Chapter 4

Introduction to IBM PC Assembly Languages

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

Program Title (Optional)

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

- **Details in 4.7.1 (Table 4.4)**

SMALL-> code in one segment
data in one segment
MEDIUM ->code in more than one
data in one
COMPACT-> code in one
data in more than one
Similarly LARGE and HUGE

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

- **Details in 4.7.3**

  `.STACK  size_of_the_stack`

  if not specified, then the default size is 1KB

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

- **Details in 4.7.2**
- Data Segment
- Variable and Constant declarations are done here

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

- **Details in 4.7.4**
- Inside a code segment, Instructions are organized as procedures.

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

- **Details in 4.7.4**
- The program instructions are packed inside procedures.
- The definition of a single procedure is

```
name PROC
; body of the procedure
name ENDP
```

- Here it is an example of main procedure

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

- **Details in 4.7.4**
- Other procedure declarations are done here

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

- **Details in 4.7.4**
- Write this at the end of all procedures (that means at the end of the code segment)

Assembly Language Syntax

- Assembly language code is generally not case sensitive
- Program consists of statements, one per line.
- Each statement is of two type
- Type1: instruction

```
name operation operand(s) comment
```

❑ **Details are in 4.1 4.1.1 to 4.1.4**

An Example:

```
START:      MOV CX,5          ;initialize counter
```

- Type2: Assembler directive

An Example:

```
MAIN        PROC
```

```
TITLE EXAMPLE: EXAMPLE1
.MODEL SMALL
.STACK 100H
.DATA
;data definitions go here
.CODE
MAIN PROC

;instructions go here

MAIN ENDP
;other procedures go here
END MAIN
```

- Let's now give focus on it !!

```
TITLE PGM4_1: ECHO PROGRAM
.MODEL SMALL
.STACK 100H
.CODE
MAIN PROC
     ;display prompt
     MOV AH,2
     MOV DL,'?'
     INT 21H
     ; input a character
     MOV AH,1
     INT 21H
     MOV BL,AL
     ; go to a new line
     MOV AH,2
     MOV DL,0DH
     INT 21H
     MOV DL,0AH
     INT 21H
     ; display character
     MOV DL,BL
     INT 21H
     ; return to DOS
     MOV AH,4CH
     INT 21H
MAIN ENDP
     END MAIN
```

- A sample instruction
  The format of MOV instruction is
  `MOV destination, source`

- XCHG instruction is also like MOV
- **Details of MOV and XCHG are in 4.5.1**

Table 4.2 Legal Combinations of Operands for MOV and XCHG

MOV

	Destination Operand			
Source Operand	*General register*	*Segment register*	*Memory location*	*Constant*
General register	yes	yes	yes	no
Segment register	yes	no	yes	no
Memory location	yes	yes	no	no
Constant	yes	no	yes	no

XCHG

	Destination Operand	
Source Operand	*General register*	*Memory location*
General register	yes	yes
Memory location	yes	no

```
TITLE PGM4_1: ECHO PROGRAM
.MODEL SMALL
.STACK 100H
.CODE
MAIN PROC
     ;display prompt
     MOV AH,2
     MOV DL,'?'
     INT 21H
     ; input a character
     MOV AH,1
     INT 21H
     MOV BL,AL
     ; go to a new line
     MOV AH,2
     MOV DL,0DH
     INT 21H
     MOV DL,0AH
     INT 21H
     ; display character
     MOV DL,BL
     INT 21H
     ; return to DOS
     MOV AH,4CH
     INT 21H
MAIN ENDP
     END MAIN
```

- There are other instructions like ADD, SUB, INC, DEC and NEG
- **Details are in 4.5.2 and 4.5.3**

- INT 21H
- **Details are in 4.8 and 4.8.1**

```
TITLE PGM4_1: ECHO PROGRAM
.MODEL SMALL
.STACK 100H
.CODE
MAIN PROC
     ;display prompt
     MOV AH,2
     MOV DL,'?'
     INT 21H
     ; input a character
     MOV AH,1
     INT 21H
     MOV BL,AL
     ; go to a new line
     MOV AH,2
     MOV DL,0DH
     INT 21H
     MOV DL,0AH
     INT 21H
     ; display character
     MOV DL,BL
     INT 21H
     ; return to DOS
     MOV AH,4CH
     INT 21H
MAIN ENDP
     END MAIN
```

Function number	*Routine*
1	single-key input
2	single-character output
9	character string output

Function 1:
Single-Key Input

Input: AH = 1
Output: AL = ASCII code if character key is pressed
= 0 if non-character key is pressed

Function 2:
Display a character or execute a control function

Input: AH = 2
DL = ASCII code of the display character or control character
Output: AL = ASCII code of the display character or control character

Time to run our first program on our own!!

```
TITLE PGM4_1.5: SAMPLE INPUT
.MODEL SMALL
.STACK 100H
.DATA
VAR1 DB ?
.CODE
MAIN PROC
     ;initialize DS
     MOV DX,@DATA
     MOV DS,DX
     ;display message
     MOV DL,5
     MOV AH,1
     INT 21H
     ;move to variable
     MOV VAR1,AL

     ; add 2 with the value
     ADD VAR1,2

     MOV DL,VAR1
     MOV AH,2
     INT 21H
     ; return to DOS
     MOV AH,4CH
     INT 21H
MAIN ENDP
     END MAIN
```

- The format of variable declaration

```
variable_name    DB       initial_value
variable_name    DW       initial_value
```

- See the table 4.1 for more

Example:

```
var1      DB       4
var2      DW       'A'
```

- If we want keep the variable uninitialized then we use a question mark (?)

```
var1      DB       ?
```

- **For Details see Section 4.2 and 4.3**

```
TITLE PGM4_1.5: SAMPLE INPUT
.MODEL SMALL
.STACK 100H
.DATA
VAR1 DB ?
.CODE
MAIN PROC
     ;initialize DS
     MOV DX,@DATA
     MOV DS,DX
     ;display message
     MOV DL,5
     MOV AH,1
     INT 21H
     ;move to variable
     MOV VAR1,AL

     ; add 2 with the value
     ADD VAR1,2

     MOV DL,VAR1
     MOV AH,2
     INT 21H
     ; return to DOS
     MOV AH,4CH
     INT 21H
MAIN ENDP
     END MAIN
```

- DS must be initialized to use the data segment
- **For Details Section 4.11(Page 74)**

Time for the second one

```
TITLE PGM4_2: PRINT
.MODEL SMALL
.STACK 100H
.DATA
MSG DB 'HELLO!$'
.CODE
MAIN PROC
     ;initialize DS
     MOV AX,@DATA
     MOV DS,AX
     ;display message
     LEA DX,MSG
     MOV AH,9
     INT 21H
     ; return to DOS
     MOV AH,4CH
     INT 21H
MAIN ENDP
     END MAIN
```

❑ Working with Array:

```
MSG     DB      'HELLO!$'
```

❑ If the address of variable MSG is 100h then

Symbol	Address	Contents
MSG	100h	48h
MSG+1	101h	45h
MSG+2	102h	4Ch
MSG+3	103h	4Ch
MSG+4	104h	4Fh
MSG+5	105h	24h

❑ The dollar character($) is used to indicate the end of a string

❑ The alternate representation of

```
MSG     DB      'HELLO!$'
```

is

```
MSG     DB      48h, 45h, 4Ch, 4Ch, 4Fh, 24h
```

❑ **For details see Section 4.3.3**

```
TITLE PGM4_2: PRINT
.MODEL SMALL
.STACK 100H
.DATA
MSG DB 'HELLO!$'
.CODE
MAIN PROC
     ;initialize DS
     MOV AX,@DATA
     MOV DS,AX
     ;display message
     LEA DX,MSG
     MOV AH,9
     INT 21H
     ; return to DOS
     MOV AH,4CH
     INT 21H
MAIN ENDP
     END MAIN
```

- **Displaying a String**

INT 21h, Function 9:
Display a String
Input: DX = offset address of string.
The string must end with a '$' character.

- To load the offset address into DX we need to use

LEA(Load Effective address)

- **For details see Section 4.11**

Problem 1

- Write an assembly program that will take a lower case letter and convert it to an upper case letter

```
TITLE PGM4_3: CASE CONVERSION PROGRAM
.MODEL SMALL
.STACK 100H
.DATA
CR   EQU 0DH,
LF   EQU 0AH
MSG1     DB  'ENTER A LOWER CASE LETTER: $'
MSG2     DB  0DH,0AH,'IN UPPER CASE IT IS: '
CHAR     DB  ?,'$'
.CODE
MAIN PROC
     ;initialize DS
     MOV AX,@DATA
     MOV DS,AX
     ;print user prompt
     LEA DX,MSG1
     MOV AH,9
     INT 21H
     ;input a character and convert to upper case
     MOV AH,1
     INT 21H
     SUB AL,20H
     MOV CHAR,AL
     ;display on the next line
     LEA DX,MSG2
     MOV AH,9
     INT 21H
     ; return to DOS
     MOV AH,4CH
     INT 21H
MAIN ENDP
     END MAIN
```

Problem 2

- Write an assembly program that will take two small digits (one is less than 5 and another is less than 6), add these and display the output.

```
TITLE PGM4_4: SMALL ADDITION PROGRAM
.MODEL SMALL
.STACK 100H
.DATA
VAR1    DB  ?
VAR2    DB  ?
MSG1    DB  'PLEASE ENTER THE FIRST DIGIT( <5 ): $'
MSG2    DB  'PLEASE ENTER THE SECOND DIGIT( <6 ): $'
R_MSG   DB  'THE RESULT IS: $'
.CODE
MAIN PROC
    ;initialize DS
    MOV AX,@DATA
    MOV DS,AX
    ;print the first message
    MOV AH,9
    LEA DX,MSG1
    INT 21H
    ; input first value
    MOV AH,1
    INT 21H
    SUB AL,'0'
    MOV BL,AL
    ; go to a new line
    MOV AH,2
    MOV DL,0DH
    INT 21H
    MOV DL,0AH
    INT 21H
    ;print the second message
    MOV AH,9
    LEA DX,MSG2
    INT 21H
    ;input second value
    MOV AH,1
    INT 21H
    SUB AL,'0'
    MOV BH,AL
    ;addition operation
    ADD BH,BL
    ADD BH,'0'
    ;go to a new line
    MOV AH,2
    MOV DL,0DH
    INT 21H
    MOV DL,0AH
    INT 21H
    ;display result message
    LEA DX,R_MSG
    MOV AH,9
    INT 21H
    ; display character
    MOV AH,2
    MOV DL,BH
    INT 21H
    ; return to DOS
    MOV AH,4CH
    INT 21H
MAIN ENDP
    END MAIN
```

Chapter 5

The Processor Status and the FLAGS Register

The FLAGS Register

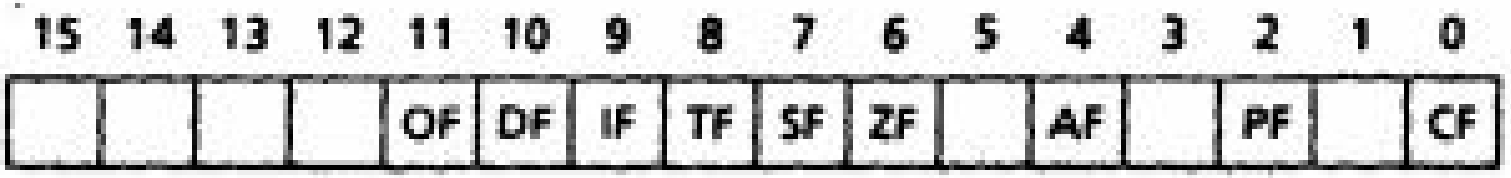


Table 5.1 Flag Names and Symbols

Status Flags

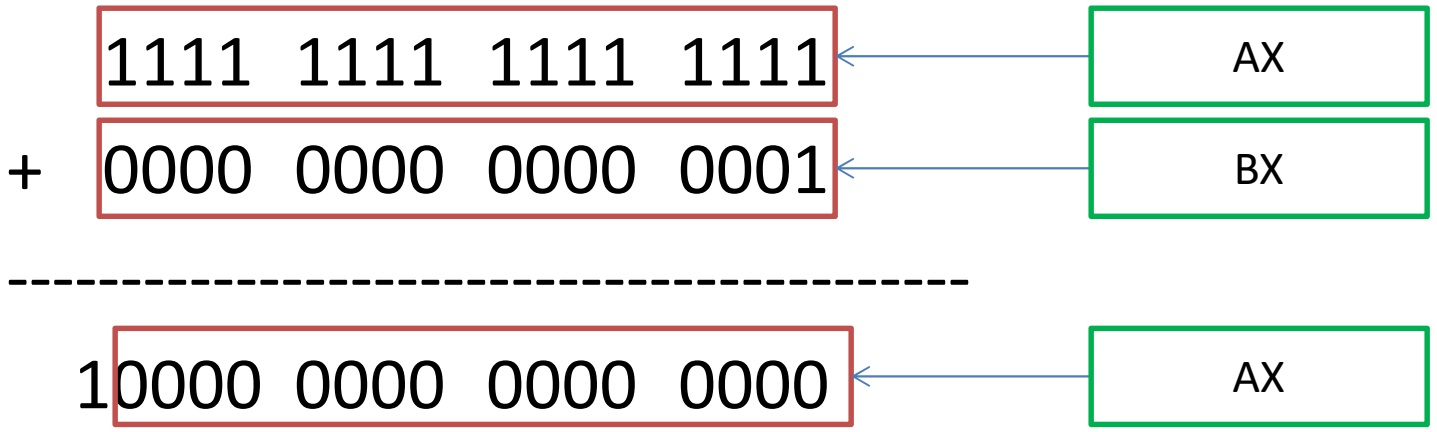
Bit	*Name*	*Symbol*
0	Carry flag	CF
2	Parity flag	PF
4	Auxiliary carry flag	AF
6	Zero flag	ZF
7	Sign flag	SF
11	Overflow flag	OF

Control Flags

Bit	*Name*	*Symbol*
8	Trap flag	TF
9	Interrupt flag	IF
10	Direction flag	DF

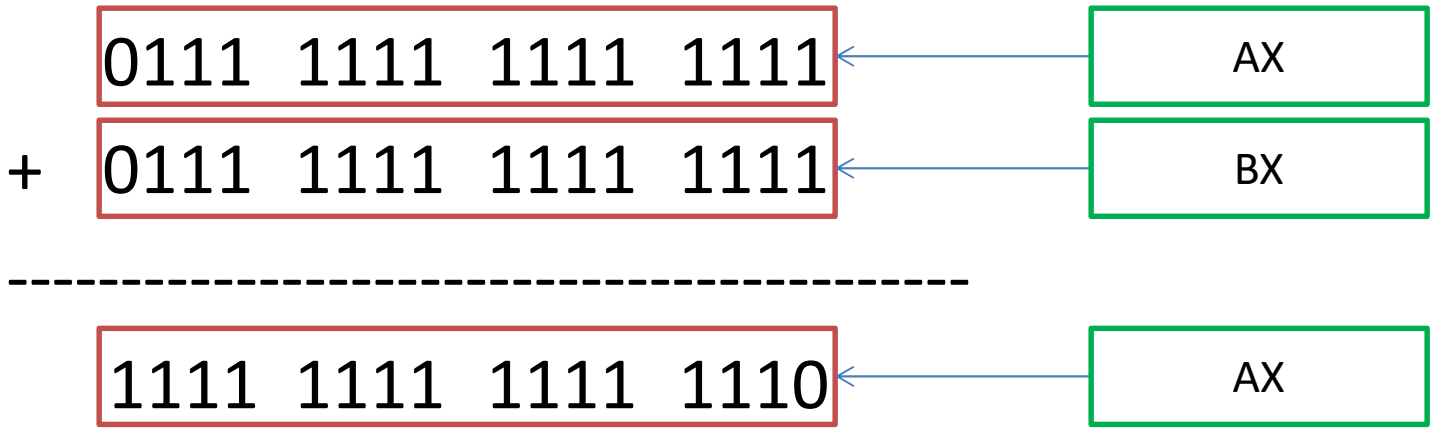
Overflow

- Example of only unsigned overflow
- IF AX=FFFFh and BX=0001h
- ADD AX,BX



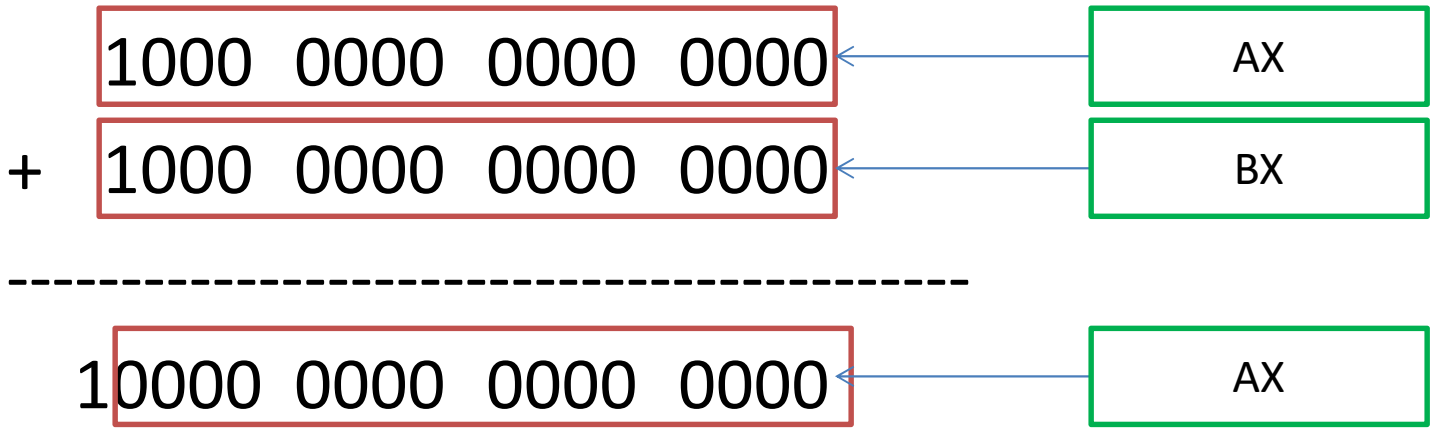
Overflow

- Example of only signed overflow
- IF AX=7FFFh and BX=7FFFh
- ADD AX,BX



Overflow

- Example of both signed and unsigned overflow
- IF AX=8000h and BX=8000h
- ADD AX,BX



Unsigned Overflow

- Causes Carry Flag to become 1
- When occurs?
  - If the result of addition is more than the limit
  - If a big number is subtracted from a small number

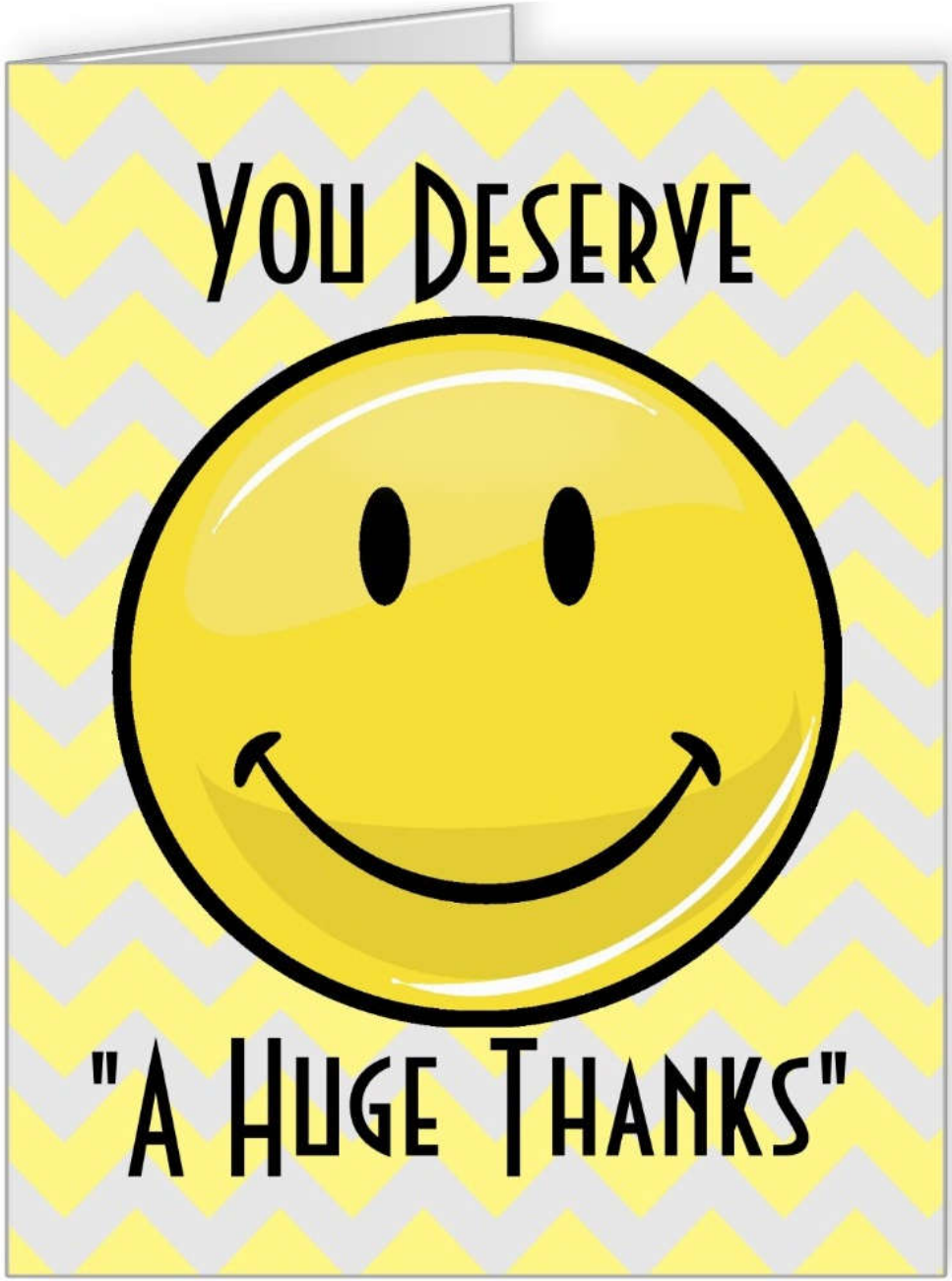
Signed Overflow

- Causes Overflow flag(OF) to become 1
- When occurs?
  - The result of addition has two different signs
  - The result of subtraction has two different signs

How Instructions Affect the Flags

Instructions	Affects Flags
MOV/XCHG	none
ADD/SUB	all
INC/DEC	all except CF
NEG	All(CF=1 unless result is 0, OF=1 if word operand is 8000h Or byte operand is 80h)

Go through 5.1 to 5.3 for all the details of chapter 5


You Deserve
"A Huge Thanks"