Lab Exercise 4: Seven Segment Display

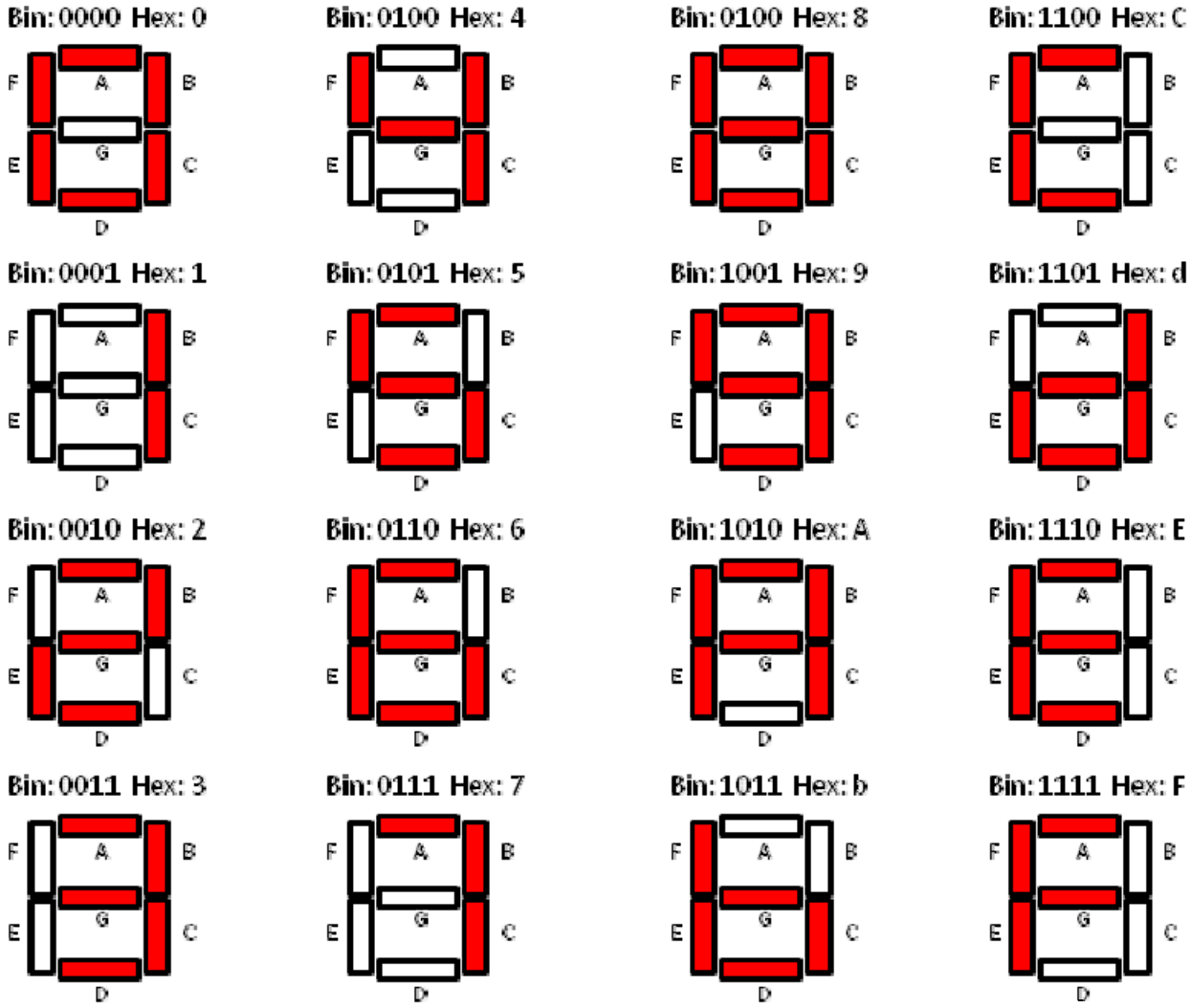
Design and implement a Seven Segment Display with the functional description given below.

The aim of this exercise is to learn how to use 4-digit seven segment display available on the BASYS3 board. It involves designing and implementing a circuit to display 16-bit binary number set on the slide switches as a 4 digit hexadecimal number (number with base 16).

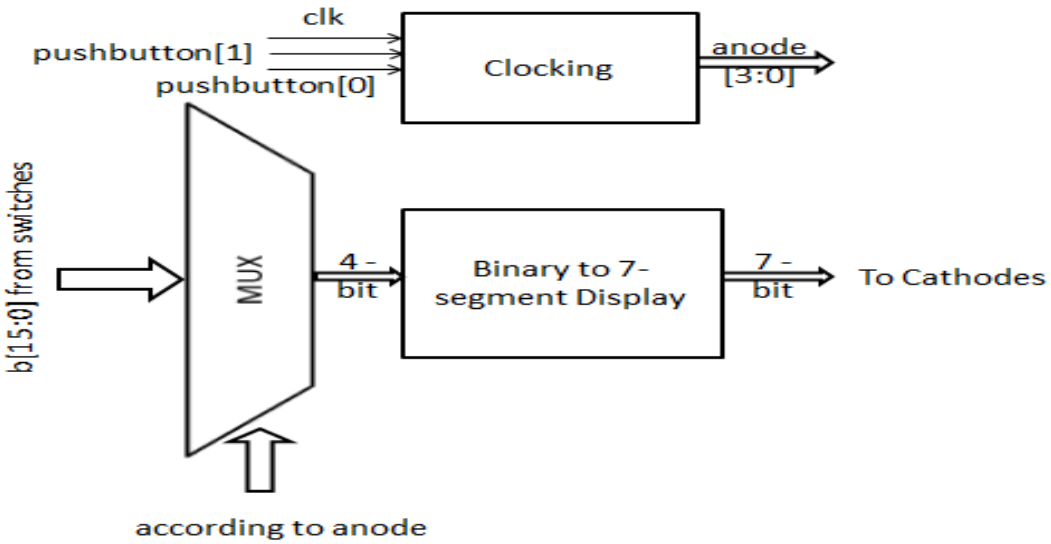
Let the 16-bit binary number be $b_{15}\ b_{14}\ \ldots\ b_1\ b_0$ and its hexadecimal equivalent be $h_3\ h_2\ h_1\ h_0$. Then these are related as follows.

$h_0 = b_3b_2b_1b_0$
$h_1 = b_7b_6b_5b_4$
$h_2 = b_{11}\ b_{10}\ b_9b_8$
$h_3 = b_{15}\ b_{14}\ b_{13}\ b_{12}$

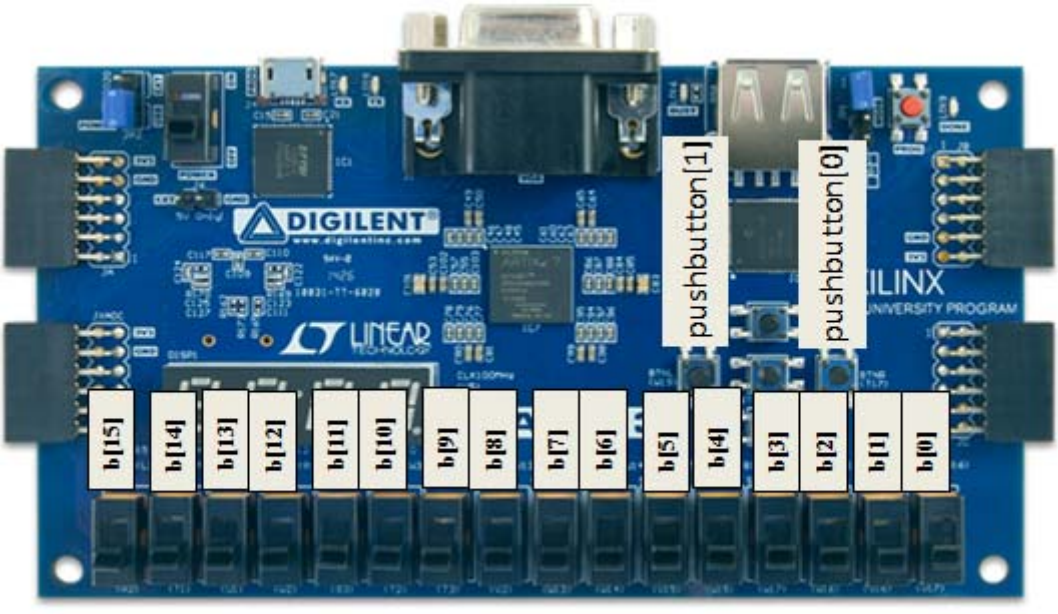
Instructions on how to use the display are given in section 8 of the BASYS3 board reference manual (available on Moodle). Patterns to be used for displaying hexadecimal digits are shown in the figure below.



A rough sketch of the circuit is shown below. The 4 digits are displayed in a time multiplexed manner with refresh rate in the range of 60 Hz to 1 KHz. The clock available on the FPGA board has a frequency of 100 MHz which needs to be suitably divided to get a clock in the required range (4 times the refresh rate, that is, from 240 Hz to 4 KHz). However, during simulation, it is convenient to work directly with the clock without dividing it. Therefore, the circuit should provide two modes – one where the clock is divided (slow clock mode) and the other where it is not (fast clock mode).



Refer Basys 3 Document (part 8) for enabling cathodes and anodes.



b[15:0] is the bit vector for 16 bit input.
pushbutton [1:0] is used to select clock rate.

Pressing pushbutton[1] selects the fast clock mode
Pressing pushbutton[0] selects the slow clock mode

For Simulation, press pushbutton[1] and for verifying the synthesized circuit board, press pushbutton[0] to “01”.

Pin Name	**Description**	**Purpose**
clk	Input (from Basys 3 Internal clock)	clocking
b[15:0]	Input	Binary input from switches
Pushbutton[1:0]	Input	Selects clock rate
anode[3:0]	Output	To enable the digit on Display
cathode[6:0]	Output	To display the Hex Digit

Top Level Module Name : lab4_seven_segment_display