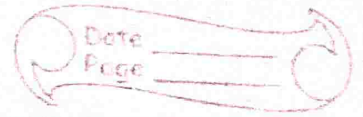


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## CO Assignment - 2

### Micro programs

#### 1. ADD R<sub>1</sub>

⇒ •  $T_0 : MAR \leftarrow PC$   
 $T_1 : IR \leftarrow M[MAR] ; PC \leftarrow PC + 1$   
 $T_2 : DCD(IR) ; MAR \leftarrow IR_{0:11}$   
 $T_3 : DR \leftarrow R_1$   
 $T_4 : ACC \leftarrow ALU_{ADD}(ACC, DR)$   
 $T_5 : CLR$

•  $T_0 \leftarrow LD_{MAR}, OE_{PC}$   
 $T_1 \leftarrow LD_{IR}, RDM, PC_{INR}$   
 $T_2 \leftarrow LD_{MAR}, OE_{IR}$   
 $T_3 \leftarrow LD_{DR}, OE_{R_1}$   
 $T_4 \leftarrow LD_{ACC}, ALU_{ADD}, OE_{ALU}$   
 $T_5 \leftarrow CLR$

#### 2. CMP

⇒ •  $T_0 : MAR \leftarrow PC$   
 $T_1 : IR \leftarrow M[MAR] ; PC \leftarrow PC + 1$   
 $T_2 : DCD(IR) ; MAR \leftarrow IR_{0:11}$   
 $T_3 : ACC \leftarrow ALU_{(CMP)} \leftarrow ACC$   
 $T_4 : CLR$

•  $T_0 \leftarrow LD_{MAR}, OE_{PC}$   
 $T_1 \leftarrow LD_{IR}, RDM, PC_{INR}$   
 $T_2 \leftarrow LD_{MAR}, OE_{IR}$   
 $T_3 \leftarrow LD_{ACC}, ALU_{CMP}, OE_{ALU}$



### 3 AND R<sub>1</sub>

⇒ • T<sub>0</sub>: MAR ← PC  
 T<sub>1</sub>: IR ← M[MAR]; PC ← PC+1  
 T<sub>2</sub>: DCD(IR); MAR ← IR<sub>0:11</sub>  
 T<sub>3</sub>: DR ← R<sub>1</sub>  
 T<sub>4</sub>: ACC ← ALU<sub>AND</sub> (ACC, DR)  
 T<sub>5</sub>: CLR

• T<sub>0</sub> ← LDMAR, OE<sub>PC</sub>  
 T<sub>1</sub> ← LDIR, RDM, PC<sub>INR</sub>  
 T<sub>2</sub> ← LDMAR, OE<sub>IR</sub>  
 T<sub>3</sub> ← LDR, OER<sub>1</sub>  
 T<sub>4</sub> ← LDACC, ALU<sub>AND</sub>, OE<sub>ALU</sub>  
 T<sub>5</sub> ← CLR

### 4 JMP

⇒ • T<sub>0</sub>: MAR ← PC  
 T<sub>1</sub>: IR ← M[MAR]; PC ← PC+1  
 T<sub>2</sub>: DCD(IR); MAR ← IR<sub>0:11</sub>  
 T<sub>3</sub>: MAR ← R<sub>1</sub>  
 T<sub>4</sub>: PC ← MAR  
 T<sub>5</sub> ~~←~~: CLR

• T<sub>0</sub> ← LDMAR, OE<sub>PC</sub>  
 T<sub>1</sub> ← LDIR, RDM, PC<sub>INR</sub>  
 T<sub>2</sub> ← LDMAR, OE<sub>IR</sub>  
 T<sub>3</sub> ← LMAR, OER<sub>1</sub>  
 T<sub>4</sub> ← LDPC, OE<sub>MAR</sub>  
 T<sub>5</sub> ← CLR

## 5 MOV R<sub>1</sub> R<sub>2</sub>

- T<sub>0</sub> : MAR ← PC
- T<sub>1</sub> : IR ← M[MAR]; PC ← PC + 1
- T<sub>2</sub> : DCD(IR); MAR ← IR<sub>0:11</sub>
- T<sub>3</sub> : R<sub>1</sub> ← R<sub>2</sub>
- T<sub>4</sub> : CLR
- T<sub>0</sub> ← LD<sub>MAR</sub>, OE<sub>PC</sub>
- T<sub>1</sub> ← LD<sub>IR</sub>, R<sub>Dm</sub>, PC<sub>INR</sub>
- T<sub>2</sub> ← LD<sub>MAR</sub>, OE<sub>IR</sub>
- T<sub>3</sub> ← LD<sub>R<sub>1</sub></sub>, OE<sub>R<sub>2</sub></sub>
- T<sub>4</sub> ← CLR

## 6 MOV R<sub>2</sub> R<sub>1</sub>

- T<sub>0</sub> : MAR ← PC
- T<sub>1</sub> : IR ← M[MAR]; PC ← PC + 1
- T<sub>2</sub> : DCD(IR); MAR ← IR<sub>0:11</sub>
- T<sub>3</sub> : R<sub>2</sub> ← R<sub>1</sub>
- T<sub>4</sub> : CLR
- T<sub>0</sub> ← LD<sub>MAR</sub>, OE<sub>PC</sub>
- T<sub>1</sub> ← ~~LD<sub>MAR</sub>, OE<sub>PC</sub>~~ LD<sub>IR</sub>, R<sub>Dm</sub>, PC<sub>INR</sub>
- T<sub>2</sub> ← LD<sub>MAR</sub>, OE<sub>IR</sub>
- T<sub>3</sub> ← LD<sub>R<sub>2</sub></sub>, OE<sub>R<sub>1</sub></sub>
- T<sub>4</sub> ← CLR



7 MOV ACC, R1

⇒ • T<sub>0</sub> : MAR ← PC  
 T<sub>1</sub> : IR ← M[MAR]; PC ← PC+1  
 T<sub>2</sub> : DCD(IR); MAR ← IR<sub>0:11</sub>  
 T<sub>3</sub> : DR ← R<sub>1</sub>  
 T<sub>4</sub> : ACC ← DR  
 T<sub>5</sub> : CLR  
 • T<sub>0</sub> ← LD<sub>MAR</sub>, OE<sub>PC</sub>  
 T<sub>1</sub> ← LD<sub>IR</sub>, RD<sub>M</sub>, PC<sub>INR</sub>  
 T<sub>2</sub> ← LD<sub>MAR</sub>, OE<sub>IR</sub>  
 T<sub>3</sub> ← LD<sub>DR</sub>, OE<sub>R<sub>1</sub></sub>  
 T<sub>4</sub> ← LD<sub>ACC</sub>, OE<sub>DR</sub>  
 T<sub>5</sub> ← CLR

8 MOV ACC, R2

⇒ • T<sub>0</sub> : MAR ← PC  
 T<sub>1</sub> : IR ← M[MAR]; PC ← PC+1  
 T<sub>2</sub> : DCD(IR); MAR ← IR<sub>0:11</sub>  
 T<sub>3</sub> : DR ← R<sub>2</sub>  
 T<sub>4</sub> : ACC ← DR  
 T<sub>5</sub> : CLR  
 • T<sub>0</sub> ← LD<sub>MAR</sub>, OE<sub>PC</sub>  
 T<sub>1</sub> ← LD<sub>IR</sub>, RD<sub>M</sub>, PC<sub>INR</sub>  
 T<sub>2</sub> ← LD<sub>MAR</sub>, OE<sub>IR</sub>  
 T<sub>3</sub> ← LD<sub>DR</sub>, OE<sub>R<sub>2</sub></sub>  
 T<sub>4</sub> ← LD<sub>ACC</sub>, OE<sub>DR</sub>  
 T<sub>5</sub> ← CLR

9 MOV R<sub>1</sub>, ACC

⇒ • T<sub>0</sub> : MAR ← PC  
 T<sub>1</sub> : IR ← M[MAR]; PC ← PC + 1  
 T<sub>2</sub> : DCD(IR); MAR ← IRO:11  
 T<sub>3</sub> : ~~DR ← R<sub>1</sub>~~ R<sub>1</sub> ← ACC  
 T<sub>4</sub> : CLR  
 T<sub>5</sub> : ~~DR ← R<sub>1</sub>~~

• T<sub>0</sub> ← LD MAR, OE PC  
 T<sub>1</sub> ← LD IR, RDM, PC INR  
 T<sub>2</sub> ← LD MAR, OE IR  
 T<sub>3</sub> ← LD R<sub>1</sub>, OE ACC  
 T<sub>4</sub> ← CLR  
 T<sub>5</sub> ← ~~DR ← R<sub>1</sub>~~

10 MOV R<sub>2</sub>, ACC

⇒ • T<sub>0</sub> : MAR ← PC  
 T<sub>1</sub> : IR ← M[MAR]; PC ← PC + 1  
 T<sub>2</sub> : DCD(IR); MAR ← IRO:11  
 T<sub>3</sub> : R<sub>2</sub> ← ACC  
 T<sub>4</sub> : CLR

• T<sub>0</sub> ← LD MAR, OE PC  
 T<sub>1</sub> ← LD IR, RDM, PC INR  
 T<sub>2</sub> ← LD MAR, OE IR  
 T<sub>3</sub> ← LD R<sub>2</sub>, OE ACC  
 T<sub>4</sub> ← CLR



## 11 MOV ACC, M

$\Rightarrow$  •  $T_0 : MAR \leftarrow PC$   
 $T_1 : IR \leftarrow M[MAR] ; PC \leftarrow PC + 1$   
 $T_2 : DCD(IR) ; MAR \leftarrow IR_{0:11}$   
 $T_3 : ACC \leftarrow M[MAR]$   
 $T_4 : CLR$

•  $T_0 \leftarrow LDMAR, OE_{PC}$   
 $T_1 \leftarrow LDIR, RDM, PC_{INR}$   
 $T_2 \leftarrow LDMAR, OE_{IR}$   
 $T_3 \leftarrow LDACC, OE_{M[MAR]}$   
 $T_4 \leftarrow CLR$

## 12 MOV M, ACC

$\Rightarrow$  •  $T_0 : MAR \leftarrow PC$   
 $T_1 : IR \leftarrow M[MAR] ; PC \leftarrow PC + 1$   
 $T_2 : DCD(IR) ; MAR \leftarrow IR_{0:11}$   
 $T_3 : MAR \leftarrow ACC$   
 $T_4 : CLR$

•  $T_0 \leftarrow LDMAR, OE_{PC}$   
 $T_1 \leftarrow LDIR, RDM, PC_{INR}$   
 $T_2 \leftarrow LDMAR, OE_{IR}$   
 $T_3 \leftarrow LDMAR, OE_{ACC}$   
 $T_4 \leftarrow CLR$

13 MVI

⇒ •  $T_0 : MAR \leftarrow PC$   
 $T_1 : IR \leftarrow M[MAR]; PC \leftarrow PC + 1$   
 $T_2 : DCD(IR); MAR \leftarrow IR_{CD}$   
 $T_3 : R_1 \leftarrow X \text{ (Immediate value)}$   
 $T_4 : CLR$

•  $T_0 \leftarrow LDMAR, OE_{PC}$   
 $T_1 \leftarrow LDIR, RDM, PC_{INR}$   
 $T_2 \leftarrow LDMAR, OE_{IR}$   
 $T_3 \leftarrow LDR1, OE_X$   
 $T_4 \leftarrow CLR$