

8086 Machine Codes

Course Teacher:

Md. Fahmidur Rahman Sakib

Lecturer, Department of Computer Science & Engineering
Metropolitan University

Course ID: CSE 237

Course Title: Microprocessor and Interfacing

Lecture References:

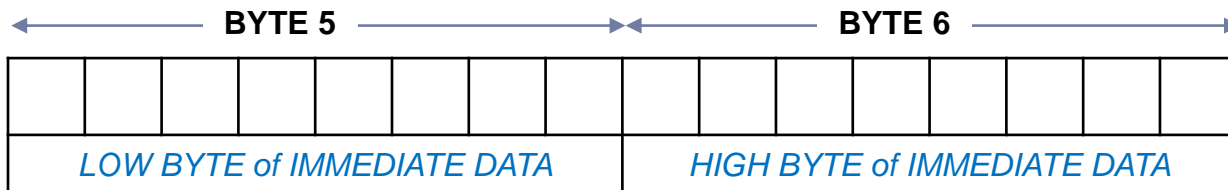
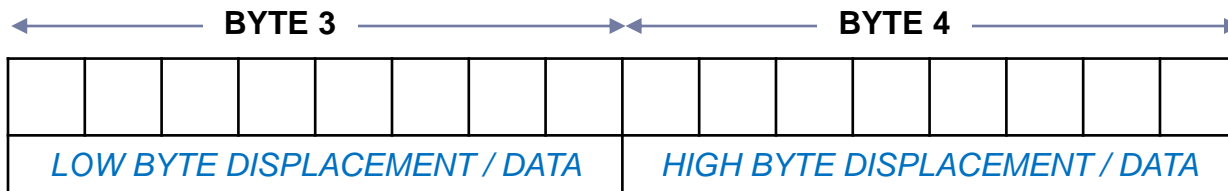
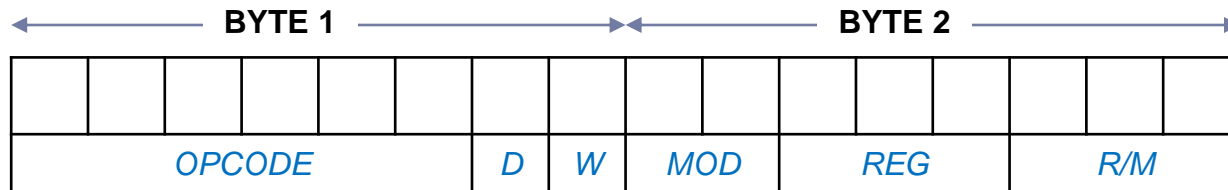
▶ **Book:**

- ▶ *Microprocessors and Interfacing: Programming and Hardware, Chapter # 2, **Author:** Douglas V. Hall*
- ▶ *The 8086/8088 Family: Design, Programming, And Interfacing, Chapter # 2, **Author:** John Uffenbeck.*

Instruction template

- ▶ For 8085: Just look up the hexadecimal code for each instruction.
- ▶ For 8086 its not simple. There are 32 ways to specify the source of the operand in MOV CX, Source.
- ▶ The source may be any one of eight 16-bit registers, or a memory location specified by any one of 24 memory addressing modes.
- ▶ If the CX is made the source then-32 possible ways of specifying the destination.
- ▶ Each of these 32 possible instructions require different binary code.
- ▶ Thus there are 64 different codes for MOV instruction using CX as a source and destination.
- ▶ Its impractical to list them all in a table.

Instruction template (6 bytes)



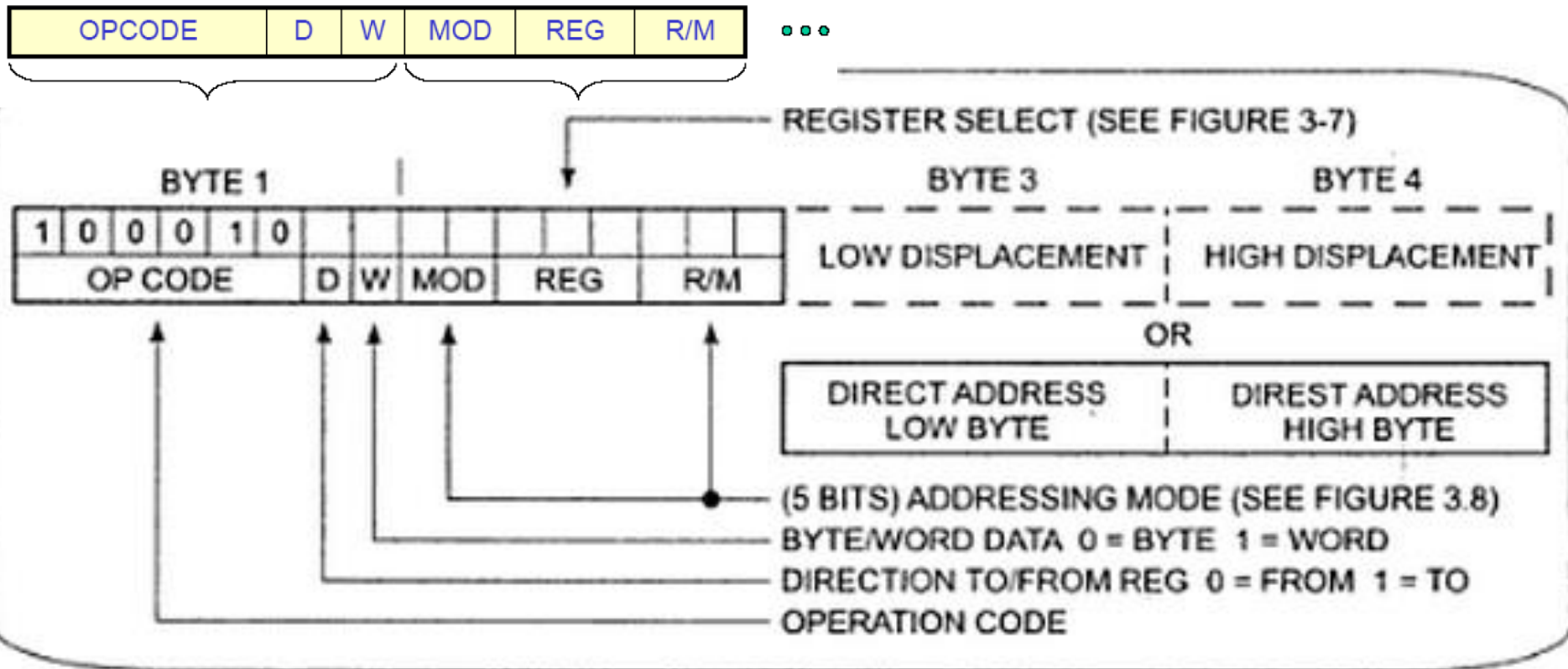
An instruction after conversion can have 1 to 6 bytes long of machine code

Constructing Machine Codes for 8086

- ▶ Each instruction in 8086 is associated with the binary code.
- ▶ You need to locate the codes appropriately.
- ▶ Most of the time this work will be done by assembler
- ▶ The things needed to keep in mind is:
 - ▶ Instruction templates and coding formats
 - ▶ MOD and R/M Bit patterns for particular instruction

MOV Instruction Coding

- ▶ MOV data from a register to a register/to a memory location or from a memory location to a register.
(Operation Code of MOV: 100010)



MOV Instruction Coding: MOD and R/M Field

- ▶ 2-bit Mode (MOD) and 3-bit Register/Memory (R/M) fields specify the other operand.
- ▶ Also specify the addressing mode.

RM \ MOD	MOD			
	00	01	10	11
				W = 0 W = 1
000	[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL AX
001	[BX] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL CX
010	[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL DX
011	[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL BX
100	[SI]	[SI] + d8	[SI] + d16	AH SP
101	[DI]	[DI] + d8	[DI] + d16	CH BP
110	d16 (direct address)	[BP] + d8	[BP] + d16	DH SI
111	[BX]	[BX] + d8	[BX] + d16	BH DI

MOV Instruction Coding: MOD and R/M Field

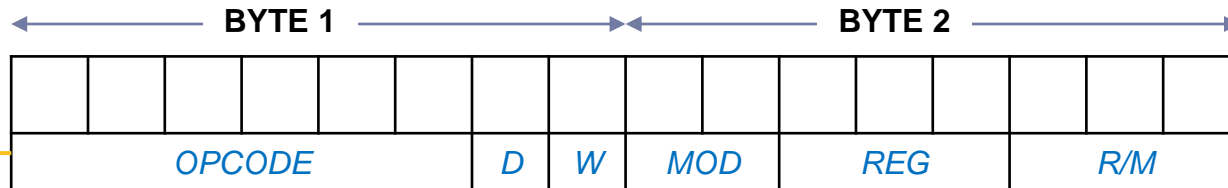
- ▶ If the other operand in the instruction is also one of the eight register then put in 11 for MOD bits in the instruction code.
- ▶ If the other operand is memory location, there are 24 ways of specifying how the execution unit should compute the effective address of the operand in the main memory.
- ▶ If the effective address specified in the instruction contains displacement less than 256 along with the reference to the contents of the register then put in 01 as the MOD bits.
- ▶ If the expression for the effective address contains a displacement which is too large to fit in 8 bits then put in 10 in MOD bits.

REG Field

- ▶ REG field is used to identify the register of the one operand

REG	W = 0	W = 1
000	AL	AX
001	CL	CX
010	DL	DX
011	BL	BX
100	AH	SP
101	CH	BP
110	DH	SI
111	BH	DI

Instruction template



6 bits of
MOV, ADD etc

D - direction

If **D=0**, then direction is from a register (source)
If **D=1**, then direction is to a register (destination)

W - word

If **W=0**, then only a byte is being transferred (8 bits)
If **W=1**, then a whole word is being transferred (16 bits)

- 34h here is an 8-bit displacement
- [BX+34h] is a memory/offset address

MOV [BX + 34h], AL

MOV AX, 1234h

- 1234h here is a 16-bit immediate data value

MODE	OPERAND NATURE
00	Memory with no displacement
01	Memory with 8-bit displacement
10	Memory with 16-bit displacement
11	Both are registers

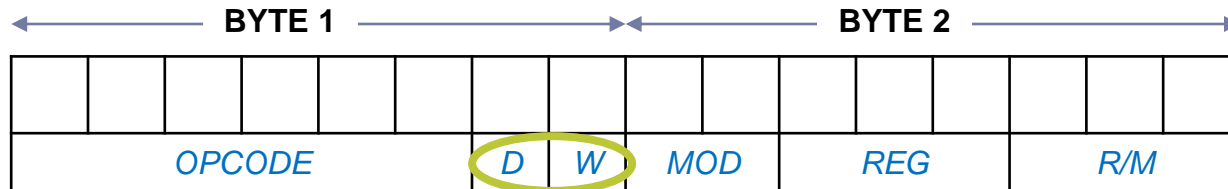
→ *MOV AX, [BX]*

→ *MOV AX, [BX + 12h]*

→ *MOV AX, [BX + 1234h]*

→ *MOV AX, BX*

Instruction template



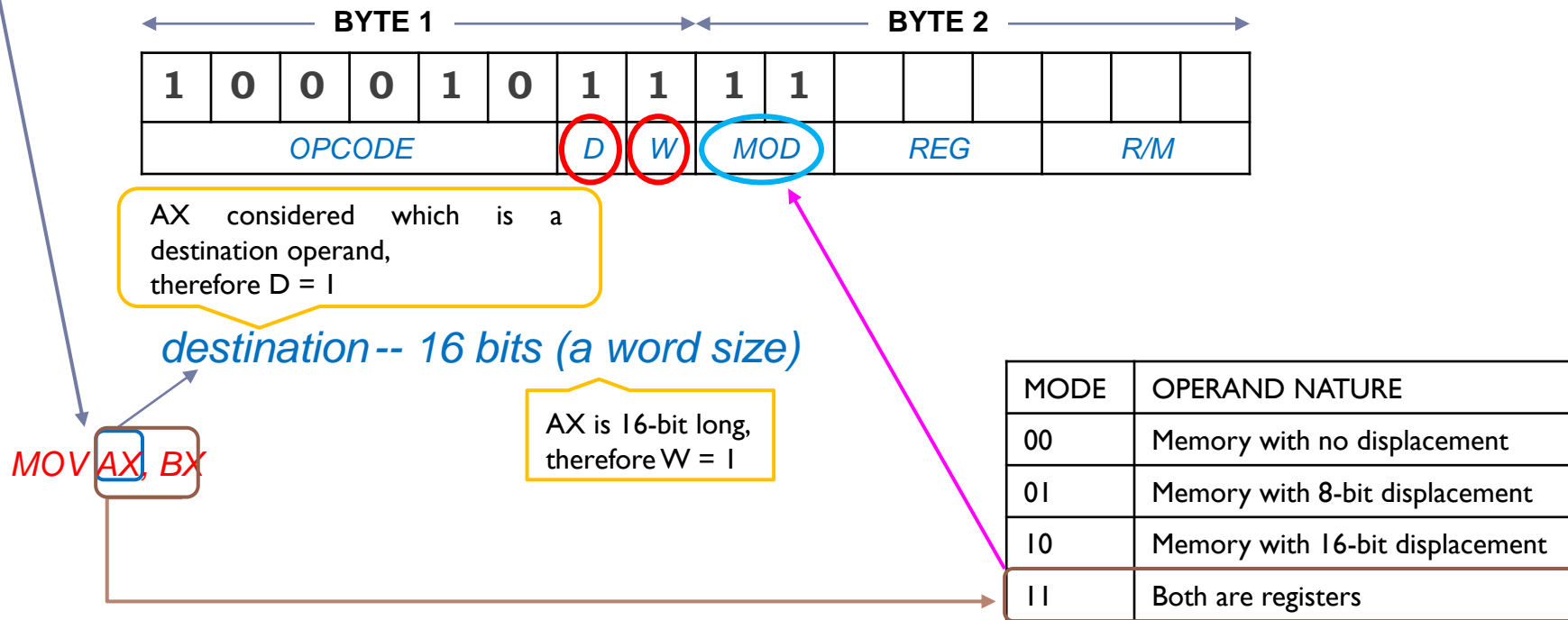
- Value for **R/M** with corresponding MOD value
- Value for REG with corresponding **W** value and the register considered in D

Check column that matches with MOD value

RM	MOD				
		00	01	10	11
					W = 0 W = 1
000		[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL AX
001		[BXI] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL CX
010		[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL DX
011		[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL BX
100		[SI]	[SI] + d8	[SI] + d16	AH SP
101		[DI]	[DI] + d8	[DI] + d16	CH BP
110		d16 (direct address)	[BP] + d8	[BP] + d16	DH SI
111		[BX]	[BX] + d8	[BX] + d16	BH DI

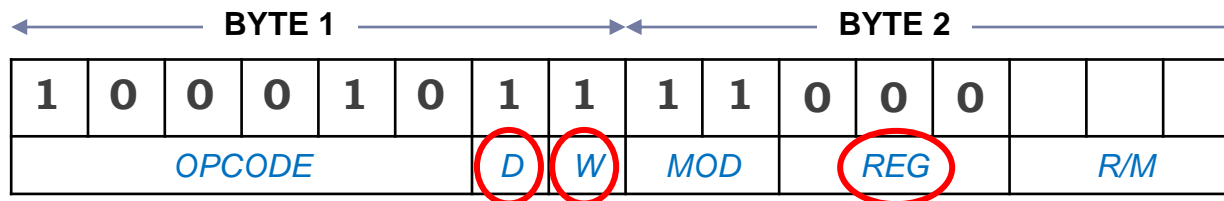
Example 1

- MOV AX, BX: given the opcode for MOV=100010



Example 1

- MOV AX, BX: given the opcode for MOV=100010

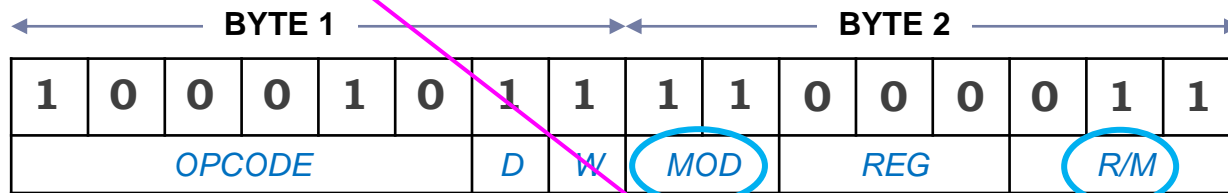


RM \ MOD	00	01	10	11	
				W = 0	W = 1
000	[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL	AX
001	[BXI] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL	CX
010	[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL	DX
011	[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL	BX
100	[SI]	[SI] + d8	[SI] + d16	AH	SP
101	[DI]	[DI] + d8	[DI] + d16	CH	BP
110	d16 (direct address)	[BP] + d8	[BP] + d16	DH	SI
111	[BX]	[BX] + d8	[BX] + d16	BH	DI

Example 1

Machine Code: $(1000\ 1011\ 1100\ 0011)_2$ or $(8B\ C3)_{16}$

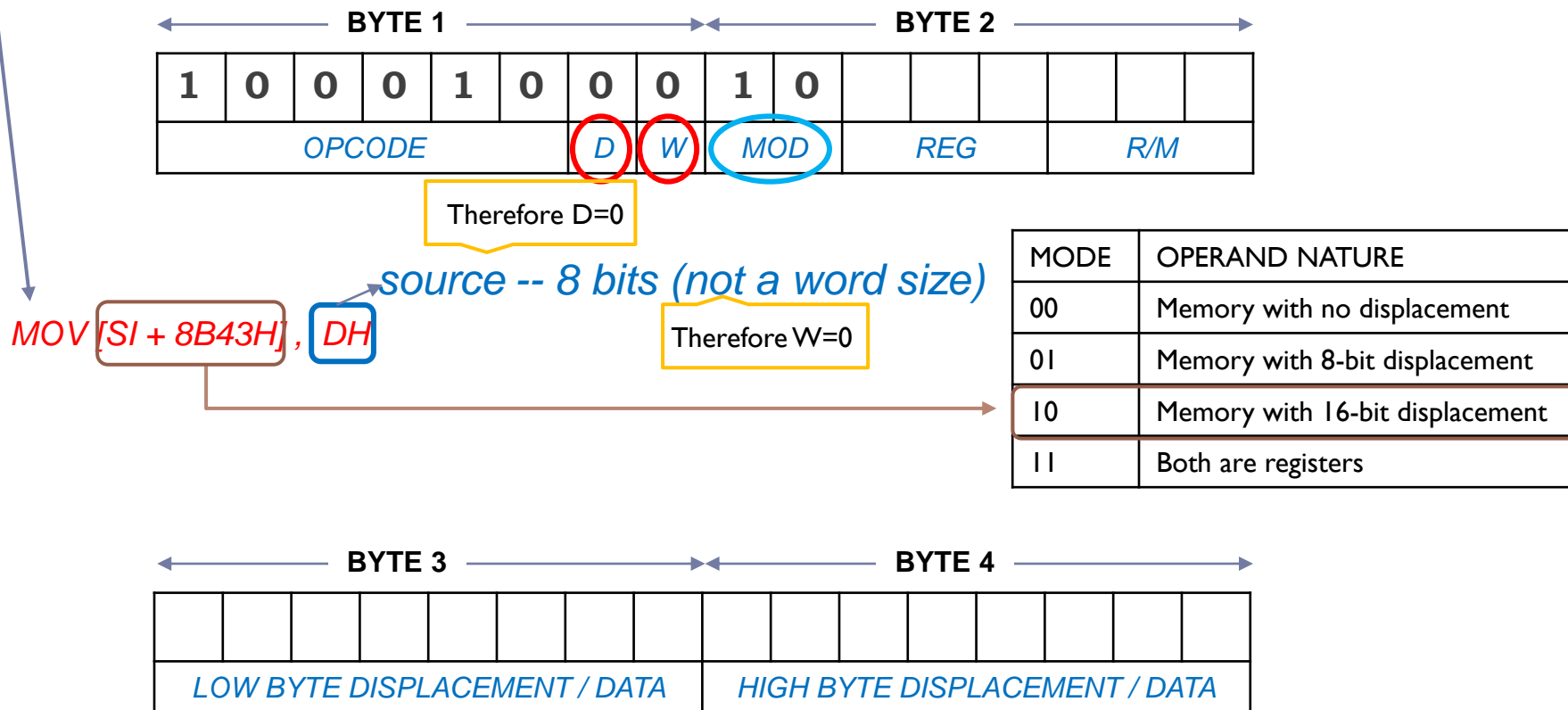
- MOV AX, BX: given the opcode for MOV=100010



RM	MOD					
		00	01	10	11	
					W = 0	W = 1
000		[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL	AX
001		[BX] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL	CX
010		[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL	DX
011		[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL	BX
100		[SI]	[SI] + d8	[SI] + d16	AH	SP
101		[DI]	[DI] + d8	[DI] + d16	CH	BP
110	d16 (direct address)		[BP] + d8	[BP] + d16	DH	SI
111		[BX]	[BX] + d8	[BX] + d16	BH	DI

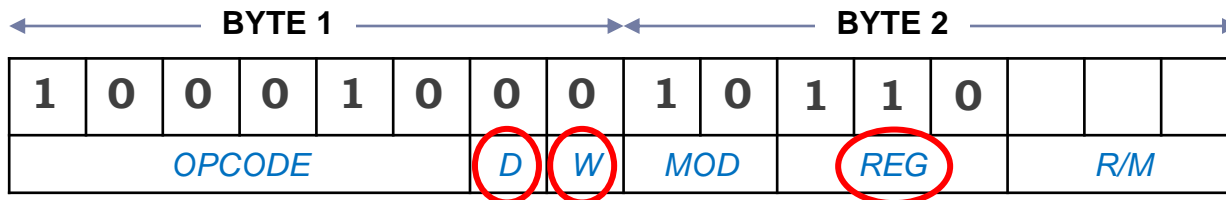
Example 2

- **MOV 8B43H [SI], DH:** Copy a byte from DH to memory with 16 bit displacement given the opcode for MOV=100010



Example 2

- **MOV 8B43H [SI], DH:** Copy a byte from DH to memory with 16 bit displacement given the opcode for MOV=100010

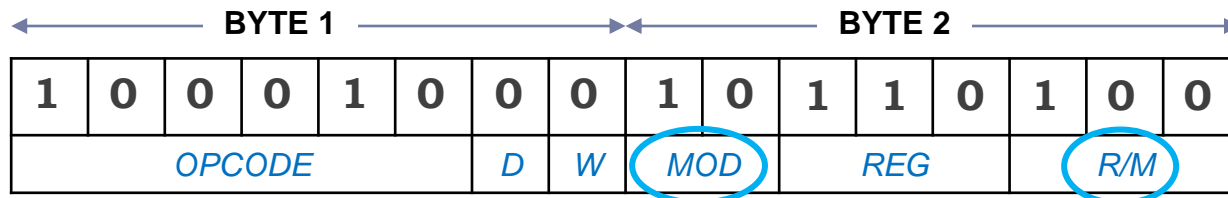


MOV [SI + 8B43H],
DH

RM \ MOD	MOD					
	00	01	10	11	W = 0	W = 1
000	[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL	AX	
001	[BXI] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL	CX	
010	[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL	DX	
011	[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL	BX	
100	[SI]	[SI] + d8	[SI] + d16	AH	SP	
101	[DI]	[DI] + d8	[DI] + d16	CH	BP	
110	d16 (direct address)	[BP] + d8	[BP] + d16	DH	SI	
111	[BX]	[BX] + d8	[BX] + d16	BH	DI	

Example 2

- **MOV 8B43H [SI], DH:** Copy a byte from DH to memory with 16 bit displacement given the opcode for MOV=100010

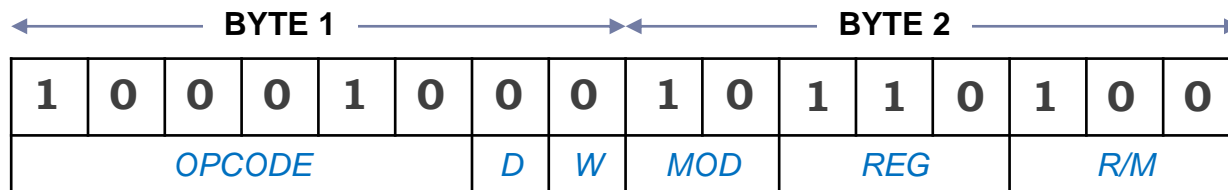


MOV [SI + 8B43H],
DH

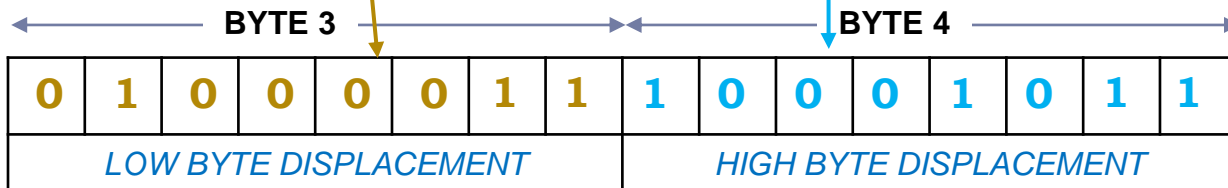
RM \ MOD	MOD				
	00	01	10	11	
				W = 0	W = 1
000	[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL	AX
001	[BXI] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL	CX
010	[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL	DX
011	[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL	BX
100	[SI]	[SI] + d8	[SI] + d16	AH	SP
101	[DI]	[DI] + d8	[DI] + d16	CH	BP
110	d16 (direct address)	[BP] + d8	[BP] + d16	DH	SI
111	[BX]	[BX] + d8	[BX] + d16	BH	DI

Example 2

- **MOV 8B43H [SI], DH:** Copy a byte from DH to memory with 16 bit displacement given the opcode for MOV=100010



MOV [SI + 8B43H], DH



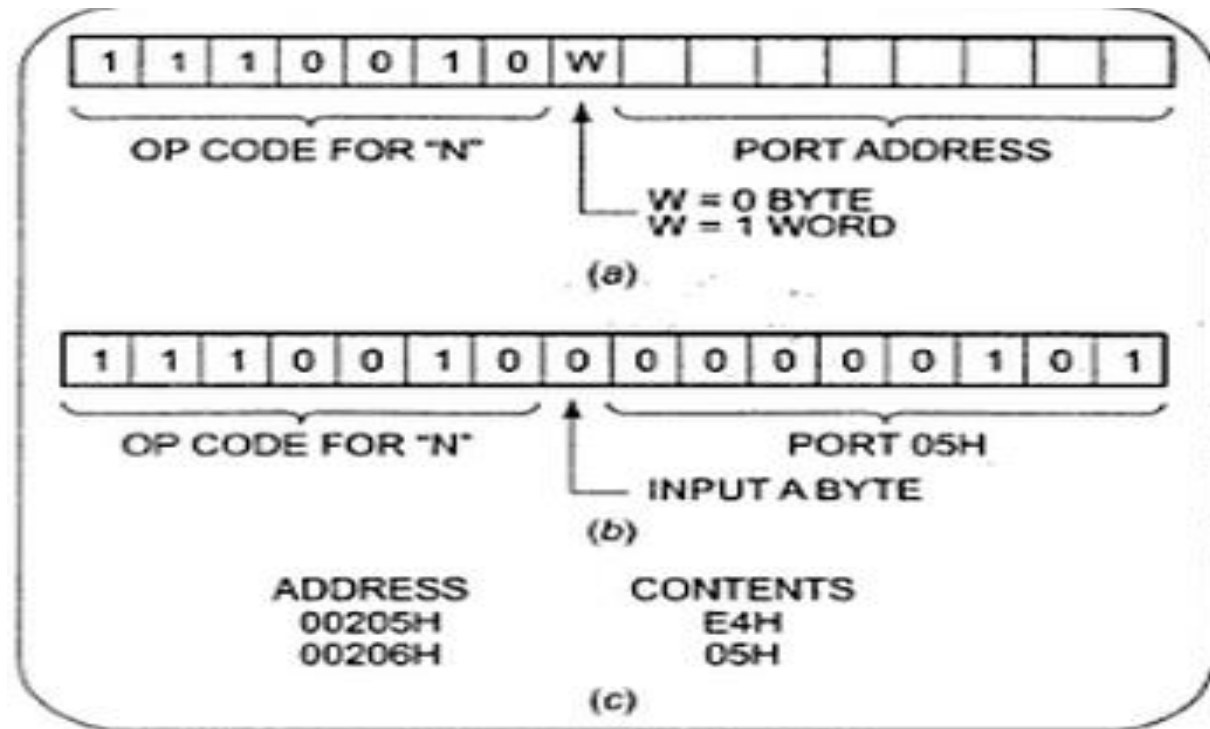
Machine Code: $(1000\ 1000\ 1011\ 0100\ 0100\ 0011\ 1000\ 1011)_2$ or $(88\ B4\ 43\ 8B)_{16}$

Instruction Template

- The Intel literature shows two different formats for coding 8086 instructions.
- Instruction templates help you to code the instruction properly.

- **Example:**

IN AL, 05H



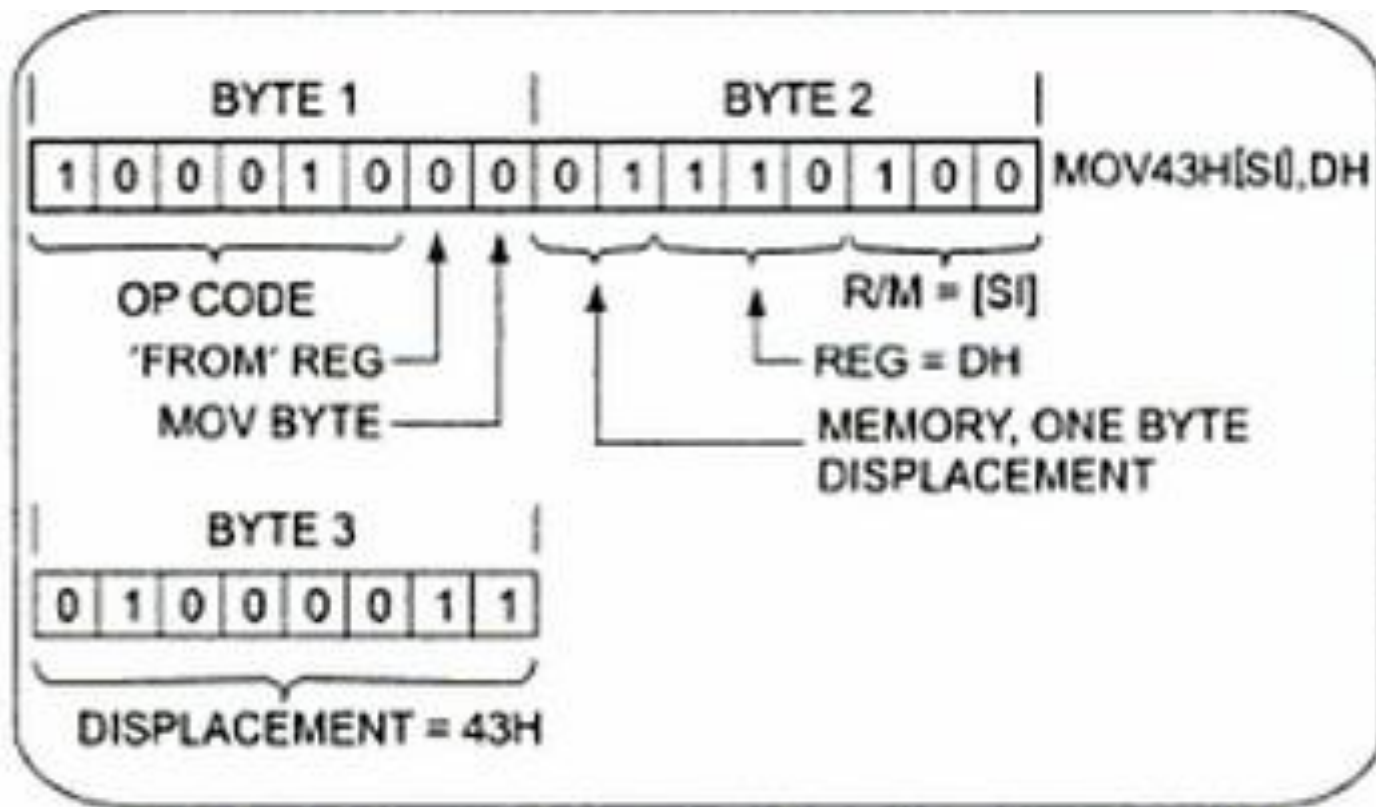
Example 3

- MOV BL,AL
- Opcode for MOV = 100010
- We'll encode AL so
 - D = 0 (AL source operand)
- W bit = 0 (8-bits)
- MOD = 11 (register mode)
- REG = 000 (code for AL)
- R/M = 011

OPCODE	D	W	MOD	REG	R/M
100010	0	0	11	000	011

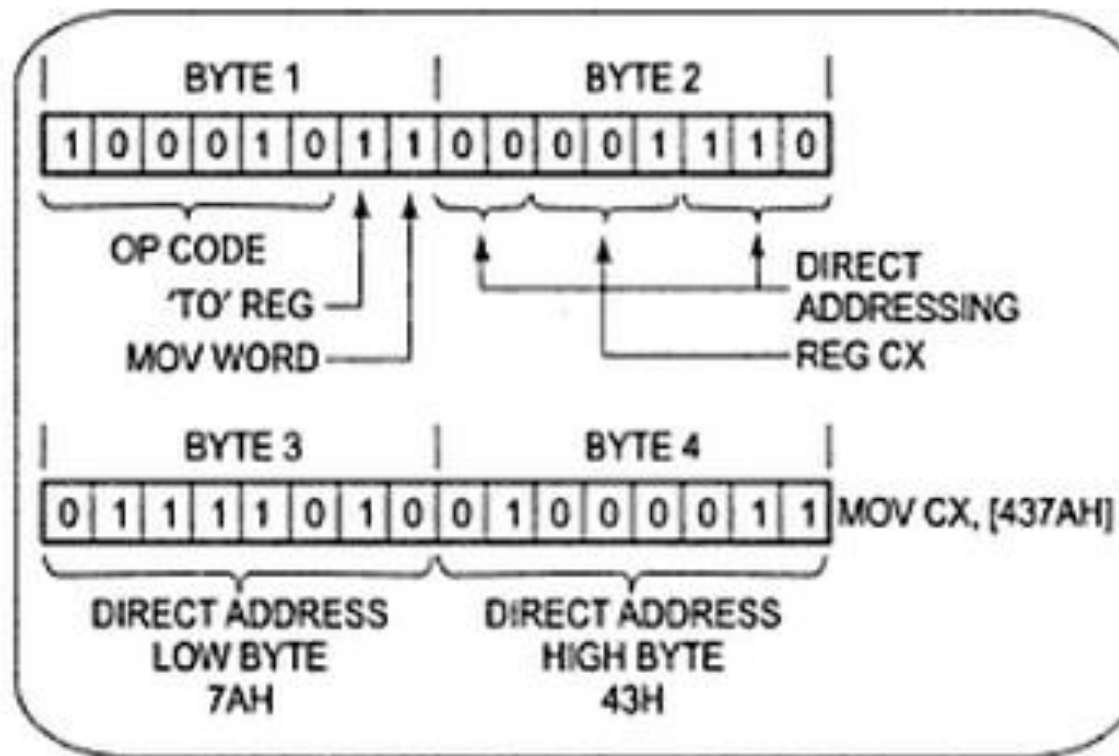
Example 4

- **MOV 43H [SI], DH:** Copy a byte from DH register to memory location.

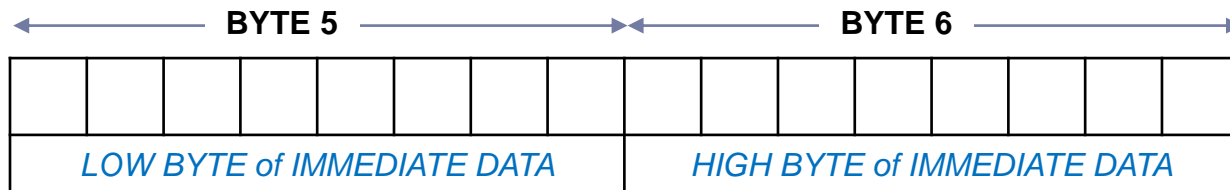
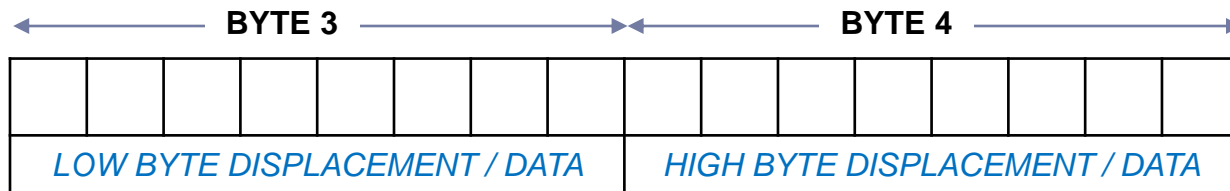
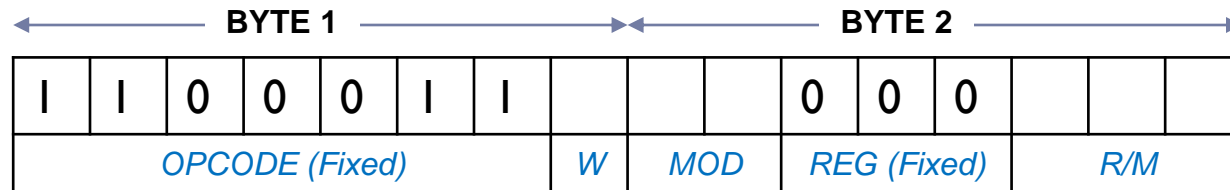


Example 5

- **MOV CX, [437AH]:** Copy the contents of the two memory locations to the register CX.



Immediate to Memory Location Operation

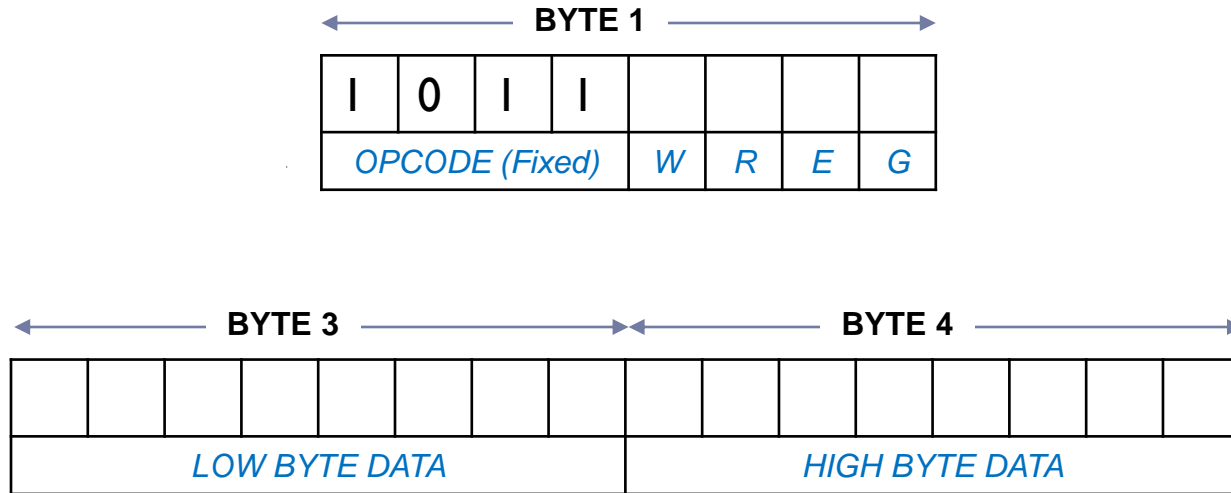


Practice Problem 1

► **MOV [BP+SI+500H], 7293h**

R/M \ MOD	00	01	10	11	
				W = 0	W = 1
000	[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL	AX
001	[BX] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL	CX
010	[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL	DX
011	[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL	BX
100	[SI]	[SI] + d8	[SI] + d16	AH	SP
101	[DI]	[DI] + d8	[DI] + d16	CH	BP
110	d16	[BP] + d8	[BP] + d16	DH	SI
111	[BX]	[BX] + d8	[BX] + d16	BH	DI

Immediate to Register Operation



Practice Problem 2

► MOV CX,AD4Ch

R/M \ MOD	00	01	10	11	
				W = 0	W = 1
000	[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL	AX
001	[BX] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL	CX
010	[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL	DX
011	[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL	BX
100	[SI]	[SI] + d8	[SI] + d16	AH	SP
101	[DI]	[DI] + d8	[DI] + d16	CH	BP
110	d16	[BP] + d8	[BP] + d16	DH	SI
111	[BX]	[BX] + d8	[BX] + d16	BH	DI

QUIZ

Compute the machine code for the following using the table below and the opcode for MOV as 100010

a) MOV AX, 5E9Ch

b) MOV DH, [BP+SI+7Dh]

RM \ MOD	MOD			
	00	01	10	11
				W = 0 W = 1
000	[BX] + [SI]	[BX] + [SI] + d8	[BX] + [SI] + d16	AL AX
001	[BX] + [DI]	[BX] + [DI] + d8	[BX] + [DI] + d16	CL CX
010	[BP] + [SI]	[BP] + [SI] + d8	[BP] + [SI] + d16	DL DX
011	[BP] + [DI]	[BP] + [DI] + d8	[BP] + [DI] + d16	BL BX
100	[SI]	[SI] + d8	[SI] + d16	AH SP
101	[DI]	[DI] + d8	[DI] + d16	CH BP
110	d16 (direct address)	[BP] + d8	[BP] + d16	DH SI
111	[BX]	[BX] + d8	[BX] + d16	BH DI

Thank You !!

