

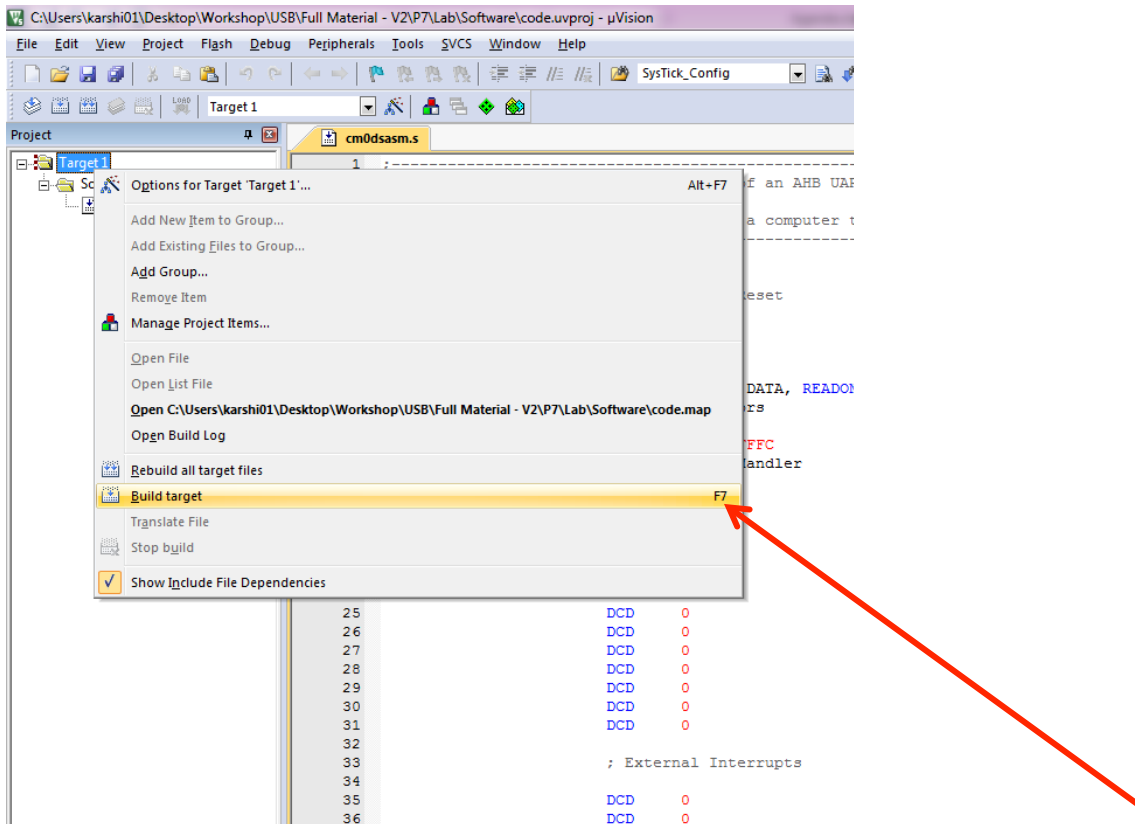
Programming in C and Interrupts

SUMMARY

1. Compile the Software using KEIL MDK ARM and generate code.hex file
2. Download code.hex onto PSRAM
3. Use Vivado hardware manager to download the .bit file given in the FPGA directory
4. Communicate with the board using HyperTerminal (or any other serial terminal). See the snake game on the VGA output. Use these keys as the arrow keys on your keyboard,
 - a. W → UP Arrow
 - b. A → Left Arrow
 - c. S → Down Arrow
 - d. D → Right Arrow

SOFTWARE COMPILATION

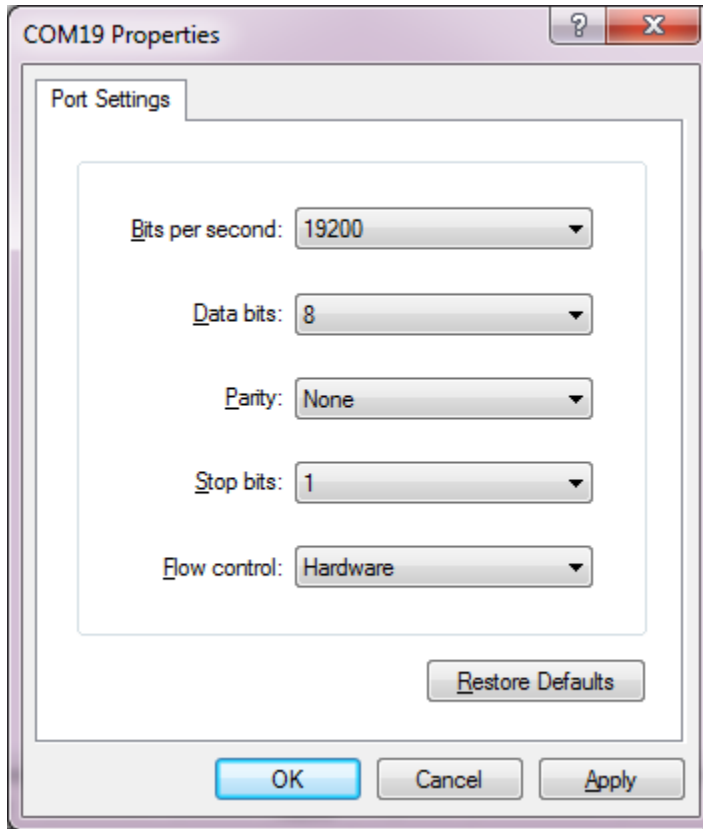
1. Open the software project lab/software/code.uvproj
2. Right click on Target and press “Build Target”



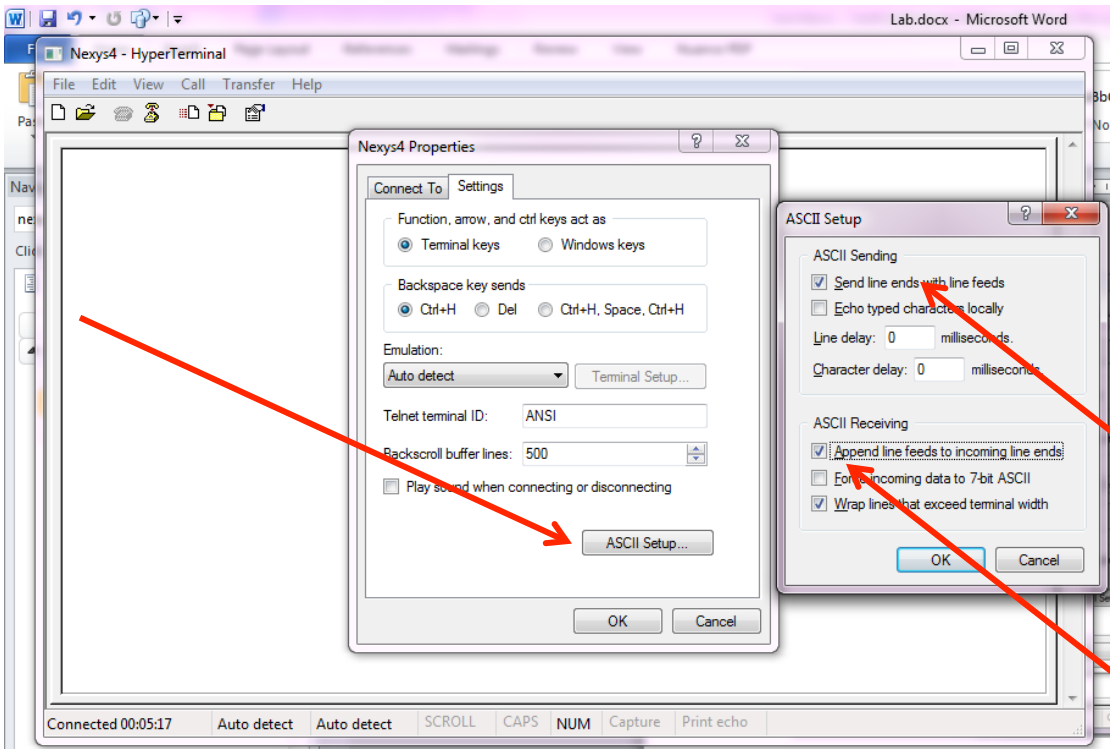
3. Check code.hex get generated inside software folder
4. The code binary is now ready to be downloaded onto the board

DOWNLOADING CODE.HEX ONTO ONBOARD PSRAM USING SERIAL COMMUNICATION

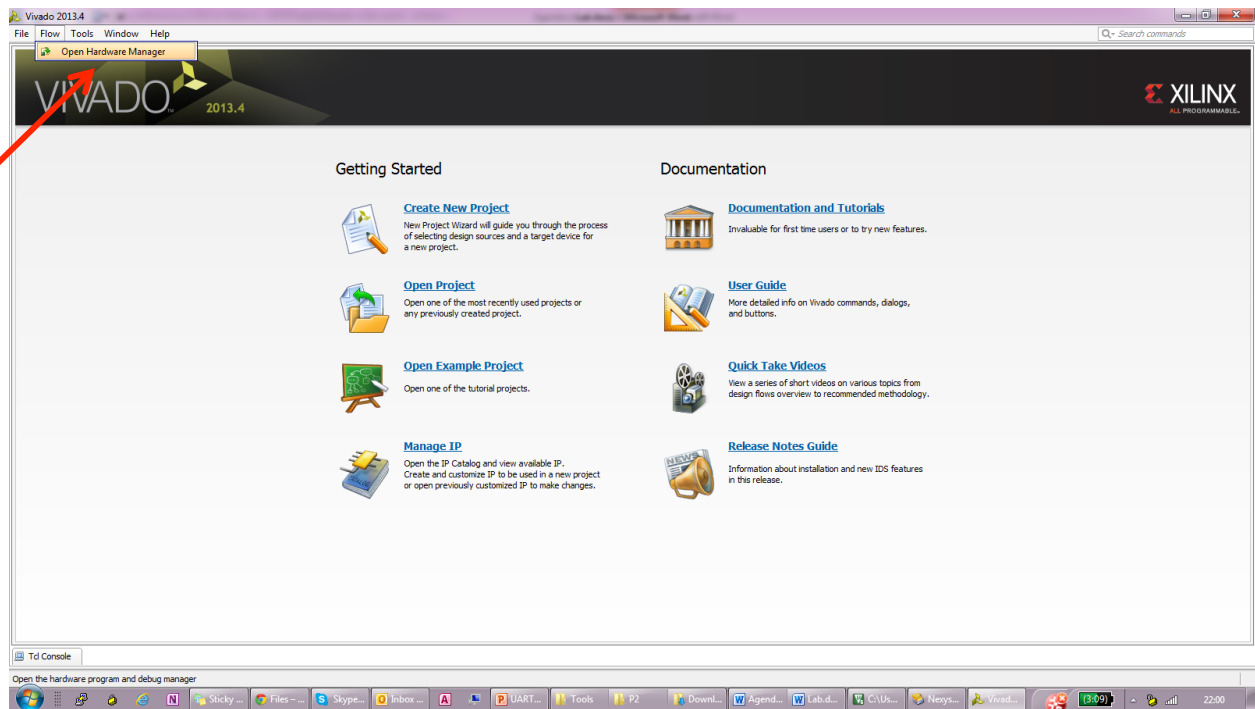
1. Go to the tools directory and open HyperTerminal.exe
2. Set the serial terminal with the following setting



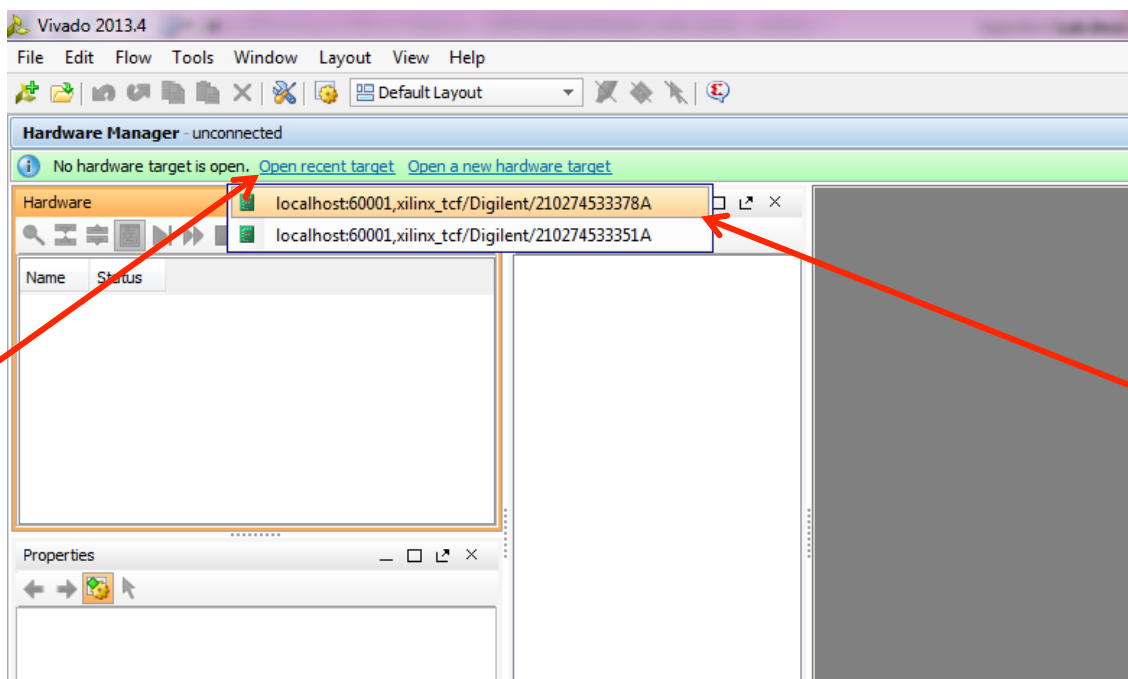
3. Now click FILE → Properties and change the ASCII setting,



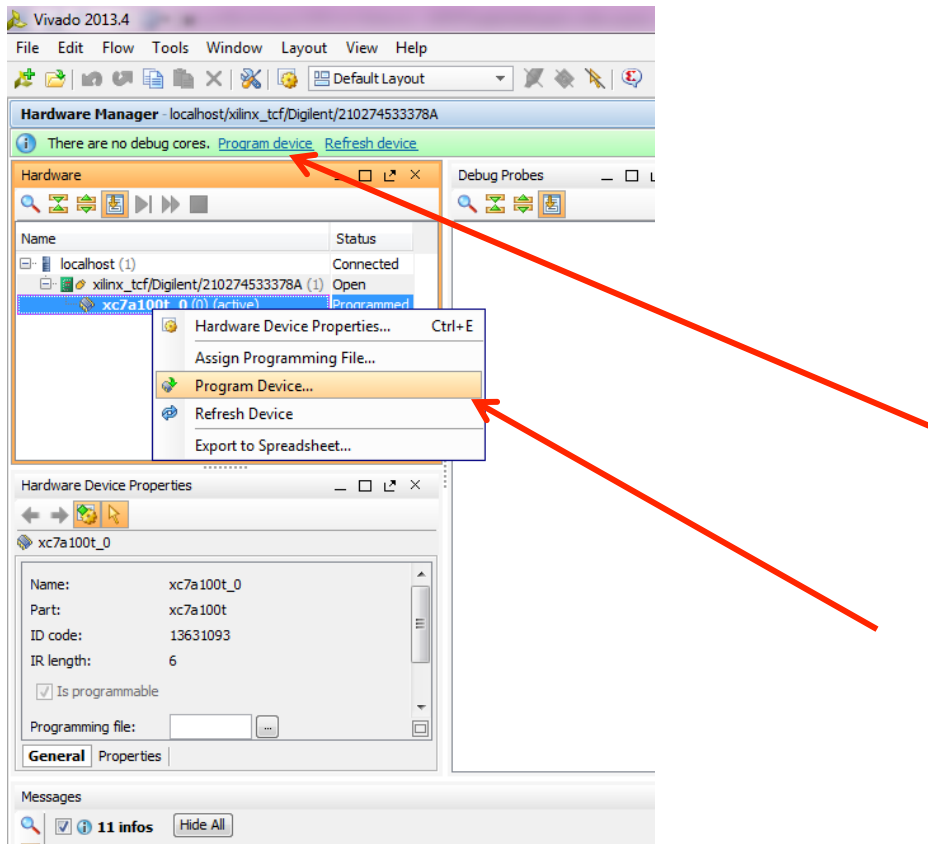
4. Now open a new Vivado window
5. Open Flow → Hardware Manager as show below



6. Click on “Open Recent Target” and choose the connection you established in the previous lab



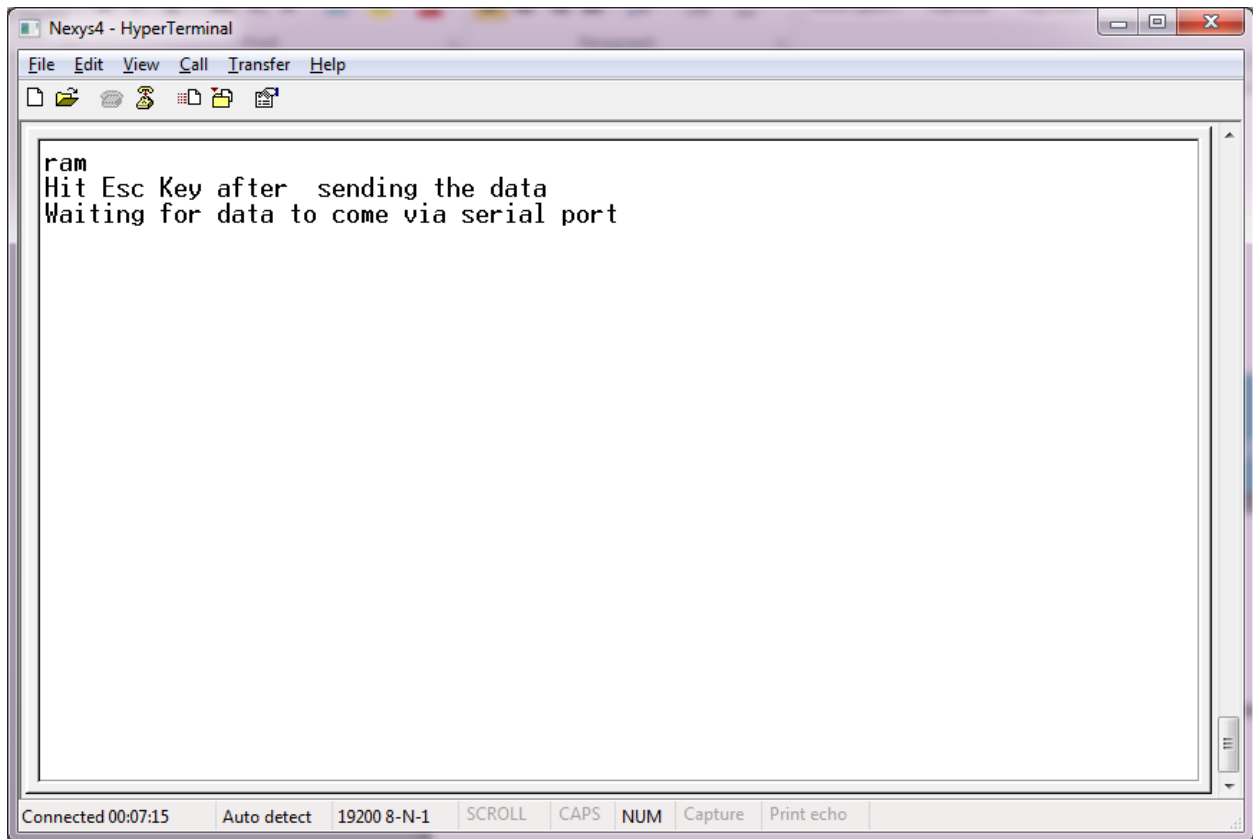
7. Right click on the device and choose “Program device”



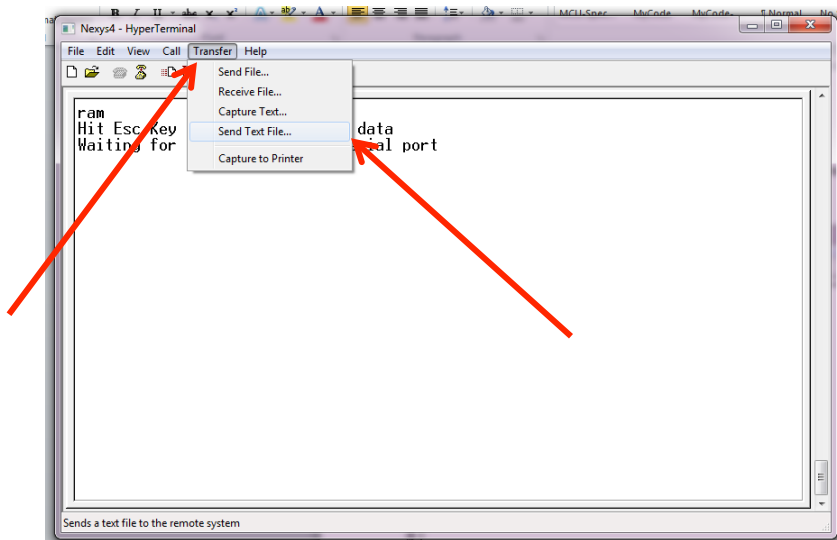
8. Choose “download_19200.bit” present in the tools directory

9. This will load the download program which will transfer binary file into PSRAM

10. Open HyperTerminal and you should see below message,



11. Send the code.hex file using “Send Text File” wizard in HyperTerminal



12. Choose code.hex file generated in lab/software directory

13. At the end of the transfer hit <ESC> key to complete the transfer. You should see the below message

The screenshot shows a HyperTerminal window titled "Nexys4 - HyperTerminal". The window contains the following text:

```
C5C0C5C0
C5C0C5C0
C5C0C5C0
C5C0C5C0
00493D40
47704680
46C04604
462046C0
FF7F7FF
47704800
00000238
20184901
E7FEBEAB
00020026
00004770
00000238
00000238
00000868
000000C4

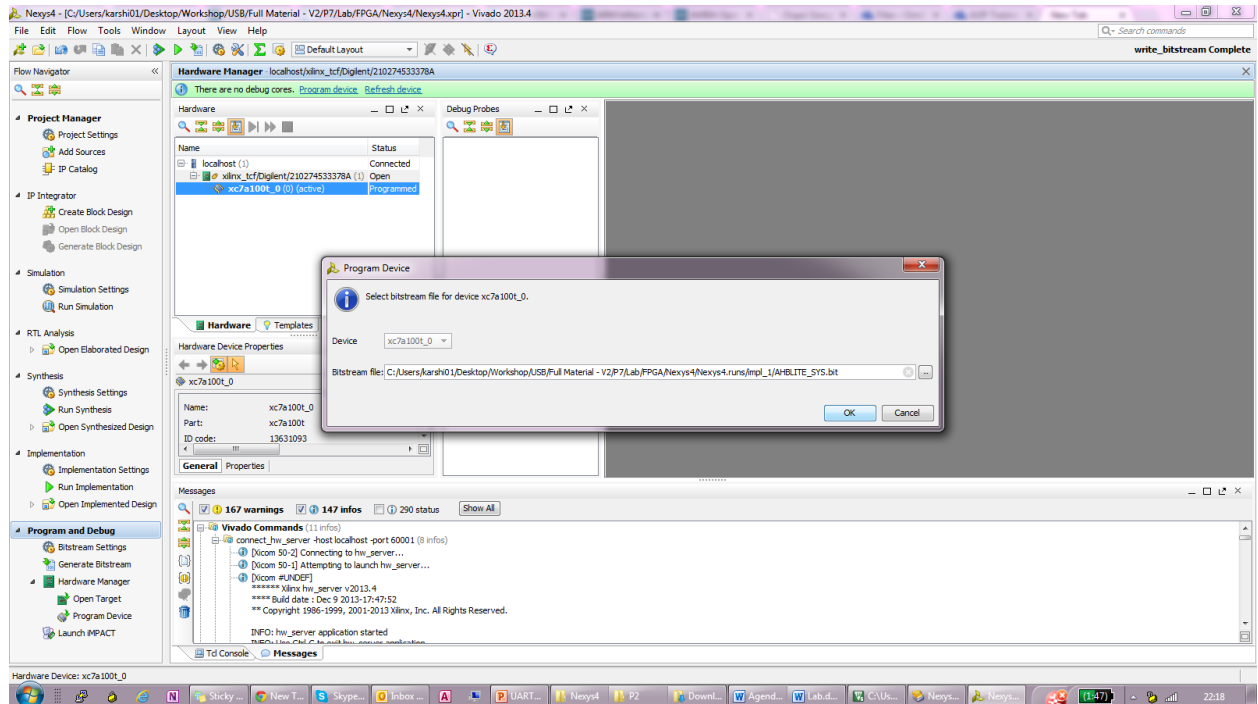
Reading and displaying first 16 bytes from the external memory
FC FF 0 0 D 1 0 0 0 0 0 0 0 0 0 0
-- Exiting main() --
```

At the bottom of the window, there is a status bar with the following information: "Connected 00:00:49", "Auto detect", "19200 8-N-1", "SCROLL", "CAPS", "NUM", "Capture", and "Print echo".

14. This complete the binary transfer and loads the PSRAM with code.hex binary data

DOWNLOAD THE HARDWARE .BIT FILE ONTO FPGA

1. Download the bit stream given in lab/FPGA folder onto FPGA using hardware manager



2. Once the hardware is loaded onto FPGA, the CM0 in the design starts to execute the program loaded onto PSRAM
3. Communicate with the board using HyperTerminal (or any other serial terminal). See the snake game on the VGA output. Use these keys as the arrow keys on your keyboard,
 - a. W → UP Arrow
 - b. A → Left Arrow
 - c. S → Down Arrow
 - d. D → Right Arrow
4. If everything is working fine you should see something like below, (Note nothing will be printed on the serial terminal for this demo).

