

Microprocessor and Microcontroller (4341101) - Winter 2024 Solution

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Question 1 [a marks]

3 List Common features of Microcontrollers.

Solution

Answer:

Table 1. Common Features

Feature	Purpose
CPU Core	Process instructions
Memory (RAM/ROM)	Store program and data
I/O Ports	Interface with external devices
Timers/Counters	Measure time intervals
Interrupts	Handle asynchronous events
Serial Communication	Transfer data with other devices

Mnemonic

“CRITICS” (CPU-ROM-I/O-Timers-Interrupts-Communication-Serial)

Question 1 [b marks]

4 Explain the functions of ALU.

Mnemonic

“ALFS” (Arithmetic-Logic-Flags-Status)

Question 1 [c marks]

7 Define: Memory, Operand, Instruction Cycle, Opcode, CU, Machine Cycle, CISC

Solution

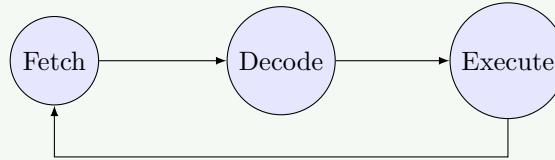
Answer:

Table 3. Definitions

Term	Definition
Memory	Storage unit that holds data and instructions (Valid Address Space).
Operand	Data value or address used in an operation.
Instruction Cycle	Complete process of fetching and executing an instruction.
Opcode	Operation code that specifies the instruction type (e.g., MOV, ADD).
CU	Control Unit that coordinates processor operations.
Machine Cycle	Basic operation cycle consisting of T-states required to access memory or I/O.
CISC	Complex Instruction Set Computer with rich instruction set.

- **Memory:** Organized array of storage cells with unique addresses.
- **Operand:** Data elements that instructions operate upon.
- **Instruction Cycle:** Fetch-decode-execute sequence for each instruction.
- **Opcode:** Binary code that tells processor what operation to perform.

Instruction Cycle Diagram:



Mnemonic

“MO-ICO-MC” (Memory-Operand-Instruction-Control-Operation-Machine-Complex)

OR

Question 1 [c marks]

7 i) Define: Microprocessor. ii) Compare Von-Neumann and Harvard architecture.

Solution

Answer:

i) **Microprocessor Definition:** An integrated circuit containing the CPU functionality of a computer, capable of fetching, decoding, and executing instructions with ALU and control circuitry on a single chip.

ii) Von-Neumann vs Harvard Architecture:

Table 4. Comparison

Feature	Von-Neumann	Harvard
Memory	Single shared memory	Separate program & data memory
Bus	Single bus for data & instructions	Separate buses
Speed	Slower (memory bottleneck)	Faster (parallel access)
Complexity	Simpler design	More complex
Applications	General computing	Real-time systems

Diagrams:



Mnemonic

“Harvard Has Separate Spaces”

Question 2 [a marks]

3 Explain various Registers of 8085 microprocessor.

Solution

Answer:

Table 5. 8085 Registers

Register	Size	Function
Accumulator (A)	8-bit	Main register for arithmetic & logic operations.
General Purpose	8-bit	B, C, D, E, H, L (Temporary data storage). Pairs: BC, DE, HL.
Program Counter (PC)	16-bit	Points to the address of the next instruction.
Stack Pointer (SP)	16-bit	Points to the top of the stack memory.
Flag Register	8-bit	Stores status flags (Z, S, P, CY, AC).

Mnemonic

“AGSF” (Accumulator-General-Stack-Flags)

Question 2 [b marks]

4 Explain Fetching, Decoding and Execution of Instruction.

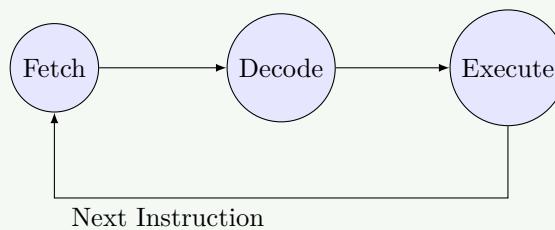
Solution

Answer:

Table 6. Instruction Phases

Phase	Activity	Hardware Involved
Fetching	Processor gets instruction from memory address pointed by PC.	PC, Address bus, Memory, Data Bus
Decoding	Processor identifies the operation and operands.	Instruction Register, Decoder, Control Unit
Execution	Processor performs the specified operation (Arithmetic, Logic, Move).	ALU, Registers, Data bus

Diagram:



- Fetching:** PC contents are placed on address bus. Memory reads op-code and places it on data bus. Op-code moves to Instruction Register (IR).

- **Decoding:** Control unit interprets the op-code to determine what action to take.
- **Execution:** Control unit generates signals to perform the action (e.g., enable ALU, read/write memory).

Mnemonic

“FDE” (Fetch-Decode-Execute)

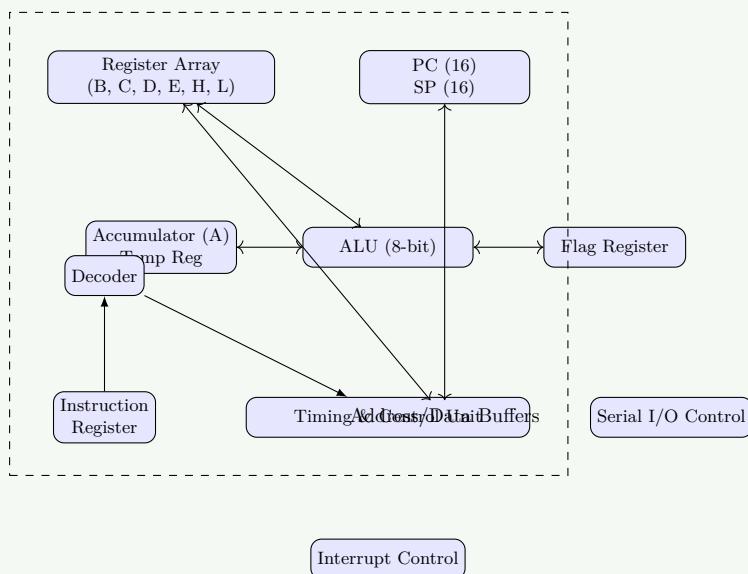
Question 2 [c marks]

7 Describe block diagram of 8085 microprocessor with the help of neat diagram.

Solution

Answer:

Diagram:



- **ALU:** Performs arithmetic and logical operations in 8-bit.
- **Register Array:** Includes temporary registers (B, C, D, E, H, L) and special purpose registers (PC, SP).
- **Control Unit:** Generates timing and control signals (RD, WR, ALE, etc.).
- **Instruction Register & Decoder:** Fetches op-code, decodes it, and executes.
- **Interrupt Control:** Handles hardware interrupts (INTR, RST, TRAP).
- **Serial I/O:** Handles SID (Serial Input Data) and SOD (Serial Output Data).

Mnemonic

“RAID” (Registers-ALU-Instructions-Decoders)

OR

Question 2 [a marks]

3 Compare Microprocessor & Microcontroller.

Solution

Answer:

Table 7. Comparison

Feature	Microprocessor	Microcontroller
Design	CPU only (External components needed)	CPU + Peripherals (System on Chip)
Memory	External RAM/ROM	Internal RAM/ROM
I/O ports	Limited/None (External interfacing)	Many built-in I/O ports
Applications	General purpose computing (Laptops, PCs)	Embedded systems (Washing machines, Remotes)
Cost	Higher system cost	Lower system cost
Example	Intel 8085, 8086, Core i7	Intel 8051, AVR, PIC

Mnemonic

“Micro-P Processes, Micro-C Controls”

OR

Question 2 [b marks]

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

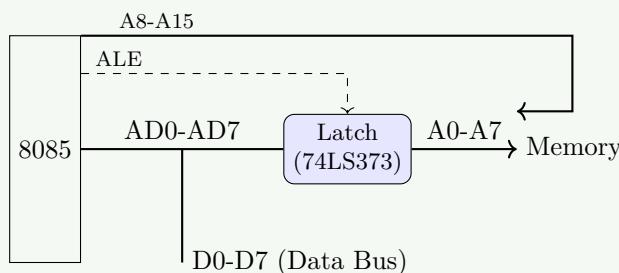
Solution

Answer: Address lines A0-A7 and Data lines D0-D7 are multiplexed as AD0-AD7 to save pins. They must be separated (demultiplexed) to talk to memory.

Steps:

1. **ALE High:** Microprocessor sends ALE=1. AD0-AD7 carries address. Latch is enabled.
2. **Latch:** External Latch (e.g., 74LS373) captures the address (A0-A7).
3. **ALE Low:** ALE=0. Latch holds the address. AD0-AD7 lines are now free to carry Data (D0-D7).

Diagram:



Mnemonic

“ALAD” (ALE-Latches-Address-Data)

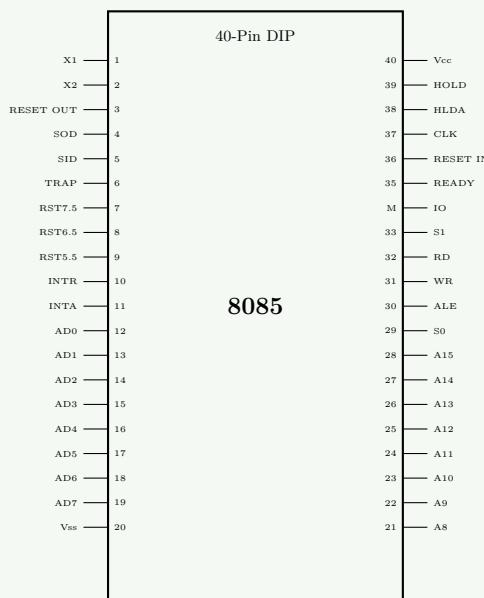
OR

Question 2 [c marks]

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

Solution

Answer:



- Address/Data:** AD0-AD7 (Multiplexed), A8-A15 (High Address).
- Control & Status:** ALE (Address Latch Enable), RD (Read), WR (Write), IO/M (Select IO or Memory), S0, S1 (Status).
- Interrupts:** INTR, INTA, RST 5.5, RST 6.5, RST 7.5, TRAP.
- Serial I/O:** SID (Input), SOD (Output).
- DMA:** HOLD, HLDA.
- Power/Clock:** Vcc (+5V), Vss (GND), X1, X2 (Crystal).

Mnemonic

“ACID-PS” (Address-Control-Interrupt-DMA-Power-Serial)

Question 3 [a marks]

3 Explain interrupts of 8051 microcontroller.

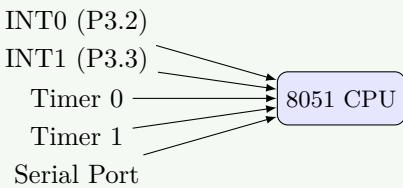
Solution

Answer:

Table 8. 8051 Interrupts

Interrupt	Vector	Priority	Source
External 0	0003H	1 (Highest)	Pin INT0 (P3.2)
Timer 0	000BH	2	Timer 0 overflow (TF0)
External 1	0013H	3	Pin INT1 (P3.3)
Timer 1	001BH	4	Timer 1 overflow (TF1)
Serial	0023H	5 (Lowest)	RI or TI (Serial Port)

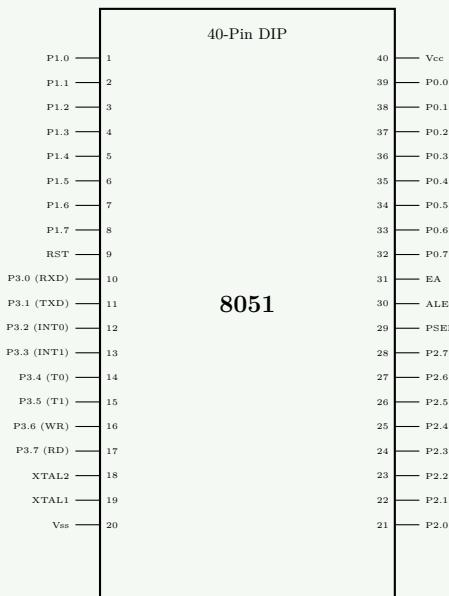
Diagram:

**Mnemonic**

“ETTES” (External-Timer-Timer-External-Serial)

Question 3 [b marks]

4 Draw Pin diagram of 8051 microcontroller.

Solution**Answer:**

- P0.0-P0.7:** Port 0 (Address/Data AD0-AD7).
- P1.0-P1.7:** Port 1 (I/O).
- P2.0-P2.7:** Port 2 (Address A8-A15).
- P3.0-P3.7:** Port 3 (Special functions like RD, WR, INT).
- Power:** Vcc (40), Vss (20).
- Control:** RST, ALE, PSEN, EA.

Mnemonic

“PORT 0123”

Question 3 [c marks]

7 Explain Internal RAM Organization of 8051 microcontroller.

- Register Banks (00H-1FH):** 4 Banks of 8 registers each. Selected by RS0, RS1 bits in PSW.

- **Bit Addressable (20H-2FH)**: 16 bytes where each bit can be individually accessed (set/cleared).
- **General Purpose (30H-7FH)**: 80 bytes used for data storage and stack.
- **SFRs (80H-FFH)**: Mapped in upper 128 bytes (Direct Access only).

OR

Question 3 [a marks]

3 List SFRs with their addresses.

Solution

Answer:

Table 9. Special Function Registers

SFR	Address	Function
P0	80H	Port 0
SP	81H	Stack Pointer
DPH:DPL	83H:82H	Data Pointer (16-bit)
PCON	87H	Power Control
TCON	88H	Timer Control
TMOD	89H	Timer Mode
TL0	8AH	Timer 0 Low Byte
TL1	8BH	Timer 1 Low Byte
TH0	8CH	Timer 0 High Byte
TH1	8DH	Timer 1 High Byte
P1	90H	Port 1
SCON	98H	Serial Control
SBUF	99H	Serial Buffer
P2	A0H	Port 2
IE	A8H	Interrupt Enable
P3	B0H	Port 3
IP	B8H	Interrupt Priority
PSW	D0H	Program Status Word
ACC (A)	E0H	Accumulator
B	F0H	B Register

Mnemonic

“PDPT-SP” (Ports-Data-Program-Timers-Serial-Prioritized)

OR

Question 3 [b marks]

4 Explain Timers/Counters logic diagram of 8051 microcontroller.

OR

Question 3 [c marks]

7 Explain block diagram of 8051 microcontroller.

!

Question 4 [a marks]

3 Write an 8051 Assembly Language Program to add two bytes of data and store result in R4 register.

Solution

Answer:

b₇ A, 25H ; Load first value (25H) into Accumulator
 MOV R3, 18H ; Load second value (18H) into R3
 ADD A, R3 ; Add R3 to Accumulator (A = A + R3)
 MOV R4, A ; Store result from A into R4

Steps:

1. Load first operand in A.
2. Load second operand in R3.
3. Perform ADD operation.
4. Move result to R4.

Mnemonic

“LLAS” (Load-Load-Add-Store)

Question 4 [b marks]

4 Write an 8051 Assembly Language Program to OR the contents of Port-1 and Port-2 then put the result in external RAM location 0200H.

Solution

Answer:

```

1 MOV A, P1      ; Read Port 1 into Accumulator
2 ORL A, P2      ; OR Accumulator with Port 2
3 MOV DPTR, #0200H ; Load Data Pointer with 0200H
4 MOVX @DPTR, A   ; Move content of A to External RAM at 0200H

```

Steps:

1. Read P1 to A.
2. Logical OR with P2.
3. Set DPTR to address.
4. Write A to external memory using MOVX.

Mnemonic

“PORT” (Port-OR-Register-Transfer)

Question 4 [c marks]

7 List Addressing Modes of 8051 Microcontroller and explain them with at least one example.

Solution

Answer:

Table 10. Addressing Modes

Mode	Example	Description
Immediate	MOV A, #25H	Data is provided directly in the instruction (#).
Register	MOV A, R0	Data is in one of the registers (R0-R7).
Direct	MOV A, 30H	Address of the data is given directly.
Indirect	MOV A, @R0	Address is stored in a register (@R0 or @R1).
Indexed	MOVC A, @A+DPTR	Access data from Code memory (Base + Offset).
Bit	SETB P1.3	Operation on a single bit.
Relative	SJMP LABEL	Jump to a relative address (offset).

Mnemonic

“I'M DIRBI” (Immediate-Register-Direct-Indirect-Relative-Bit-Indexed)

OR

Question 4 [a marks]

3 Explain following instructions: (i) DJNZ (ii) POP (iii) CJNE.

Solution

Answer:

- **DJNZ (Decrement and Jump if Not Zero):**
 - Syntax: DJNZ Rn, rel
 - Operation: Decrement register Rn. If result is not 0, jump to relative address. Used for loops.
 - Example: DJNZ R7, LOOP
- **POP:**
 - Syntax: POP direct
 - Operation: Pop data from Stack to direct memory address. SP is decremented.
 - Example: POP 30H
- **CJNE (Compare and Jump if Not Equal):**
 - Syntax: CJNE A, #data, rel
 - Operation: Compare A with data. If not equal, jump. Sets Carry flag if A < data.
 - Example: CJNE A, #25H, NEXT

Mnemonic

“DPC” (Decrement-Pop-Compare)

OR

Question 4 [b marks]

4 For 8051 Microcontroller with a crystal frequency of 12 MHz, generate a delay of 4ms.

Solution

Answer: Calculation:

- Crystal Freq = 12 MHz.
- Machine Cycle Freq = $12 \text{ MHz} / 12 = 1 \text{ MHz}$.
- Time for 1 Machine Cycle = $1/1\text{MHz} = 1\mu\text{s}$.
- Required Delay = 4 ms = $4000 \mu\text{s} = 4000 \text{ Machine Cycles}$.

Program:

```

1      MOV R7, #16          ; Outer Loop: 16
2      DELAY1:
3      MOV R6, #250         ; Inner Loop: 250
4      DELAY2:
5      NOP                 ; 1 Cycle
6      NOP                 ; 1 Cycle
7      DJNZ R6, DELAY2    ; 2 Cycles. Total Inner = 4 * 250 = 1000
8      DJNZ R7, DELAY1    ; Total = 16 * 1000 = 16000 cycles
9      RET

```

Note: The above calculation in MDX ($16 \times 250 \times 4$) gives 16000 cycles = 16ms. To get 4ms, Outer loop should be 4.

Corrected for 4ms:

```

1      MOV R7, #08          ; Outer Loop
2      DELAY_LOOP:
3      MOV R6, #250         ; Inner Loop (250 x 2 = 500us)
4      DJNZ R6, $           ; 2 cycles per loop
5      DJNZ R7, DELAY_LOOP ; 8 x 500 = 4000 us = 4ms
6      RET

```

Mnemonic

“LNDD” (Load-NOP-Decrement-Decrement)

OR

Question 4 [c marks]

7 Explain any seven Logical instructions with example for 8051 Microcontroller.

Solution

Answer:

Table 11. Logical Instructions

Instruction	Example	Operation
ANL	ANL A, #0FH	Logical AND. Masking bits.
ORL	ORL P1, #80H	Logical OR. Setting bits.
XRL	XRL A, R0	Logical XOR. Toggling bits.
CLR	CLR A	Clear Accumulator (A=00H).
CPL	CPL A	Complement Accumulator (Invert bits).
RL	RL A	Rotate Left (circular shift).
RR	RR A	Rotate Right (circular shift).

Mnemonic

“A-OX-CCR” (AND-OR-XOR-Clear-Complement-Rotate)

Question 5 [a marks]

3 List Applications of microcontroller in various fields.

Solution**Answer:**

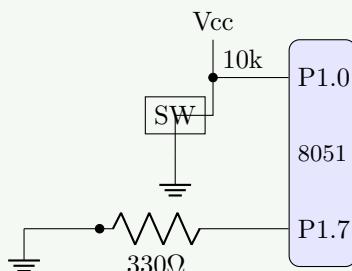
- **Industrial:** Motor control, Automation, PLCs.
- **Medical:** Patient monitoring, X-ray machines.
- **Consumer:** Washing machines, Microwave ovens, Toys.
- **Automotive:** ECU, ABS, Airbags.
- **Communication:** Modems, Routers, Mobile phones.
- **Security:** CCTV, Biometric systems.

Mnemonic

“I-MACS” (Industrial-Medical-Automotive-Consumer-Security)

Question 5 [b marks]

4 Interface Push button Switch and LED with 8051 microcontroller.

Solution**Answer:****Circuit Diagram:****Program:**

```

1 AGAIN:
2     JB P1.0, LED_OFF    ; If P1.0 is High (Not pressed), Jump
3     SETB P1.7           ; If Low (Pressed), Turn ON LED
4     SJMP AGAIN
5 LED_OFF:
6     CLR P1.7            ; Turn OFF LED
7     SJMP AGAIN

```

Mnemonic

“PLIC” (Push-LED-Input-Control)

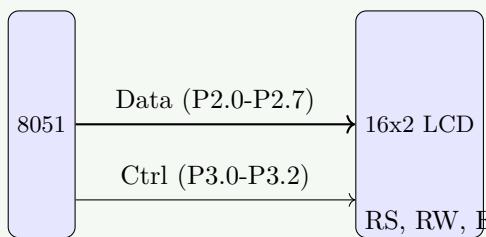
Question 5 [c marks]

7 Interface LCD with microcontroller and write a program to display "HELLO".

Solution

Answer:

Circuit Diagram:



Program:

```

1   MOV A, #38H      ; Init LCD 2 lines, 5x7
2   ACALL CMD
3   MOV A, #0EH      ; Display ON, Cursor ON
4   ACALL CMD
5   MOV A, #'H'      ; Data 'H'
6   ACALL DISP
7   MOV A, #'E'
8   ACALL DISP
9   MOV A, #'L'
10  ACALL DISP
11  MOV A, #'L'
12  ACALL DISP
13  MOV A, #'O'
14  ACALL DISP
15  SJMP $
16
17 CMD: MOV P2, A    ; Send Command
18   CLR P3.0          ; RS=0
19   CLR P3.1          ; RW=0
20   SETB P3.2         ; E=1
21   ACALL DELAY
22   CLR P3.2          ; E=0
23   RET
24
25 DISP: MOV P2, A    ; Send Data
26   SETB P3.0          ; RS=1
27   CLR P3.1          ; RW=0
28   SETB P3.2         ; E=1
29   ACALL DELAY
30   CLR P3.2
31   RET
  
```

Mnemonic

"DICE" (Data-Instruction-Control-Enable)

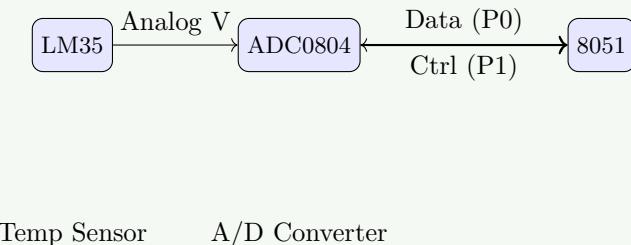
OR

Question 5 [a marks]

3 Draw Interfacing of LM35 with 8051 microcontroller.

Solution

Answer:



Mnemonic

“TAC” (Temperature-Analog-Convert)

OR

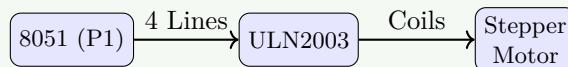
Question 5 [b marks]

4 Interface Stepper motor with 8051 microcontroller.

Solution

Answer:

Circuit:



Logic:

- Send sequence: 0x08, 0x0C, 0x04, 0x06, 0x02, 0x03, 0x01, 0x09.
- Delay between steps determines speed.

Mnemonic

“PDCS” (Port-Driver-Current-Sequence)

OR

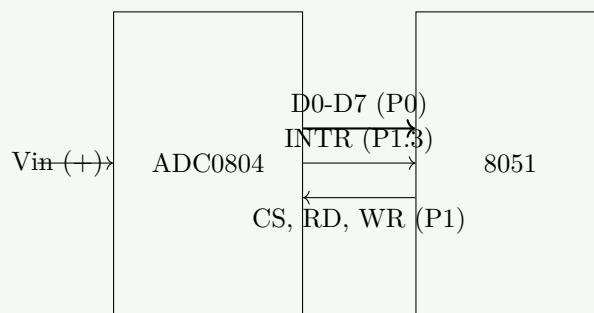
Question 5 [c marks]

7 Interface ADC0804 with 8051 microcontroller.

Solution

Answer:

Interfacing:



Control Signals:

1. **CS=0**: Select Chip.
2. **WR=0 then 1**: Start Conversion.
3. **Wait for INTR=0**: Conversion Complete.
4. **RD=0**: Read Data.

Mnemonic

“CRIW” (Control-Read-Interrupt-Write)

