3. 연산자(Operator)

연산자 종류

- 연산자(operator)와 피연산자(operand)

연산자

$$A + 3$$

피연산자
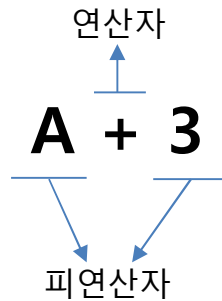
[연산자 종류]

종류	결합규칙	연산자	우선순위
단항연산자	←	++ -- + - ~ ! (type)	높음
산술연산자	→	* / %	
	→	+ -	
	→	« » (비트연산자)	
비교연산자	→	< > ⇐ ⋟ instanceof	
	→	== !=	
논리연산자	→	& (비트연산자)	
	→	^ (비트연산자)	
	→		(비트연산자)	
	→	&&	
	→	||	
삼항연산자	→	? :	
대입연산자	←	= += -= *= /= %= <<= >>= &= ^= |=	낮음

실습(1)

[Ex1] OpEx.java

```java
package chap02.operator;

public class OpEx {
    public static void main(String[] args) {
        // TODO Auto-generated method stub
        int i = 10;

        i++;
        System.out.println("i는 " + i + " 입니다.");
        ++i;
        System.out.println("i는 " + i + " 입니다.");
        System.out.println("i는 " + i++ + " 입니다.");
        System.out.println("i는 " + ++i + " 입니다.");

        int j = 10;
        j--;
        System.out.println("j는 " + j + " 입니다.");
        --j;
        System.out.println("j는 " + j + " 입니다.");
        System.out.println("j는 " + j-- + " 입니다.");
        System.out.println("j는 " + --j + " 입니다.");

        int ij;
        ij = --i + j++;
        System.out.println("ij는 " + ij + " 입니다.");

        ij += 10;
        System.out.println("-ij는 " + -ij + " 입니다.");
    }
}
```

실습(2)

[Ex2] OpEx2.java

```java
package chap02.operator;

public class OpEx2 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        int num1 = 10;
        int num2 = 10;
        boolean result1 = (num1 == num2);
        boolean result2 = (num1 != num2);
        boolean result3 = (num1 <= num2);
        System.out.println("result1=" + result1);
        System.out.println("result2=" + result2);
        System.out.println("result3=" + result3);

        char char1 = 'A';
        char char2 = 'B';
        boolean result4 = (char1 < char2);
        System.out.println("result4=" + result4);
    }
}
```

실습(3)

[Ex3] OpEx3.java

```java
package chap02.operator;

public class OpEx03 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        int v2 = 1;
        double v3 = 1.0;
        System.out.println(v2 == v3); //true

        double v4 = 0.1;
        float v5 = 0.1f;
        System.out.println(v4 == v5); //false
        System.out.println((float)v4 == v5); //true
        System.out.println((int)(v4*10) == (int)(v5*10)); //true
    }

}
```

실습(4)

[Ex4] OpEx4.java

```java
package chap02.operator;

public class OpEx4 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        {
            int a = 1_000_000;
            int b = 2_000_000;
            long c = a * b;
            System.out.println(c);
        }

        {
            long a = 1000000 * 1000000;
            long b = 1000000 * 1000000L;
            System.out.println("a="+a);
            System.out.println("b="+b);
        }

        {
            int a = 1000000;
            int result1 = a * a / a;
            int result2 = a / a * a;
            System.out.printf("%d * %d / %d = %d\n", a, a, a, result1);
            System.out.printf("%d / %d * %d = %d\n", a, a, a, result2);
        }
    }
}
```

실습(5)

[Ex5] OpEx5.java

```java
package chap02.operator;
public class OpEx5 {
    public static void main(String[] args) {
        {
            char a = 'a', d = 'd', zero = '0', two  = '2';
            System.out.printf("'%c' - '%c' = %d\n", d, a, d - a);
            System.out.printf("'%c' - '%c' = %d\n", two, zero, two - zero);
            System.out.printf("'%c'=%d\n", a, (int)a);
            System.out.printf("'%c'=%d\n", d, (int)d);
            System.out.printf("'%c'=%d\n", zero, (int)zero);
            System.out.printf("'%c'=%d\n", two,  (int)two);
        }
        {
            char c1 = 'a', c2 = c1, c3 =' ';
            int i = c1 + 1;
            c3 = (char)(c1 + 1);
            c2++; c2++;
            System.out.println("i=" + i);
            System.out.println("c2=" + c2);
            System.out.println("c3=" + c3);
        }
        {
            char c1 = 'a';
//          char c2 =  c1+1;            // 에러 발생
            char c3 = 'a'+1;
            System.out.println(c3);
        }
    }
}
```

실습(6)

[Ex6] OpEx6.java

```java
package chap02.operator;

public class OpEx6 {
    public static void main(String args[]) {
        {
            double pi = 3.141592;
            double shortPi = (int)(pi * 1000 + 0.5) / 1000.0;

            System.out.println(shortPi);
        }
        {
            double pi = 3.141592;
            double shortPi = Math.round(pi * 1000) / 1000.0;

            System.out.println(shortPi);
        }
        {
            int x = 10;
            int y = 8;

            System.out.printf("%d을 %d로 나누면, \n", x, y);
            System.out.printf("몫은 %d이고, 나머지는 %d입니다.\n", x / y, x % y);
        }
    }
}
```

실습(7)

[Ex7] OpEx7.java

```java
package chap02.operator;

public class OpEx7 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        System.out.printf("10 == 10.0f  \t %b\n", 10==10.0f);
        System.out.printf("'0'== 0      \t %b\n", '0'== 0);
        System.out.printf("'\\0'== 0    \t %b\n", '\0'== 0);
        System.out.printf("'A'== 65     \t %b\n", 'A'== 65);
        System.out.printf("'A' > 'B'    \t %b\n", 'A' > 'B');
        System.out.printf("'A'+1 != 'B' \t %b\n", 'A'+1 != 'B');

        float  f  = 0.1f;
        double d  = 0.1;
        double d2 = (double)f;

        System.out.printf("10.0==10.0f  %b\n", 10.0==10.0f);
        System.out.printf("0.1==0.1f    %b\n",  0.1==0.1f);
        System.out.printf("f =%19.17f\n", f);
        System.out.printf("d =%19.17f\n", d);
        System.out.printf("d2=%19.17f\n", d2);
        System.out.printf("d==f    %b\n", d==f);
        System.out.printf("d==d2   %b\n", d==d2);
        System.out.printf("d2==f   %b\n", d2==f);
        System.out.printf("(float)d==f  %b\n", (float)d==f);
    }

}
```

실습(8)

[Ex8] OpEx8.java

```java
package chap02.operator;

public class OpEx8 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        int  x = 0;
        char ch = ' ';

        x = 15;
        System.out.printf("x=%2d, 10 < x && x < 20 =%b\n", x, 10 < x && x < 20);

        x = 6;
        System.out.printf("x=%2d,  x%%2==0 || x%%3==0  && x%%6!=0 =%b\n", x, x%2==0||x%3==0&&x%6!=0);
        System.out.printf("x=%2d, (x%%2==0 || x%%3==0) && x%%6!=0 =%b\n", x,(x%2==0||x%3==0)&&x%6!=0);

        ch='1';
        System.out.printf("ch='%c', '0' <= ch && ch <= '9' =%b\n", ch, '0' <= ch && ch <='9');

        ch='a';
        System.out.printf("ch='%c', 'a' <= ch && ch <= 'z' =%b\n", ch, 'a' <= ch && ch <='z');

        ch='A';
        System.out.printf("ch='%c', 'A' <= ch && ch <= 'Z' =%b\n", ch, 'A' <= ch && ch <='Z');

        ch='q';
        System.out.printf("ch='%c', ch=='q' || ch=='Q' =%b\n", ch, ch=='q' || ch=='Q');
    }
}
```

실습(9)

[Ex9] OpEx9.java

```java
package chap02.operator;

import java.util.Scanner;

public class OpEx9 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        Scanner scanner = new Scanner(System.in);
        char ch = ' ';

        System.out.printf("문자를 하나 입력하세요.>");

        String input = scanner.nextLine();
        ch = input.charAt(0);

        if('0'<= ch && ch <= '9') {
            System.out.printf("입력하신 문자는 숫자입니다.\n");
        }

        if(('a'<= ch && ch <= 'z') || ('A'<= ch && ch <= 'Z')) {
            System.out.printf("입력하신 문자는 영문자입니다.\n");
        }
    }
}
```

실습(9)

[Ex10] OpEx10.java

```java
package chap02.operator;

public class OpEx10 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        boolean  b  = true;

        System.out.printf("b=%b\n", b);
        System.out.printf("!b=%b\n", !b);
        System.out.printf("!!b=%b\n", !!b);
        System.out.printf("!!!b=%b\n", !!!b);
    }
}
```

비트 연산자

- | (OR연산자), & (AND연산자), ^ (XOR연산자), ~ (부정연산자)

X	Y	X | Y	X & Y	X ^ Y	~X
1	1	1	1	0	0
1	0	1	0	1	0
0	1	1	0	1	1
0	0	0	0	0	1

- <<, >> (시프트연산자)

  - 비트를 왼쪽(<<) 또는 오른쪽으(>>)으로 자리 이동

수식	초기값		연산결과	
	2진수	10진수	2진수	10진수
8 >> 1	0000 1000	8	0000 0100	4
8 >> 2	0000 1000	8	0000 0010	2
-8 >> 1	1111 1000	-8	1111 1100	-4
-8 >> 2	1111 0110	-8	1111 1110	-2
8 << 1	0000 1000	8	0001 0000	16
8 << 2	0000 1000	8	0010 0000	32
-8 << 1	1111 1000	-8	1111 0000	-16
-8 << 2	1111 1000	-8	1110 0000	-32

실습(1)

[Ex11] OpBit.java

```java
package chap02.operator;

public class OpBit {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        byte x = 0b0101;
        System.out.println(x);
        byte y = 0b1010;
        System.out.println(y);
        long z = 0b0101L;

        System.out.printf("x & y = 0x%X\n", x & y);
        System.out.printf("x | y = 0x%X\n", x | y);
        System.out.printf("x ^ y = 0x%X\n", x ^ y);
        System.out.printf("~x = 0x%X\n", ~x);
        System.out.printf("~z = 0x%X\n", ~z);
        System.out.printf("~x = 0x%X\n", ~~x);
        System.out.printf("~z = 0x%X\n", ~~z);
    }
}
```

실습(2)

[Ex12] OpBit2.java

```java
package chap02.operator;

public class OpBit2 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        {
            int x = 0x0A;   // 0b0000_1010

            System.out.printf("x >> 1 = 0x%X(%d)\n", x >> 1, x >> 1);
            System.out.printf("x >> 2 = 0x%X(%d)\n", x >> 2, x >> 2);
            System.out.printf("x >> 3 = 0x%X(%d)\n", x >> 3, x >> 3);

            System.out.printf("x << 1 = 0x%X(%d)\n", x << 1, x << 1);
            System.out.printf("x << 2 = 0x%X(%d)\n", x << 2, x << 2);
            System.out.printf("x << 3 = 0x%X(%d)\n", x << 3, x << 3);
        }
        {
            int x = -10;   // -0b1111_0110

            System.out.printf("x >> 1 = 0x%X(%d)\n", x >> 1, x >> 1);
            System.out.printf("x >> 2 = 0x%X(%d)\n", x >> 2, x >> 2);
            System.out.printf("x >> 3 = 0x%X(%d)\n", x >> 3, x >> 3);

            System.out.printf("x << 1 = 0x%X(%d)\n", x << 1, x << 1);
            System.out.printf("x << 2 = 0x%X(%d)\n", x << 2, x << 2);
            System.out.printf("x << 3 = 0x%X(%d)\n", x << 3, x << 3);
        }
    }
}
```
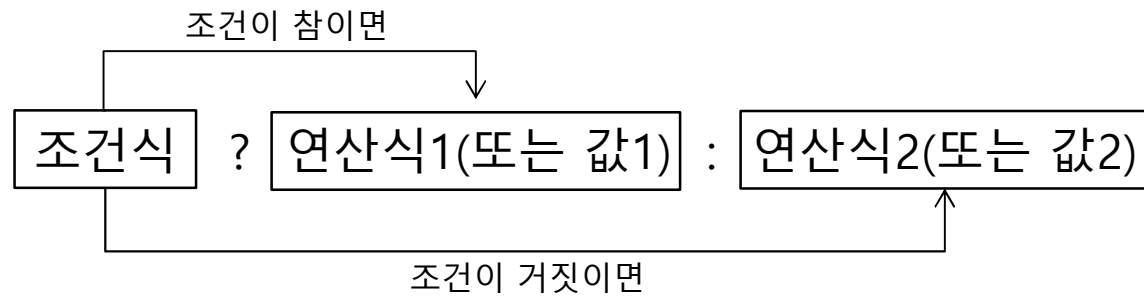
삼항 연산자

- 3개의 피연산자를 필요로 하는 연산자

조건이 참이면

| 조건식 | ? | 연산식1(또는 값1) | : | 연산식2(또는 값2) |

조건이 거짓이면

```
int a = 10;

int b = (a > 5) ? a : 5;   // b = 10
```

```
int x = 3;

int y = x > 5 ? 1 : (x == 0 ? 0 : -1);  // y = -1
```

실습

[Ex13] OpTernary.java

```java
package chap02.operator;

public class OpTernary {

    public static void main(String[] args) {
        // TODO Auto-generated method stub
        int score = 97;
        char grade = (score < 60) ? 'F' : (
                     (score < 70) ? 'D' : (
                     (score < 80) ? 'C' : (
                     (score < 90) ? 'B' : 'A')));

        System.out.printf("grade = %c\n", grade);
    }
}
```