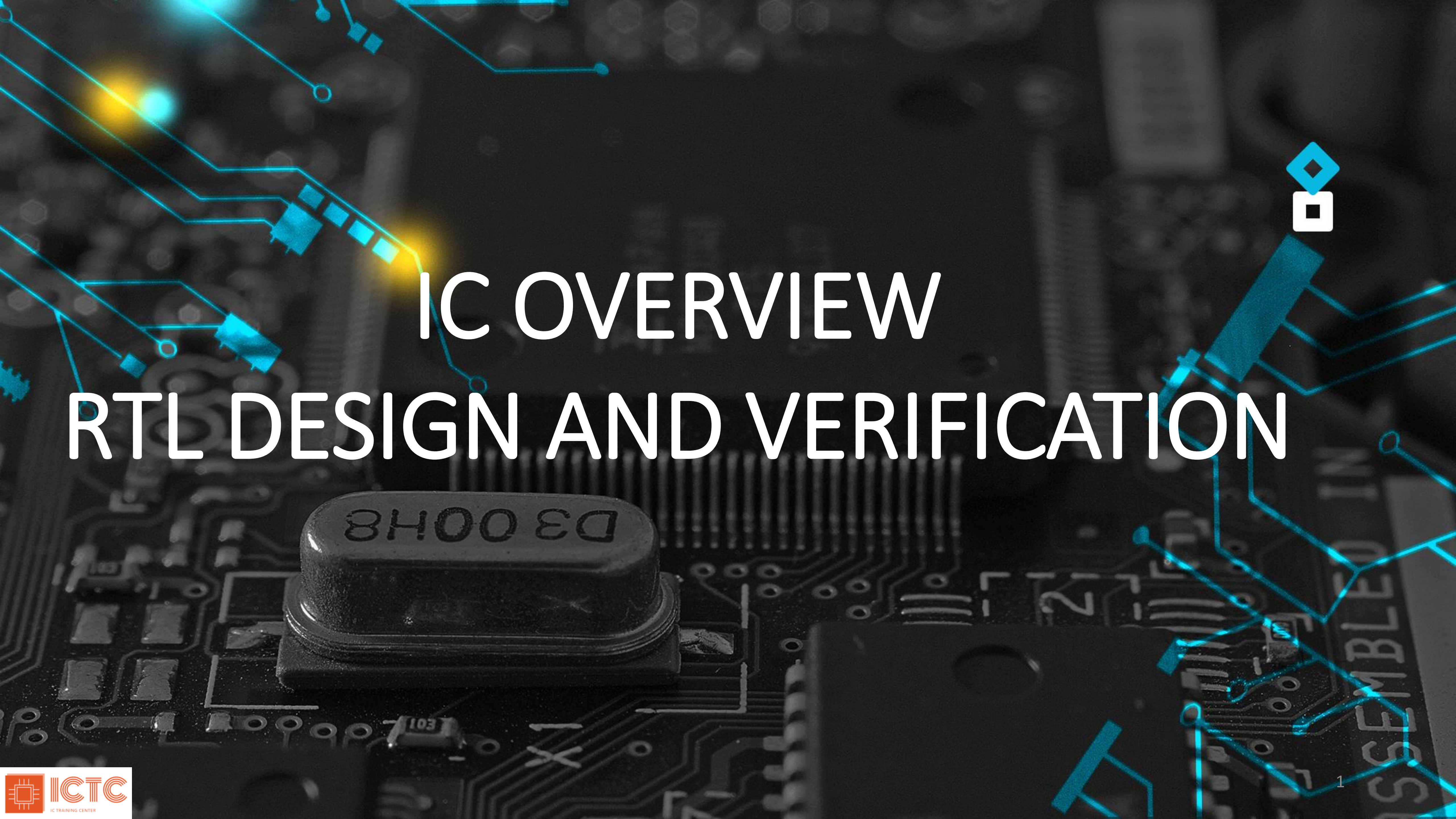
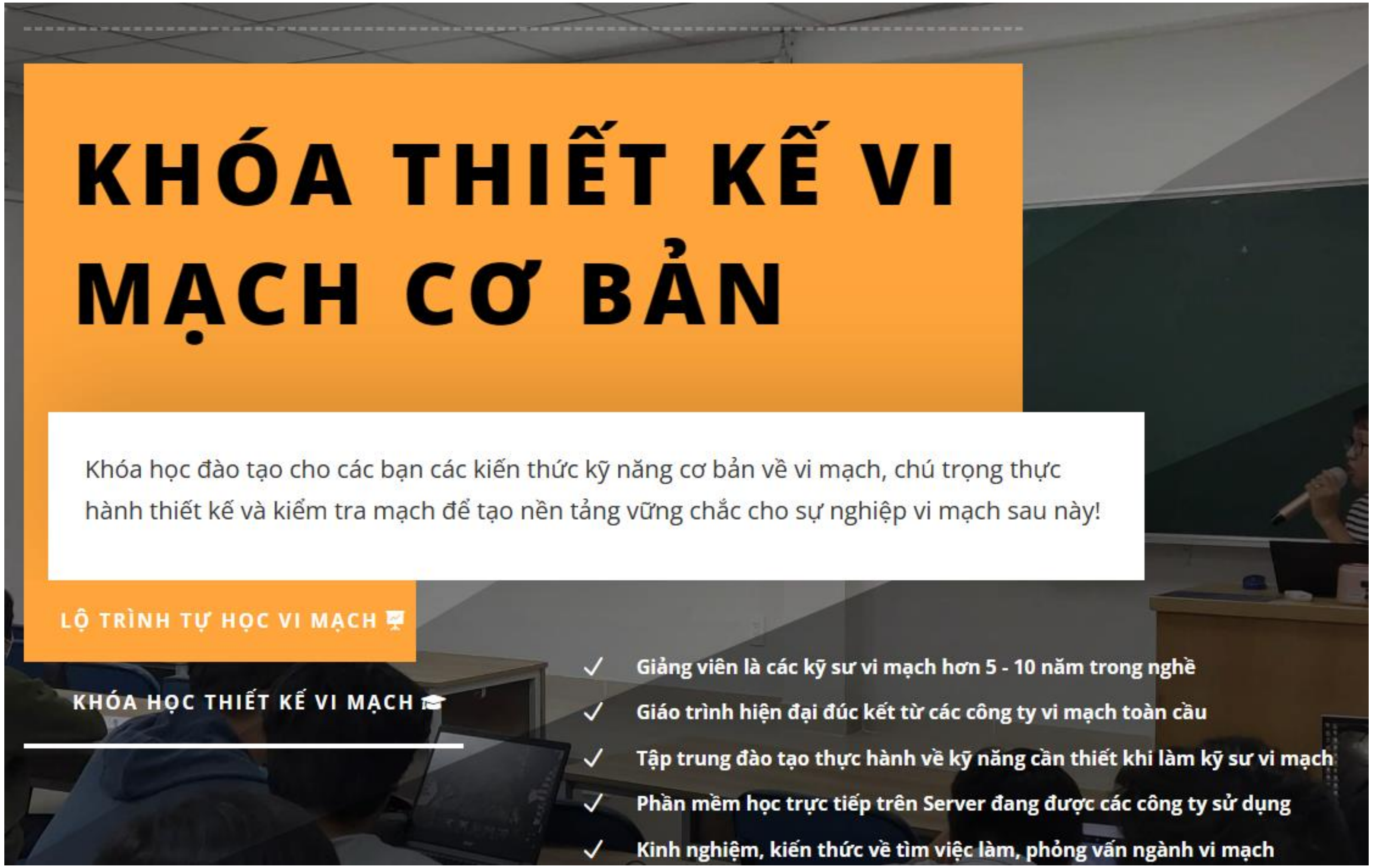


IC OVERVIEW
RTL DESIGN AND VERIFICATION

ICTC
IC TRAINING CENTER

COURSE INTRODUCTION

[Khóa Học Thiết Kế Vi Mạch Cơ Bản - Trung Tâm Đào Tạo Thiết Kế Vi Mạch ICTC]



KHÓA THIẾT KẾ VI MẠCH CƠ BẢN

Khóa học đào tạo cho các bạn các kiến thức kỹ năng cơ bản về vi mạch, chú trọng thực hành thiết kế và kiểm tra mạch để tạo nền tảng vững chắc cho sự nghiệp vi mạch sau này!

LỘ TRÌNH TỰ HỌC VI MẠCH

KHÓA HỌC THIẾT KẾ VI MẠCH

- ✓ Giảng viên là các kỹ sư vi mạch hơn 5 - 10 năm trong nghề
- ✓ Giáo trình hiện đại đúc kết từ các công ty vi mạch toàn cầu
- ✓ Tập trung đào tạo thực hành về kỹ năng cần thiết khi làm kỹ sư vi mạch
- ✓ Phần mềm học trực tiếp trên Server đang được các công ty sử dụng
- ✓ Kinh nghiệm, kiến thức về tìm việc làm, phỏng vấn ngành vi mạch

COURSE INTRODUCTION

- SUMMARY
- HOMEWORK
- QUESTION
- SELF-LEARNING

Session 5: LINUX, VIM, EDA

1. LINUX
2. VIM
3. EDA

LINUX ENVIRONMENT

Why Linux is widely used among semiconductor companies ?

LINUX ENVIRONMENT

Many semiconductor companies use Linux environments for various reasons:

❑ Open source

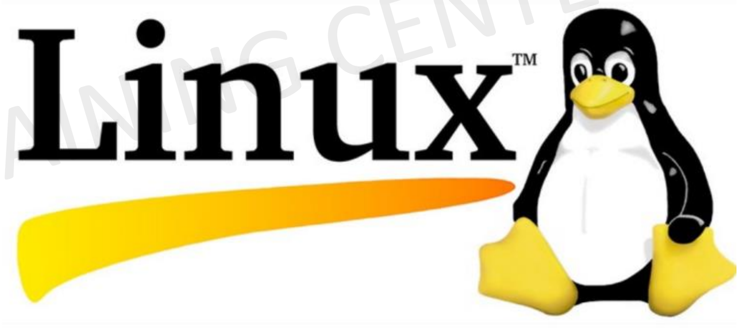
❑ Customization

❑ Stability and Reliability

❑ Cost efficiency

❑ Security

❑ Ecosystem



COMMON LINUX COMMANDS

Command	Description	Example
ls	List a directory content	ls <dir_name> ls
pwd	Shows the current working path	pwd
cd	Change the current working directory	cd <dir_name> : go to <dir_name> cd .. : go to upper 1 level cd - : go back to directory before entering current directory
mkdir	Creates a new directory	mkdir <dir_name>
tree	Display the hierarchy of current location	tree : display full hierarchy of current location tree –L 2: display hierarchy of 2 level from current location
rm	Remove file or directory	rm –rf <dir_name/file_name>
cp	Copy file or directory	cp –rf <dir_name/file_name> <new_file/new_location>
mv	Move file or directory	mv <dir_name/file_name> <new_file/new_location>
touch	Create a new empty file	touch <file_name>
cat	Print the content of file to Linux terminal, or concatenate files together	cat <file_name> cat <file_1> <file_2> … <file_n>

LINUX ENVIRONMENT

Common Linux Commands

Lab1: create working directory

1. Login to ICTC, enter your provided ID and password
2. Open Terminal
3. At your home directory, create a folder named “**05_ss5_practice**” and create below hierarchy under it:

```
|--05_ss5_practice
|    |-- lab1
|    |-- lab2
|    |-- lab3
```

4. Create an empty file, named “lab1.txt” under **lab1**
5. Change the file name from “lab1.txt” to “lab1_<your_name>”.txt, example lab1_duc.txt
6. Copy **/ictc/student-data/share/teacher/05_ss5_practice/lab1/lab1.txt** under your **lab1** folder
7. Display the content of lab1.txt in your **lab1** folder, it should appears the message “**You PASSED this lab**”.

Lab2: modify working directory

1. Copy **lab3** under **lab2** and change the directory name (of lab3 under lab2 folder) to **lab2_subdir**
2. Replace **lab2_subdir** directory by **/ictc/student-data/share/teacher/05_ss5_practice/lab2/lab2_subdir**
3. Check if there is a **README** file inside **00_linux/lab2/lab2_subdir**. If it is existed, display the content of README. it should appears the message “**You PASSED this lab**”.

OTHER LINUX COMMANDS FOR SELF-LEARNING

Command	Description	Example
grep	Search a string within a file	grep <string> <file_name>
du	Check the size of the file or directory	du –sh <file/dir_name>
clear	Clear terminal	clear
diff/vimdiff	Check difference between files	diff/vimdiff <file_1> <file_2> … <file_n>
find	Find a file, directory	find <location> -name <file_name> : find <file_name> in <location> dind <location> -type d –name <dir_name> : find <dir_name> in <location>
echo	Print something to terminal	echo “text”: print “text” to terminal echo “file.txt”: print “file.txt” (the file name is file.txt) to terminal
date	Print current date	date
head	Display the beginning of the file	head –n 10 <file> : display first 10 lines of <file>
tail	Display the end of the file	tail –n 10 <file> display last 10 lines of <file>

LINUX ENVIRONMENT

VIM Editor

- ❑ Vim is a text editor for Unix. It is mainly because it can be managed entirely without menus or a mouse with a keyboard
- ❑ Vim is a powerful text editor popular among developers. It's based on shortcuts, called the Vim language, which can make coding and writing faster and more efficient.
- ❑ To open Vim, on Linux terminal you can use: vi <file_name>
- ❑ We have 2 common modes usually used in Vim:
  - ➢ Insert mode: for typing text
    - ▪ To switch Insert mode, use can type “i” and “insert” on keyboard, so you can start editing the file.
    - ▪ To exit this mode, use “Esc” on keyboard (back to command mode)
  - ➢ Command mode: You can execute commands like undo, redo, find and replace, save, quit, etc. This mode is default mode when starting VIM.

LINUX ENVIRONMENT

VIM Editor – Common commands

Type of command	Command	Description
Delete command	x or “delete” on keyboard	To delete the character
	dd	To delete the current line
Copy, Paster command	yy	Copy current line
	P	Paste the line and place it below the cursor
Save and exit file	:w	Save the file
	:w <file_name>	Save the file to another file with name is “file_name”
	:wq	Save and quit
	:q!	Exit but not save
Search and replace	/text	Forward search with text keyword
	?text	Backward search with text keyword
	n	Find the previous match string
	N (Shift + n)	Find next match string
Undo and redo	u	Undo the last command
	ctrl + r	Redo

LINUX ENVIRONMENT

VIM Editor: Self-Learning

Type of command	Command	Description
Others	:vs	Vertically split widows To change to other split windows, do either below: 1.set mouse=a then move the mouse to other window 2.ctrl+w → left arrow button to go to left, right arrow button to go to right window
	:sp	Horizontally split window To change to other split windows, do either below: 1.set mouse=a then move the mouse to other window 2.ctrl+w → upward arrow button to go up, downward arrow button to go to bottom window
	gg	Go to first line of the file
	GG	Go to final line of the file
	:set nu	Display line number
	:%s/text1/text2/g	Replace string text1 by text2

LINUX ENVIRONMENT

Working directory

Lab3

Step 1: Make directory tree as below under **lab3**, all the files are empty

```
|--lab3
|    |--rtl                          //design dir
|    |    |-- top.v                  //design file
|    |--sim                          //simulation dir
|    |    |-- rtl.f                  //rtl list
|    |    |-- tb.f                   //testbench list
|    |    |-- compile.f              //compile list
|    |    |-- Makefile               //run script
|    |--tb                           //testbench dir
|    |    |-- test_bench.v           //testbench file
```

LINUX ENVIRONMENT

Working directory

Step 2: Open *top.v* and type exactly as below

```
module top (
   input   wire a,
   input   wire b,
   output wire z
);
   assign z = a ^ b;
endmodule
```

LINUX ENVIRONMENT

Working directory

Step 3: Open *rtl.f tb.f compile.f* and type exactly as below:

rtl.f

```
../rtl/top.v
```

tb.f

```
../tb/test_bench.v
```

compile.f

```
-f rtl.f
-f tb.f
```

LINUX ENVIRONMENT

Working directory

Step 4:

- Copy Makefile from /ictc/student-data/share/teacher/05_ss5_practice/lab3/sim/Makefile and replace your Makefile.
- Copy folder tb from /ictc/student-data/share/teacher/05_ss5_practice/lab3/tb and replace your tb folder

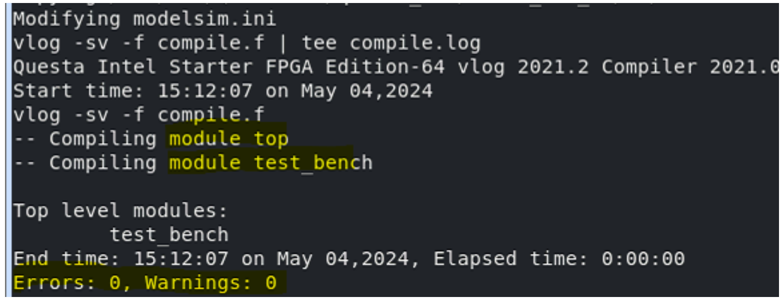
LINUX ENVIRONMENT

Working directory

Basic environment is like below:

```
|--rtl                    //design dir
|    |-- top.v            //design file
|--sim                    //simulation dir
|    |-- rtl.f            //rtl list
|    |-- tb.f             //testbench list
|    |-- compile.f        //compile list
|    |-- Makefile         //run script
|--tb                     //testbench dir
|    |-- test_bench.v     //testbench file
```

```
% cd sim
% make build  //compile the design and tb
```



```
Modifying modelsim.ini
vlog -sv -f compile.f | tee compile.log
Questa Intel Starter FPGA Edition-64 vlog 2021.2 Compiler 2021.0
Start time: 15:12:07 on May 04,2024
vlog -sv -f compile.f
-- Compiling module top
-- Compiling module test_bench

Top level modules:
        test_bench
End time: 15:12:07 on May 04,2024, Elapsed time: 0:00:00
Errors: 0, Warnings: 0
```

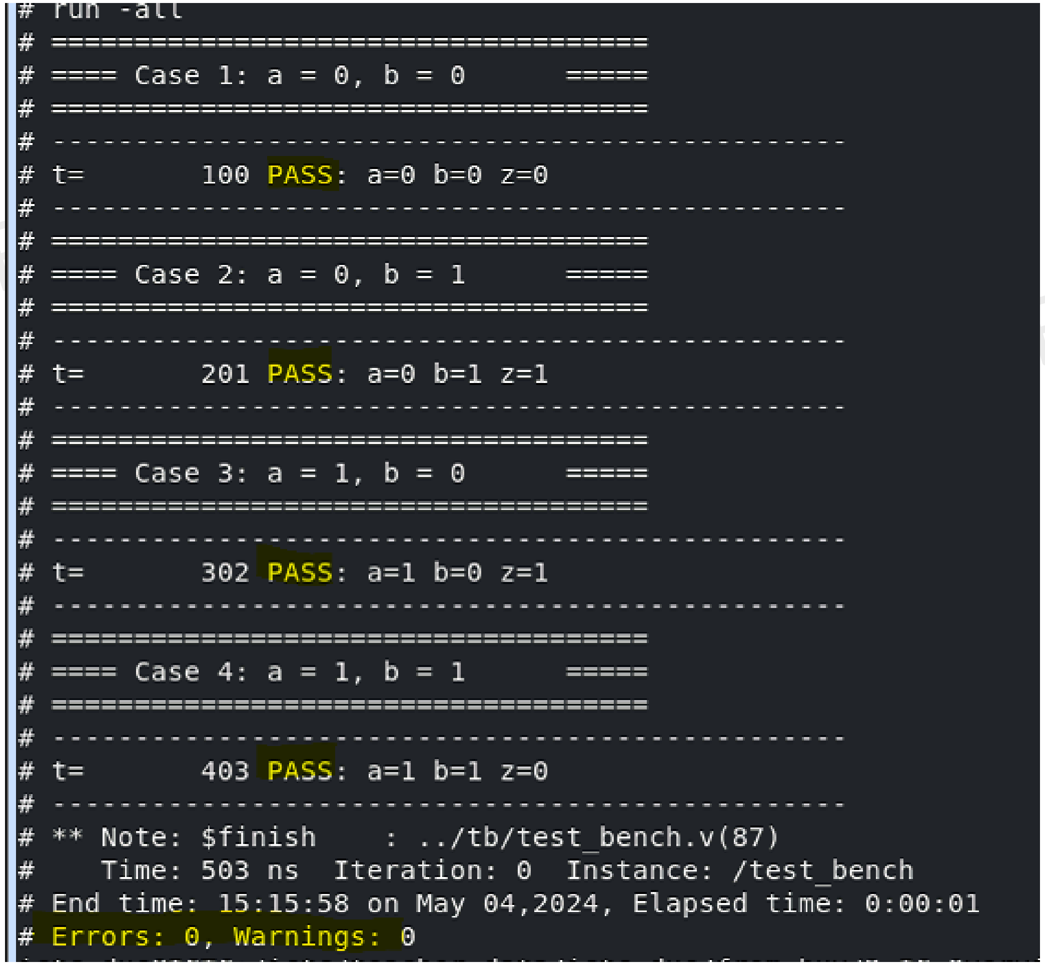
LINUX ENVIRONMENT

Working directory

Basic environment is like below:

```
|--rtl                  //design dir
|    |-- top.v          //design file
|--sim                  //simulation dir
|    |-- rtl.f          //rtl list
|    |-- tb.f           //testbench list
|    |-- compile.f      //compile list
|    |-- Makefile       //run script
|--tb                   //testbench dir
|    |-- test_bench.v   //testbench file
```

```
% make run  //run simulation
```



```
# run -all
# ====================================
# ==== Case 1: a = 0, b = 0      =====
# ====================================
# ------------------------------------------------
# t=       100 PASS: a=0 b=0 z=0
# ------------------------------------------------
# ====================================
# ==== Case 2: a = 0, b = 1      =====
# ====================================
# ------------------------------------------------
# t=       201 PASS: a=0 b=1 z=1
# ------------------------------------------------
# ====================================
# ==== Case 3: a = 1, b = 0      =====
# ====================================
# ------------------------------------------------
# t=       302 PASS: a=1 b=0 z=1
# ------------------------------------------------
# ====================================
# ==== Case 4: a = 1, b = 1      =====
# ====================================
# ------------------------------------------------
# t=       403 PASS: a=1 b=1 z=0
# ------------------------------------------------
# ** Note: $finish    : ../tb/test_bench.v(87)
#    Time: 503 ns  Iteration: 0  Instance: /test_bench
# End time: 15:15:58 on May 04,2024, Elapsed time: 0:00:01
# Errors: 0, Warnings: 0
```

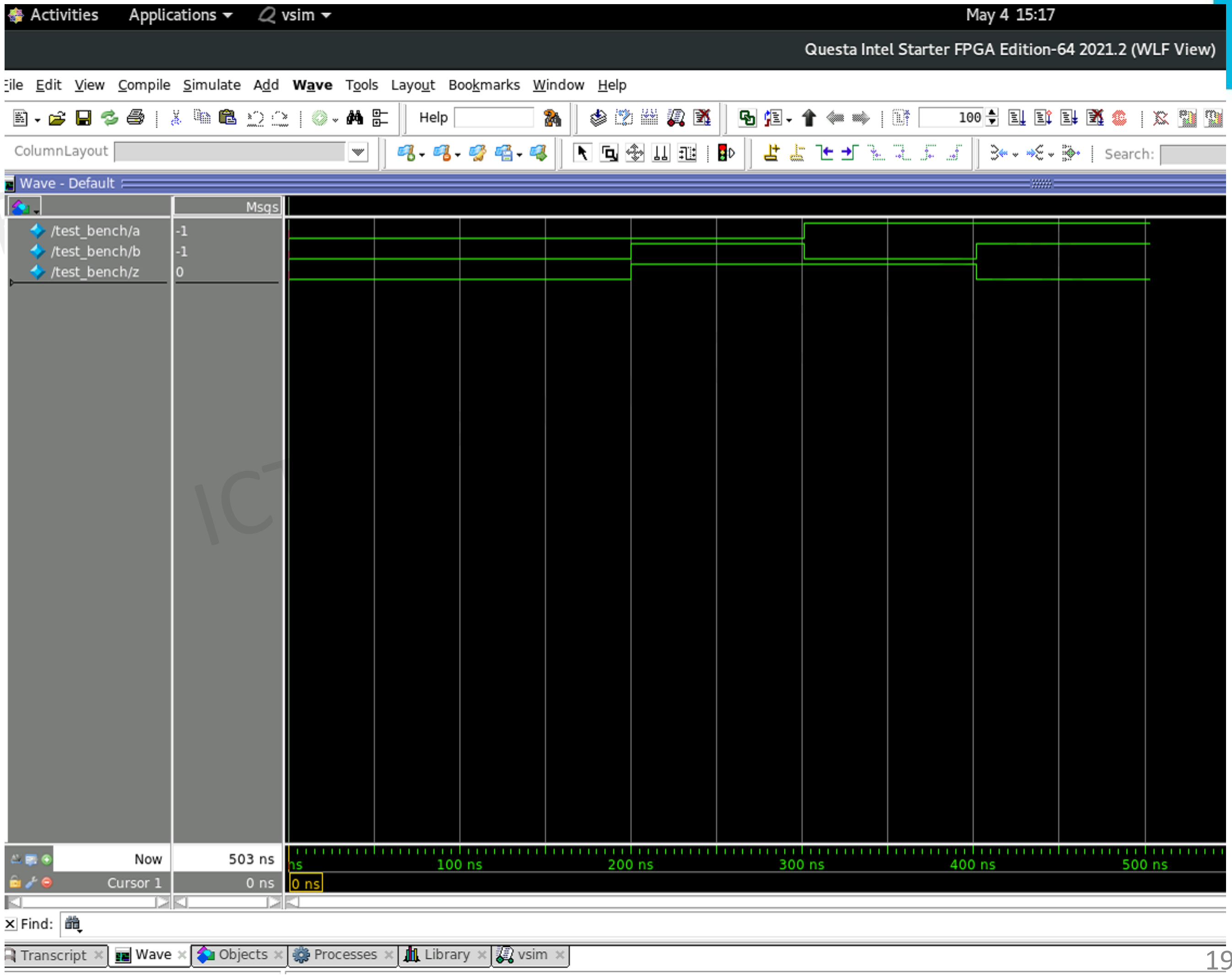
LINUX ENVIRONMENT

Working directory

Basic environment is like below:

```
|--rtl                //design dir
|    |-- top.v        //design file
|--sim                //simulation dir
|    |-- rtl.f        //rtl list
|    |-- tb.f         //testbench list
|    |-- compile.f    //compile list
|    |-- Makefile     //run script
|--tb                 //testbench dir
|    |-- test_bench.v //testbench file
```

```
% make wave  //open waveform
```



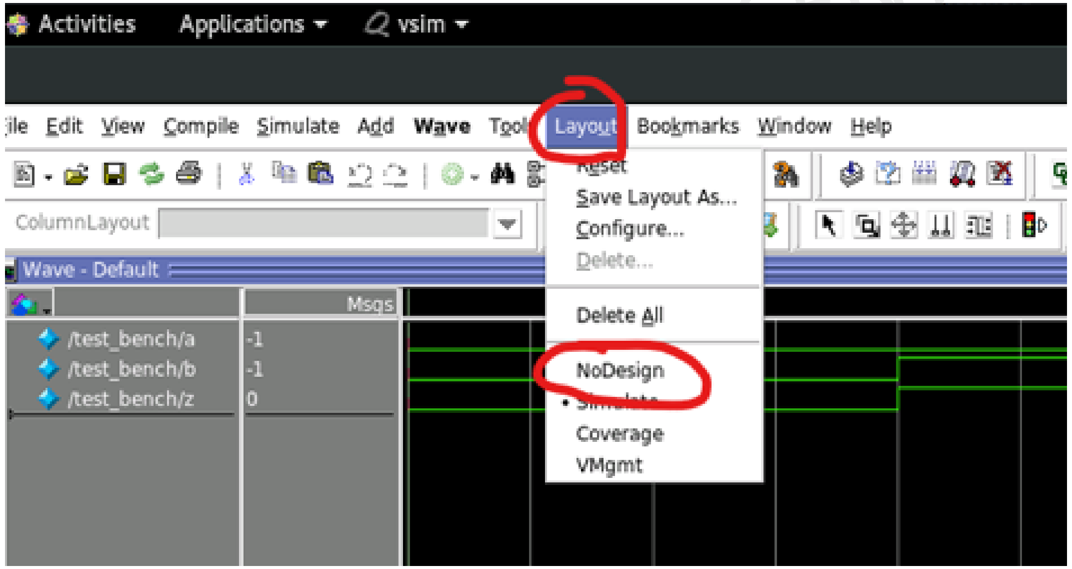
Questa Intel Starter FPGA Edition-64 2021.2 (WLF View)

	Msgs
/test_bench/a	-1
/test_bench/b	-1
/test_bench/z	0
Now	503 ns
Cursor 1	0 ns

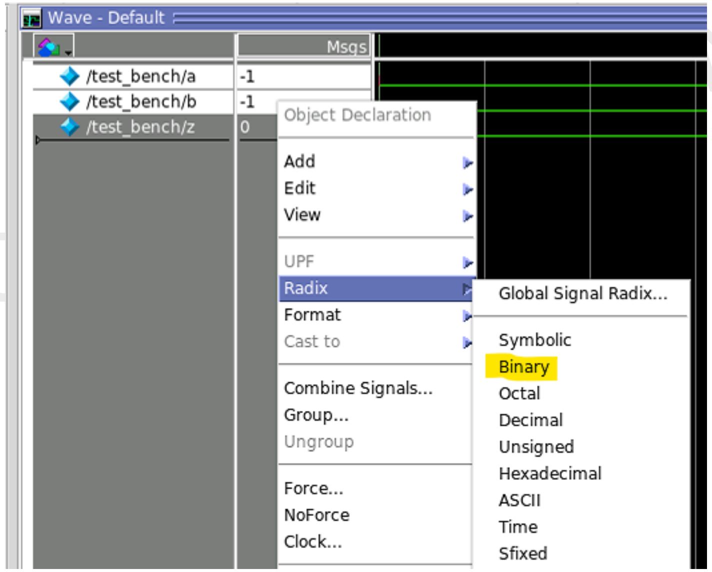
LINUX ENVIRONMENT

Working directory

Choose Layout → **NoDesign** to see the hierarchy in same window



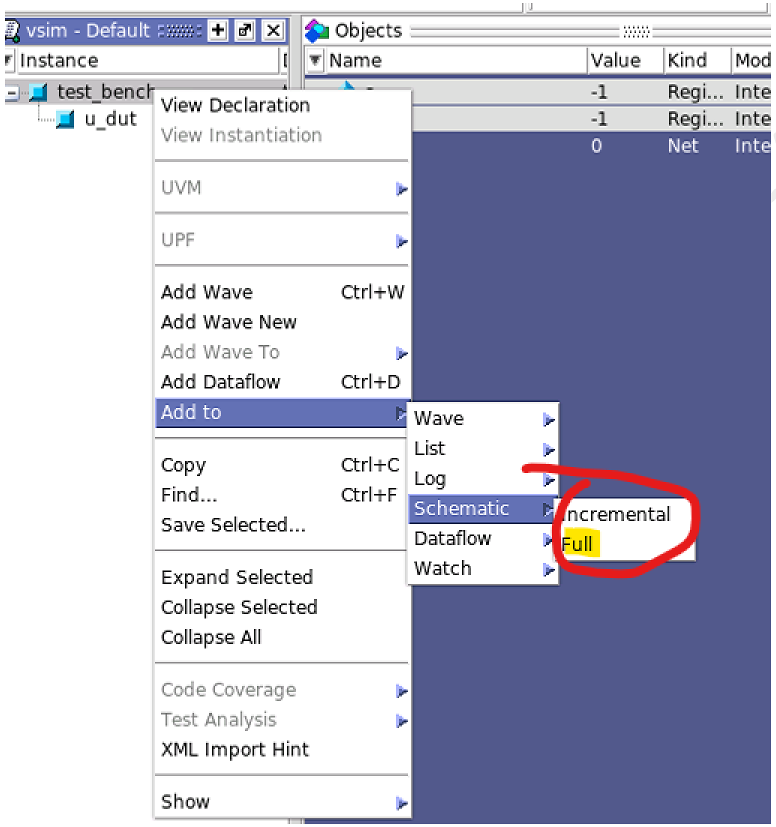
Choose signal → right click → Radix to change signals' display value



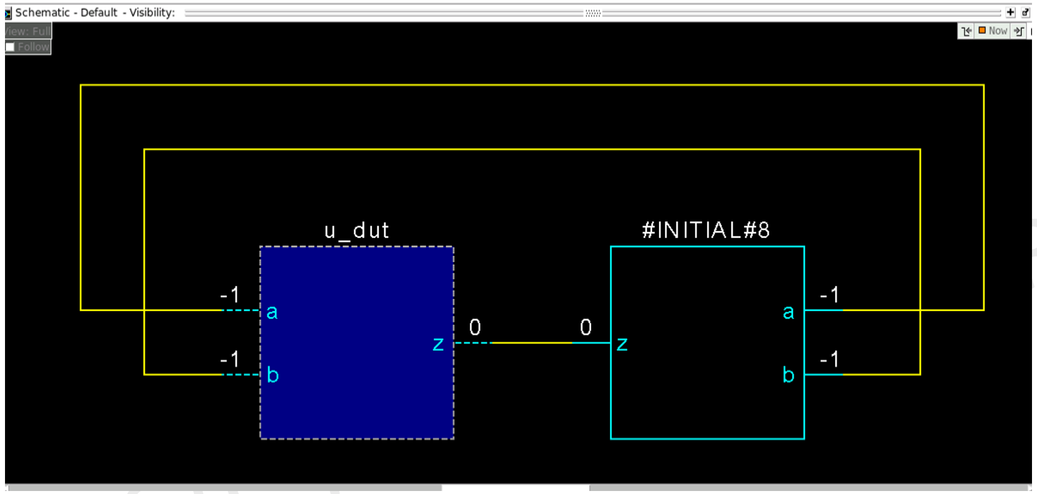
LINUX ENVIRONMENT

Working directory

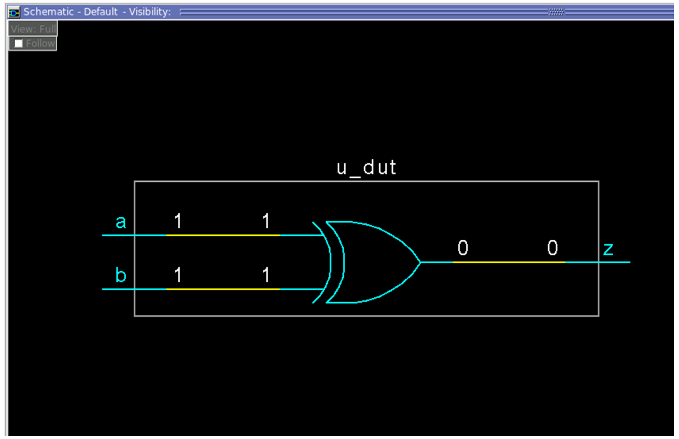
Choose hierarchy → right click → Add to → Schematic → Full to see the schematic



Testbench schematic view



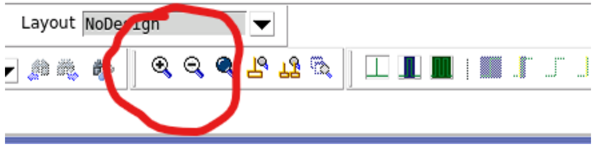
Double click to dut to see the dut schematic



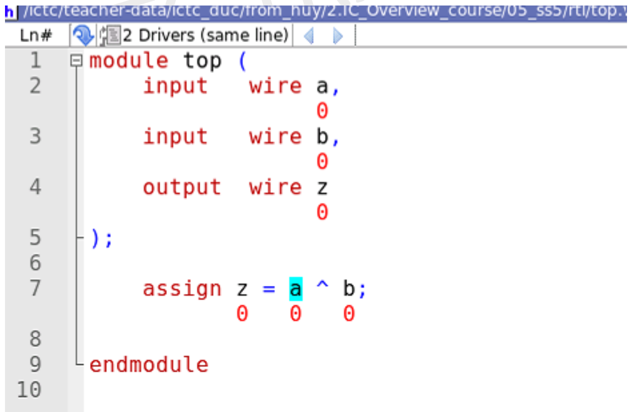
LINUX ENVIRONMENT

Working directory

Press Ctrl and use scroll button on your mouse to zoom-in and zoom-out
Or Use (+) and (-) on your control panel



Can double click on the waveform signal for tracing value in the design


h /ictc/teacher-data/ictc_duc/from_huy/2.IC_Overview_course/05_ss5/rtl/top.
Ln#
2 Drivers (same line)

```
module top (
       input   wire a,
                    0
       input   wire b,
                    0
       output  wire z
                    0
);

       assign z = a ^ b;
              0   0   0

endmodule
```

SESSION 5

SUMMARY

SUMMARY:

- ❑ CPU: acts as brain of the computer.
- ❑ MCU: often used for general purpose, includes: CPU, BUS, Memory, peripherals.
- ❑ SOC: often used for specific applications, structure same as MCU but more complex.
- ❑ Linux operating system is widely used in semiconductor industry.
- ❑ Vim is powerful Linux text editor.
- ❑ Makefile is one kind of Linux scripting, can be used to do multiple user tasks.

HOMEWORK

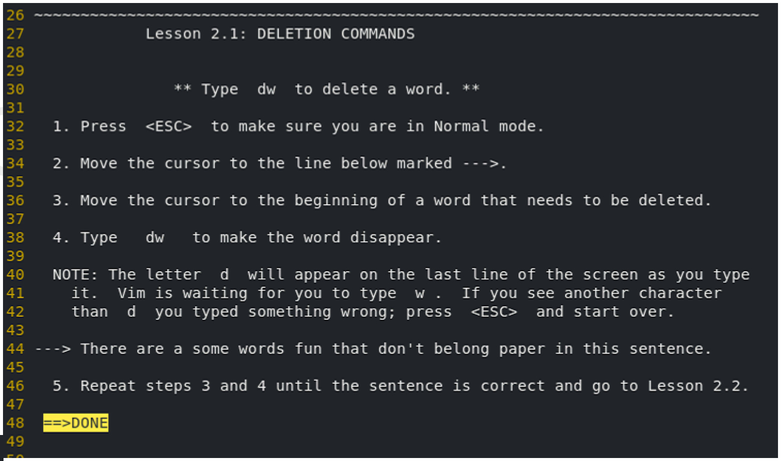
Homework1:

- ❑ **Step 1**: create homework folder under your **05_ss5_practice** dir
- ❑ **Step 2**: Copy /ictc/student-data/share/teacher/05_ss5_practice/homework/vimtutor.txt to your homework directory
- ❑ **Step 3**: Finish all the lessons in the vimtutor.txt, marked **"==>DONE"** at the end of all the Lession. Refer to the picture on the right as an example

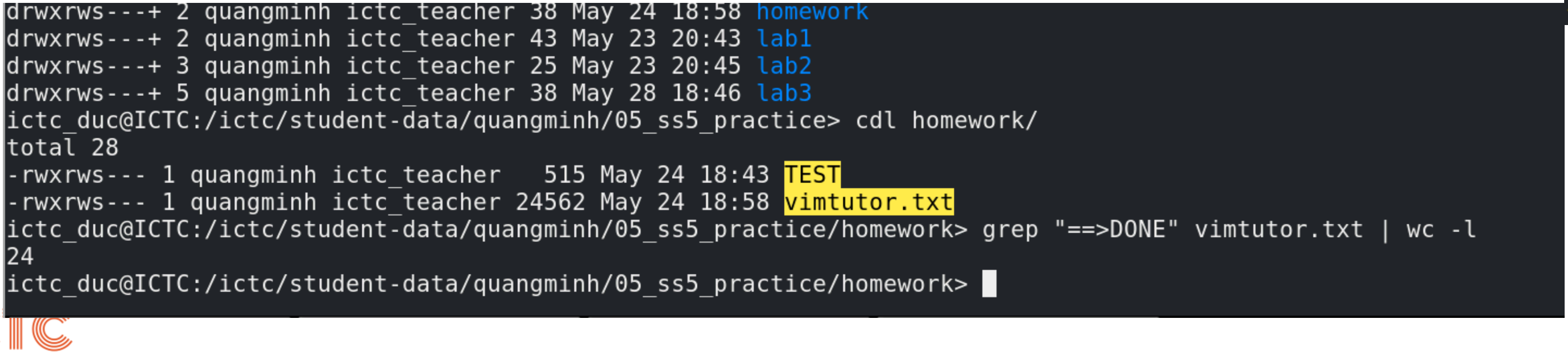
  Note: "Summary" is not a lesson, should not put "==>DONE" there.
- ❑ **Step 4**: Type below command in linux:

  grep "==>DONE" vimtutor.txt. (Expectation is 24)
- ❑ **Step 5**: snapshot the result and submit to your homewok form. Below is an example. Submit this picture.

  Your lecturer will check again in your directory.



```
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
                Lesson 2.1: DELETION COMMANDS


                   ** Type  dw  to delete a word. **

  1. Press  <ESC>  to make sure you are in Normal mode.

  2. Move the cursor to the line below marked --->.

  3. Move the cursor to the beginning of a word that needs to be deleted.

  4. Type   dw   to make the word disappear.

  NOTE: The letter  d  will appear on the last line of the screen as you type
    it.  Vim is waiting for you to type  w .  If you see another character
    than  d  you typed something wrong; press  <ESC>  and start over.

---> There are a some words fun that don't belong paper in this sentence.

  5. Repeat steps 3 and 4 until the sentence is correct and go to Lesson 2.2.

 ==>DONE

```



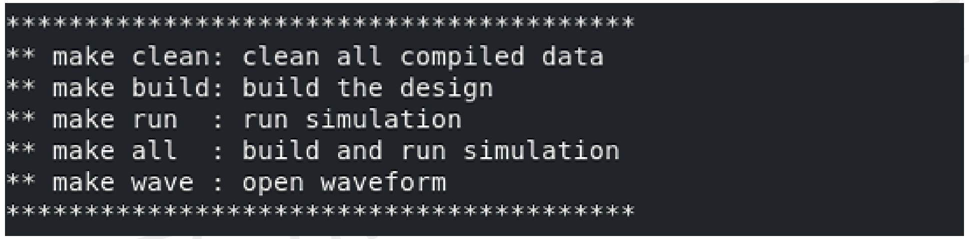
```
drwxrws---+ 2 quangminh ictc_teacher 38 May 24 18:58 homework
drwxrws---+ 2 quangminh ictc_teacher 43 May 23 20:43 lab1
drwxrws---+ 3 quangminh ictc_teacher 25 May 23 20:45 lab2
drwxrws---+ 5 quangminh ictc_teacher 38 May 28 18:46 lab3
ictc_duc@ICTC:/ictc/student-data/quangminh/05_ss5_practice> cdl homework/
total 28
-rwxrws--- 1 quangminh ictc_teacher   515 May 24 18:43 TEST
-rwxrws--- 1 quangminh ictc_teacher 24562 May 24 18:58 vimtutor.txt
ictc_duc@ICTC:/ictc/student-data/quangminh/05_ss5_practice/homework> grep "==>DONE" vimtutor.txt | wc -l
24
ictc_duc@ICTC:/ictc/student-data/quangminh/05_ss5_practice/homework> █
```

HOMEWORK

Homework2 (*):

❑ Investigate the Makefile and add following requirement

- When type "make help", it will output



```
****************************************
** make clean: clean all compiled data
** make build: build the design
** make run   : run simulation
** make all   : build and run simulation
** make wave : open waveform
****************************************
```

- When type "make clean", it will remove all the file generated by the simulation.
- When type "make all", it will build and run the simulation

➢ Keep the new Makefile under your lab3/sim directory

➢ Open Makefile, Screenshot and submit it to your homework form. Your mentor will check again in your home directory. Note that snapshot of homework1 and homework2 should be attached in 1 file.