

# ENGR 101

## Engineering Technology

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**Victoria**  
UNIVERSITY OF WELLINGTON  
*Te Whare Wānanga  
o te Ūpoko o te Ika a Māui*



CAPITAL CITY UNIVERSITY

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- Course Outline
- Lecture Schedule**
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- Submission
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- Summary

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## XMUT 101 Tentative Schedule

Lecture:		Lecture Slides	Video (Zip) files
1	Introduction to the course	<a href="#">Wk01Lec01a</a> <a href="#">Wk01Lec01b</a>	<a href="#">Wk01Lec01a.zip</a> <a href="#">Wk01Lec01b.zip</a>
2	Computer architecture. Computer data.	<a href="#">Wk01Lec02a</a> <a href="#">Wk01Lec02b</a>	<a href="#">Wk01Lec02a.zip</a> <a href="#">Wk01Lec02b.zip</a>
<b>Lecture: 8 - 14 March</b>			
3	Number systems: Decimal, binary, octal and hexadecimal	<a href="#">Wk02Lec01a</a> <a href="#">Wk02Lec01b</a>	<a href="#">Wk02Lec01a.zip</a> <a href="#">Wk02Lec01b.zip</a>
<b>Lecture: 15 - 21 March</b>			
4	Number system conversion		
5	Logic Gates		
<b>Lecture: 22 - 28 March</b>			
6	Boolean Algebra		
7			
<b>Lecture: 29 March - 4 April</b>			
8		Lecture Slides (pdf)	Video (Zip) files
9			

Lecture  
reference  
number



# Week 3 Lecture 4a

- Main topics
  - Introduction to Engineering Technology
  - Number system
  - Logic Gates
  - Boolean Algebra
- Course web page:  
[https://ecs.wgtn.ac.nz/Courses/XMUT101\\_2021T1/](https://ecs.wgtn.ac.nz/Courses/XMUT101_2021T1/)
- [kerese@ecs.vuw.ac.nz](mailto:kerese@ecs.vuw.ac.nz)

# Convert a **Integer from Decimal to Another Base**

For each digit position:

1. Divide decimal number by the base (8)
2. The *remainder* is the lowest-order digit
3. Repeat first two steps until no *divisor* remains.

## Exercise 3 – CORRECTION!!

Convert the following decimal numbers to octal:

$$\text{a) } (172)_{10} = \cancel{(21)}_8 = (254)_8$$

$$\text{b) } (32)_{10} = (40)_8$$

$$\text{c) } (99)_{10} = \cancel{(126)}_8 = (143)_8$$

$$\text{d) } (114)_{10} = (162)_8$$

# Convert an Integer from Decimal to Hexadecimal

For each digit position:

1. Divide decimal number by the base (e.g. 16)
2. The *remainder* is the lowest-order digit
3. Repeat first two steps until no *divisor* remains.

## Exercise 5

Convert the following decimal numbers to hexadecimal:

a)  $(171)_{10} = \cancel{(11)}_{16} = (AB)_{16}$

b)  $(32)_{10} = (20)_{16}$

c)  $(85)_{10} = (55)_{16}$

d)  $(114)_{10} = \cancel{(172)}_{16} = (72)_{16}$

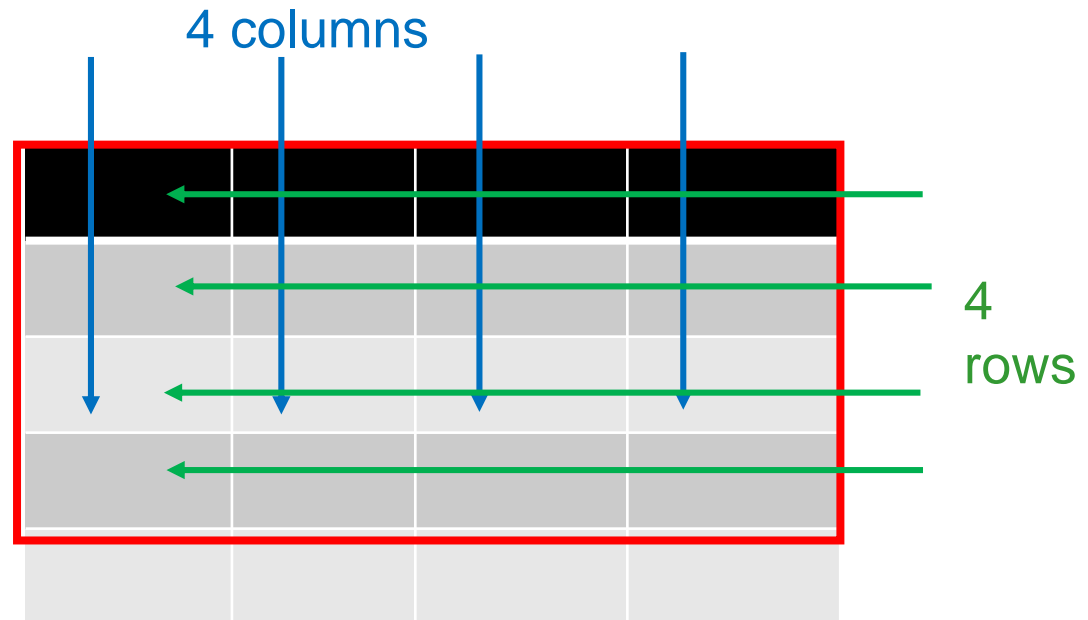
# Convert an Integer from **Binary to Decimal**

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Convert the binary number  $(1001)_2$  to decimal number.

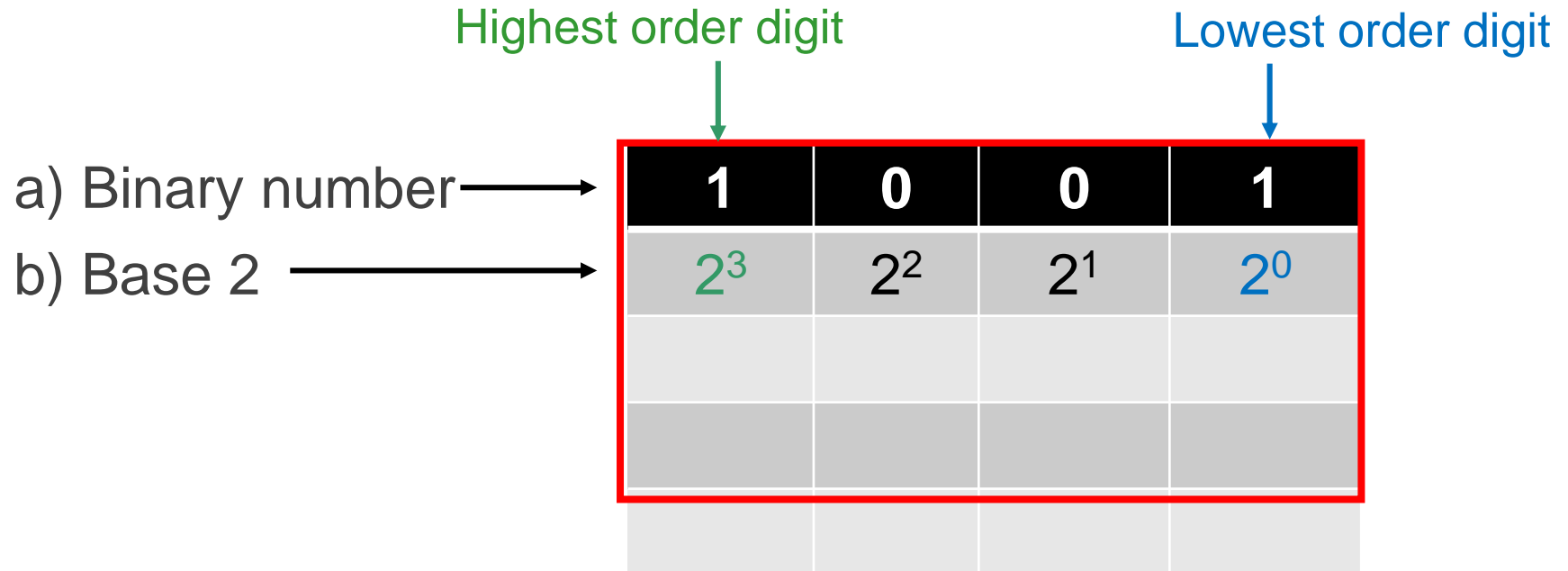
# Convert an Integer from **Binary to Decimal**

Convert the binary number  $(1001)_2$  to decimal number.



# Convert an Integer from **Binary to Decimal**

Convert the binary number  $(1001)_2$  to decimal number.





# Convert an Integer from **Binary to Decimal**

Convert the binary number  $(1001)_2$  to decimal number.

	Highest order digit			Lowest order digit
	↓			↓
a) Binary number →	1	0	0	1
b) Base 2 →	$2^3$	$2^2$	$2^1$	$2^0$
c) Decimal equivalent	8	4	2	1

# Convert an Integer from **Binary to Decimal**

Convert the binary number  $(1001)_2$  to decimal number.

	Highest order digit ↓			Lowest order digit ↓
a) Binary number →	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>
b) Base 2 →	$2^3$	$2^2$	$2^1$	$2^0$
c) Decimal equivalent	8	4	2	1
a) x c)	1 x 8 = 8	0 x 4 = 0	0 x 2 = 0	1 x 1 = 1

# Convert an Integer from **Binary to Decimal**

Convert the binary number  $(1001)_2$  to decimal number.

<b>a) Binary number</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>
b) Base 2	$2^3$	$2^2$	$2^1$	$2^0$
c) Decimal equivalent	8	4	2	1
a) x b)	$1 \times 8$ $= 8$	$0 \times 4$ $= 0$	$0 \times 2$ $= 0$	$1 \times 1$ $= 1$

$$(1001)_2 = (8 + 0 + 0 + 1)_{10} = (9)_{10}$$

# Convert an **Integer** from **Binary** to Decimal

Highest order digit

Lowest order digit

	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
Decimal Digit Value	256	128	64	32	16	8	4	2	1

Decimal Digit Value

# Convert an Integer *from Binary to Decimal*

Highest order digit

Lowest order digit

$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
256	128	64	32	16	8	4	2	1

Decimal Digit Value

1  
↑  
First digit

0 0 1  
↑  
Last digit

# Convert an **Integer** from **Binary** to Decimal

Highest order digit

Lowest order digit

	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
Decimal Digit Value	256	128	64	32	16	8	4	2	1

Convert binary number 1001 to decimal

# Convert an **Integer** from **Binary** to Decimal

Highest order digit

Lowest order digit

	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
Decimal Digit Value	256	128	64	32	16	8	4	2	1

Convert binary number 1001 to decimal

$$(1\ 0\ 0\ 1)_2 = (1 \times 8) + (0 \times 4) + (0 \times 2) + (1 \times 1) = (9)_{10}$$

# Convert an Integer *from* Binary to Decimal

## Exercise 4.1

Convert the following binary numbers to decimal:

a)  $(1\ 0\ 1\ 1)_2$

b)  $(1\ 0\ 1\ 0\ 1\ 0)_2$

c)  $(1\ 1\ 1\ 1\ 0\ 1)_2$

d)  $(1\ 1\ 0\ 0\ 0\ 1\ 0)_2$

**5 minutes to convert these 4  
binary numbers to decimal!!**



# Convert an Integer *from* **Binary** to **Decimal**

## Exercise 4.1

Convert the following binary numbers to decimal:

$$\text{a) } (1\ 0\ 1\ 1)_2 = (11)_{10}$$

$$\text{b) } (1\ 0\ 1\ 0\ 1\ 0)_2 = (42)_{10}$$

$$\text{c) } (1\ 1\ 1\ 1\ 0\ 1)_2 = (61)_{10}$$

$$\text{d) } (1\ 1\ 0\ 0\ 0\ 1\ 0)_2 = (98)_{10}$$

# Convert an **Integer** *from* **Binary** to Octal

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- 1) First convert the binary number to decimal
- 2) Convert the decimal number to octal

# Convert an Integer *from* Binary to Octal

	Most Significant Bit								Least Significant Bit
	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
Decimal Digit Value	256	128	64	32	16	8	4	2	1

1) Convert binary number 1001 to decimal

$$(1\ 0\ 0\ 1)_2 = (1 \times 8) + (0 \times 4) + (0 \times 2) + (1 \times 1) = (9)_{10}$$

# Convert an Integer from Binary to Octal

	Most Significant Bit								Least Significant Bit
	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
Decimal Digit Value	256	128	64	32	16	8	4	2	1

1) Convert binary number 1001 to decimal

$$(1\ 0\ 0\ 1)_2 = (1 \times 8) + (0 \times 4) + (0 \times 2) + (1 \times 1) = (9)_{10}$$

2) Convert  $(9)_{10}$  to octal:  $(9)_{10} \rightarrow 9/8 = 1$  remainder 1  
 $(9)_{10} \rightarrow (11)_8$

# Convert an Integer *from* Binary to Octal

## Exercise 4.2

Convert the following binary numbers to octal:

a)  $(1\ 0\ 1\ 1)_2$

b)  $(1\ 0\ 1\ 0\ 1\ 0)_2$

c)  $(1\ 1\ 1\ 1\ 0\ 1)_2$

d)  $(1\ 1\ 0\ 0\ 0\ 1\ 0)_2$

**5 minutes to convert these 4  
binary numbers to octal numbers!!**

# Convert an Integer *from* Binary to Octal

## Exercise 4.2

Convert the following binary numbers to octal:

$$\text{a) } (1\ 0\ 1\ 1)_2 = (13)_8$$

$$\text{b) } (1\ 0\ 1\ 0\ 1\ 0)_2 = (52)_8$$

$$\text{c) } (1\ 1\ 1\ 1\ 0\ 1)_2 = (75)_8$$

$$\text{d) } (1\ 1\ 0\ 0\ 0\ 1\ 0)_2 = (142)_8$$

# Convert an Integer *from* Binary to Hexadecimal

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- 1) First convert the binary number to decimal
- 2) Convert the decimal number to hexadecimal

# Convert an Integer *from* Binary to Hexadecimal

Most Significant Bit

Least Significant Bit

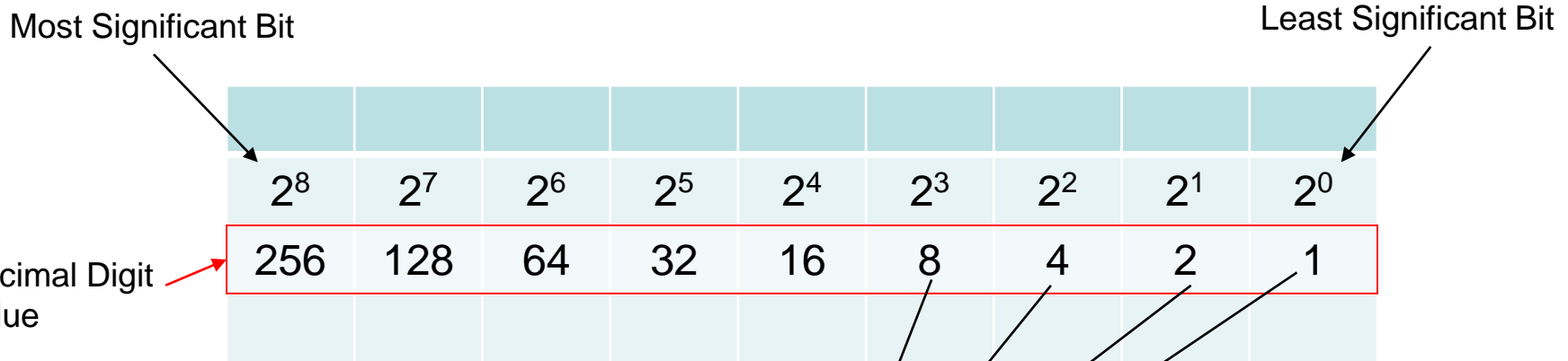
	$2^8$	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
Decimal Digit Value	256	128	64	32	16	8	4	2	1

Convert binary number 1001 to decimal

$$(1\ 0\ 0\ 1)_2 = (1 \times 8) + (0 \times 4) + (0 \times 2) + (1 \times 1) = (9)_{10}$$



# Convert an Integer *from* Binary to Hexadecimal



Convert binary number 1001 to decimal

$$(1\ 0\ 0\ 1)_2 = (1 \times 8) + (0 \times 4) + (0 \times 2) + (1 \times 1) = (9)_{10}$$

Convert  $(9)_{10}$  to hexadecimal:

$$9/16 = 0 \text{ remainder } 9$$

$$(9)_{10} \rightarrow (9)_{16}$$

# Converting between **Base 16** and **Base 2**

- Conversion is easy!
  - Determine 4-bit value for each hex digit
- Note that there are  $2^4 = 16$  different values of four bits
- Easier to read and write in hexadecimal.
- Representations are equivalent!

# Converting between **Base 16** and **Base 2**

$$3A9F_{16} = (\underbrace{0011}_{\uparrow 3} \ \underbrace{1010}_{\uparrow A} \ \underbrace{1001}_{\uparrow 9} \ \underbrace{1111}_{\uparrow F})_2$$

# Converting Between **Base 16** and **Base 8**

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1. Convert from Base 16 to Base 2
2. Regroup bits into groups of three starting from right
3. Ignore leading zeros
4. Each group of three bits forms an octal digit.

# Converting Between Base 16 and Base 8

---

$$3A9F_{16} = (0011\ 1010\ 1001\ 1111)_2$$

1. Convert from Base 16 to Base 2
2. Regroup bits into groups of three starting from right
3. Ignore leading zeros
4. Each group of three bits forms an octal digit.

# Converting Between Base 16 and Base 8

$$3A9F_{16} = (0011\ 1010\ 1001\ 1111)_2$$

Start from right

1. Convert from Base 16 to Base 2
2. Regroup bits into groups of three starting from right
3. Ignore leading zeros
4. Each group of three bits forms an octal digit.

# Converting Between Base 16 and Base 8

$$3A9F_{16} = \underline{0011} \ \underline{1010} \ \underline{1001} \ \underline{1111}_2$$

3      A      9      F

↓

$$\underline{011} \ \underline{101} \ \underline{010} \ \underline{011} \ \underline{111}_2$$

3      5      2      3      7

1. Convert from Base 16 to Base 2
2. Regroup bits into groups of three starting from right
3. Ignore leading zeros
4. Each group of three bits forms an octal digit.

# Converting Between Base 16 and Base 8

$$3A9F_{16} = \underline{0011} \ \underline{1010} \ \underline{1001} \ \underline{1111}_2$$

3      A      9      F

$$35237_8 = \underline{011} \ \underline{101} \ \underline{010} \ \underline{011} \ \underline{111}_2$$

3      5      2      3      7

1. Convert from Base 16 to Base 2
2. Regroup bits into groups of three starting from right
3. Ignore leading zeros
4. Each group of three bits forms an octal digit.



# Week 3 Lecture 4a

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- Number system conversion
  - Decimal number system
  - Binary number system
  - Octal number system
  - Hexadecimal number system
- Course web page:  
[https://ecs.wgtn.ac.nz/Courses/XMUT101\\_2021T1/](https://ecs.wgtn.ac.nz/Courses/XMUT101_2021T1/)
- `kerese@ecs.vuw.ac.nz`