ENGR 101
Engineering Technology

Dr. Kerese Manueli

School of Engineering and Computer Science
Victoria University of Wellington

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

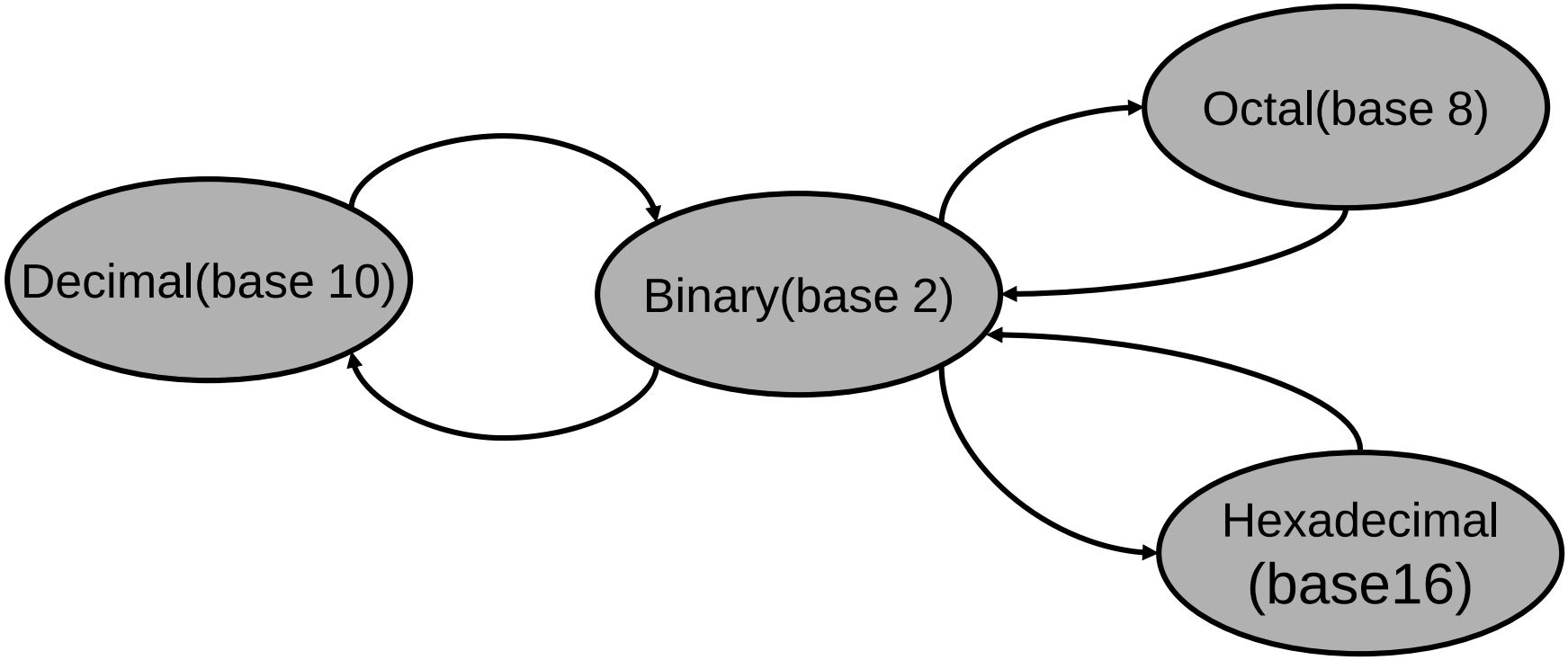
Week 2 Lecture 1b

- Main topics
  - Introduction to Engineering Technology
  - Number system
  - Logic Gates
  - Boolean Algebra

- Course web page:
  https://ecs.wgtn.ac.nz/Courses/XMUT101_2021T1/

- kerese@ecs.vuw.ac.nz

Conversion Between Number Systems



- **Learn to convert between bases.**

Convert *from* Decimal *to* Another Base

For each digit position:

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

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Example (a) $(13)_{10}$:

number

subscript

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Example for $(13)_{10}$:

	Integer Quotient		**Remainder**	**Coefficient**
13/2 =	6	+	½	$a_0 = 1$

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Example for $(13)_{10}$:

	Integer Quotient		Remainder	Coefficient
13/2 =	6	+	½	$a_0 = 1$
6/2 =	3	+	0	$a_1 = 0$

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Example for $(13)_{10}$:

	Integer Quotient		Remainder	Coefficient
13/2 =	6	+	½	$a_0 = 1$
6/2 =	3	+	0	$a_1 = 0$
3/2 =	1	+	½	$a_2 = 1$

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Example for $(13)_{10}$:

	Integer Quotient		Remainder	Coefficient
13/2 =	6	+	½	$a_0 = 1$
6/2 =	3	+	0	$a_1 = 0$
3/2 =	1	+	½	$a_2 = 1$
1/2 =	0	+	½	$a_3 = 1$

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Example for $(13)_{10}$:

	Integer Quotient		Remainder	Coefficient
13/2 =	6	+	½	$a_0 = 1$
6/2 =	3	+	0	$a_1 = 0$
3/2 =	1	+	½	$a_2 = 1$
1/2 =	0	+	½	$a_3 = 1$

Answer $(13)_{10} = (a_3\, a_2\, a_1\, a_0)_2 = (1101)_2$ ← subscript

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Exercise 1

Convert the following decimal numbers to binary:

a) $(17)_{10}$

b) $(32)_{10}$

c) $(85)_{10}$

d) $(114)_{10}$

5 minutes to solve these 4 decimal numbers to binary!!

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Exercise 1

Convert the following decimal numbers to binary:

a) $(17)_{10}$

b) $(32)_{10}$

c) $(85)_{10}$

d) $(114)_{10}$

2 minutes left!!

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Exercise 1

Convert the following decimal numbers to binary:

a) $(17)_{10}$

b) $(32)_{10}$

c) $(85)_{10}$

d) $(114)_{10}$

1 minute left!!

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Exercise 1

Convert the following decimal numbers to binary:

a) $(17)_{10}$

b) $(32)_{10}$

c) $(85)_{10}$

d) $(114)_{10}$

Please stop……

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Exercise 1

Convert the following decimal numbers to binary:

a) $(17)_{10} = (10001)_2$

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Exercise 1

Convert the following decimal numbers to binary:

a) $(17)_{10} = (10001)_2$

b) $(32)_{10} = (100000)_2$

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Exercise 1

Convert the following decimal numbers to binary:

a) $(17)_{10} = (10001)_2$

b) $(32)_{10} = (100000)_2$

c) $(85)_{10} = (1010101)_2$

Convert an Integer *from* Decimal *to* Another Base

For each digit position:

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

Exercise 1

Convert the following decimal numbers to binary:

a) $(17)_{10} = (10001)_2$

b) $(32)_{10} = (100000)_2$

c) $(85)_{10} = (1010101)_2$

d) $(114)_{10} = (1110010)_2$

Convert a Fraction *from* Decimal *to* Another Base

For each digit position:

1. **Multiply decimal number by the base (e.g. 2)**
2. **The *integer* is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Convert a Fraction *from* Decimal *to* Another Base

For each digit position:

1. **Multiply decimal number by the base (e.g. 2)**
2. **The *integer* is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Example for $(0.625)_{10}$:

	Integer		Fraction	Coefficient
0.625 x 2 =	1	+	0.25	$a_{-1} = 1$
0.250 x 2 =	0	+	0.50	$a_{-2} = 0$
0.500 x 2 =	1	+	0	$a_{-3} = 1$

Answer $(0.625)_{10} = (0.a_{-1}\, a_{-2}\, a_{-3})_2 = (0.101)_2$

Convert a Fraction *from* Decimal *to* Another Base

For each digit position:

1. **Multiply decimal number by the base (e.g. 2)**
2. **The integer is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Exercise 2

Convert the following fraction numbers to binary:

a) $(0.172)_{10}$

b) $(0.32)_{10}$

c) $(0.859)_{10}$

d) $(0.114)_{10}$

Convert an Integer *from* Decimal *to* Octal

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.**

Convert an Integer *from* Decimal *to* Octal

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.**

Example for $(175)_{10}$:

	Integer Quotient		Remainder	Coefficient
175/8 =	21	+	7/8	$a_0 = 7$
21/8 =	2	+	5/8	$a_1 = 5$
2/8 =	0	+	2/8	$a_2 = 2$

Answer $(175)_{10} = (a_2\, a_1\, a_0)_8 = (257)_8$

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

Convert the following decimal numbers to octal:

a) $(172)_{10}$

b) $(32)_{10}$

c) $(99)_{10}$

d) $(114)_{10}$

5 minutes to solve these 4 decimal numbers to binary!!

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

Convert the following decimal numbers to octal:

a) $(172)_{10}$

b) $(32)_{10}$

c) $(99)_{10}$

d) $(114)_{10}$

2 minutes left!!

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

Convert the following decimal numbers to octal:

a) $(172)_{10}$

b) $(32)_{10}$

c) $(99)_{10}$

d) $(114)_{10}$

1 minute left!!

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

Convert the following decimal numbers to octal:

a) $(172)_{10}$

b) $(32)_{10}$

c) $(99)_{10}$

d) $(114)_{10}$

Please stop……

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

Convert the following decimal numbers to octal:

a) $(172)_{10} = (21)_8$

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

c) $(99)_{10} = (125)_8$

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

Convert a Fraction *from* Decimal *to* Octal

For each digit position:

1. **Multiply decimal number by the base (e.g. 8)**
2. **The *integer* is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Convert a Fraction *from* Decimal *to* Octal

For each digit position:

1. **Multiply decimal number by the base (e.g. 8)**
2. **The *integer* is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Example for $(0.3125)_{10}$:

	Integer		Fraction	Coefficient
0.3125 x 8 =	2	+	0.5	$a_{-1} = 2$
0.5000 x 8 =	4	+	0	$a_{-2} = 4$

Answer $(0.3125)_{10} = (0.24)_8$

Convert a fraction *from* Decimal *to* Another Base

For each digit position:

1. **Multiply decimal number by the base (e.g. 8)**
2. **The integer is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Exercise 4

Convert the following decimal numbers to octal:

a) $(0.172)_{10}$

b) $(0.32)_{10}$

c) $(0.99)_{10}$

d) $(0.114)_{10}$

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.**

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.**

Example for $(130)_{10}$:

	Integer Quotient		Remainder	Coefficient
130/16 =	8	+	2	$a_0 = 2$
8/16 =	0	+	8	$a_1 = 8$

Answer $(130)_{10} = (a_1\, a_0)_{16} = (82)_{16}$

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) $(171)_{10}$

b) $(32)_{10}$

c) $(85)_{10}$

d) $(114)_{10}$

5 minutes to solve these 4 decimal numbers to binary!!

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) $(171)_{10}$

b) $(32)_{10}$

c) $(85)_{10}$

d) $(114)_{10}$

2 minutes left!!

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) $(171)_{10}$

b) $(32)_{10}$

c) $(85)_{10}$

d) $(114)_{10}$

1 minute left!!

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) $(171)_{10}$

b) $(32)_{10}$

c) $(85)_{10}$

d) $(114)_{10}$

Please stop……

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) $(171)_{10} = (11)_{16}$

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

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

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

Convert a Fraction *from* Decimal *to* Hexadecimal

For each digit position:

1. **Multiply decimal number by the base (e.g. 16)**
2. **The *integer* is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Convert a Fraction *from* Decimal *to* Hexadecimal

For each digit position:

1. **Multiply decimal number by the base (e.g. 16)**
2. **The *integer* is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Example for $(0.3125)_{10}$:

		Integer		Fraction	Coefficient
0.3125×16	=	5	+	0	$a_{-1} = 5$

Answer $(0.3125)_{10} = (0.5)_{16}$

Convert a Fraction *from* Decimal *to* Hexadecimal

For each digit position:

1. **Multiply decimal number by the base (e.g. 16)**
2. **The integer is the highest-order digit**
3. **Repeat first two steps until fraction becomes zero.**

Exercise 6

Convert the following decimal numbers to hexadecimal:

a) $(0.172)_{10}$

b) $(0.32)_{10}$

c) $(0.99)_{10}$

d) $(0.114)_{10}$

Week 2 Lecture 1b

- Decimal number conversion
  - Binary
  - Octal
  - Hexadecimal

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