ; EN=0 (pulse)
    CALL DELAY
    MOV P1,\#01H         ; Clear display
    CLR P2.0
    SETB P2.1
    CLR P2.1
    CALL DELAY
    RET

DISPLAY\_MSG:
    MOV P1,A            ; Send character
    SETB P2.0           ; RS=1 (data)
    SETB P2.1           ; EN=1
    CLR P2.1            ; EN=0
    CALL DELAY
    RET

MSG1: DB "Microprocessor and Microcontroller",0

DELAY:
    MOV R1,\#50
D1: MOV R2,\#255
D2: DJNZ R2,D2
    DJNZ R1,D1
    RET
END
```

Mnemonic

“Liquid Crystal Display Interface” (LCDI)