THE UNIVERSITY OF BRITISH COLUMBIA

Department of Electrical and Computer Engineering

CPEN312 Practice Midterm Exam

Answer all problems.
Time: 1:30 Hours.
This examination consists of 7 pages. Please check that you have a complete copy. You may use both sides of each page for your answers if needed.

NOT Permitted: FORMULA SHEETS, CALCULATORS, CELLPHONES, ELECTRONIC AIDS, NOTES, or BOOKS.

Name:

Student Number:

#	MAX	**GRADE**
1	15	
2	15	
3	15	
4	15	
5	20	
6	20	
TOTAL	100	

IMPORTANT NOTE: The announcement "stop writing" will be made at the end of the examination. Anyone writing after this announcement will receive a score of 0. No exceptions, no excuses.

All writings must be on this booklet. The blank sides on the reverse of each page may also be used.

Each candidate should be prepared to produce, upon request, his/her Library/AMS card.

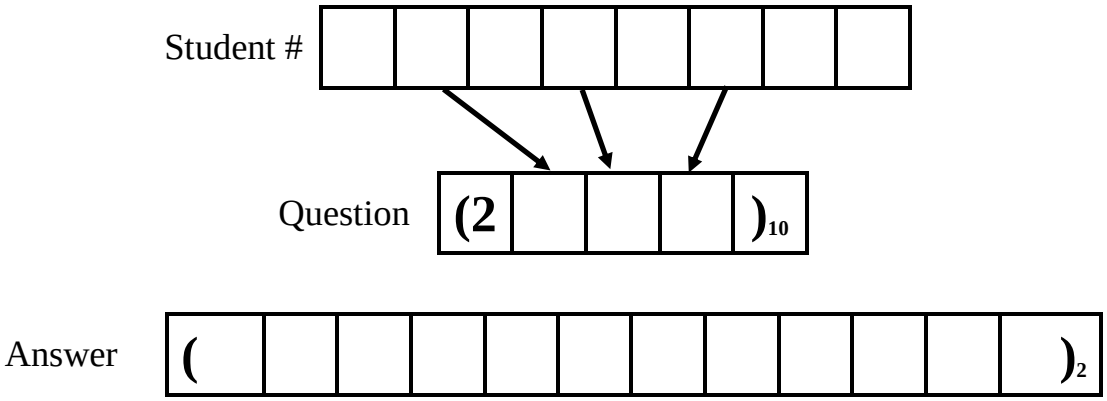
Read and observe the following rules:
No candidate shall be permitted to enter the examination room after the expiration of one-half hour, or to leave during the first half-hour of the examination.

Candidates are not permitted to ask questions of the invigilators, except in cases of supposed errors or ambiguities in examination-questions.
Caution *- Candidates guilty of any of the following, or similar, dishonest practices shall be immediately dismissed from the examination and shall be liable to disciplinary action:*

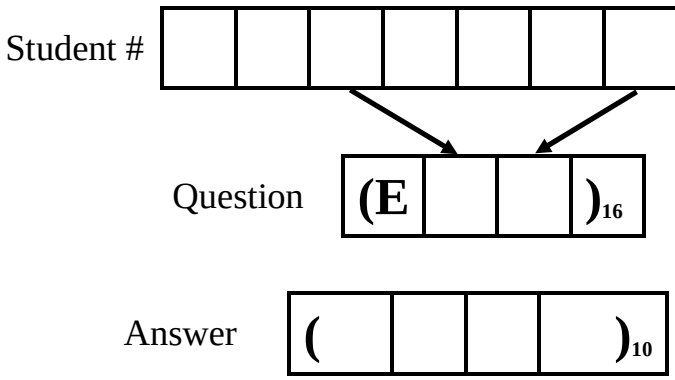
- *Making use of any books, papers or memoranda, calculators, audio or visual cassette players or other memory aid devices, other than as authorized by the examiners.*
- *Speaking or communicating with other candidates.*
- *Purposely exposing written papers to the view of other candidates.*

The plea of accident or forgetfulness shall not be received.

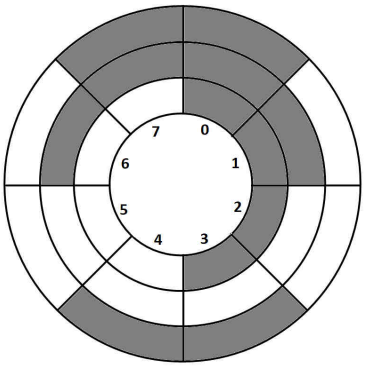
1a) Write your student number in the space provided below. Select the indicated digits and construct the question. Convert the resulting 4-digit decimal number to binary and write it down in the space provided. (8 marks) **Warning: no partial marks of any kind awarded for this question!**



1b) Write your student number in the space provided below. Select the indicated digits and copy them in the "Question" boxes. Convert the resulting 3-digit hexadecimal number to decimal and write it in the space provide. (7 marks) **Warning: no partial marks of any kind awarded for this question!**



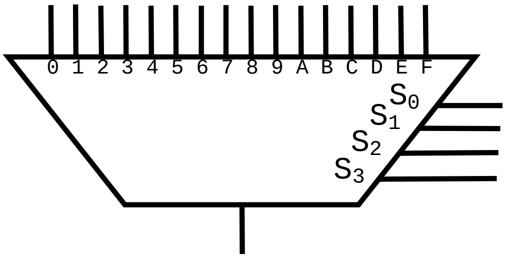
2) In the 8-position rotary encoder below a grayed-out section is interpreted as logic zero and a white section is interpreted as logic one. The least significant bit of the encoder is in the outer ring whereas the most significant bit is in the inner ring. Obtain the truth table and the Boolean equations of a converter that provides the position in binary as indicated by the decimal number in the figure. Obtain the equations **using Karnaugh maps**. (15 marks).

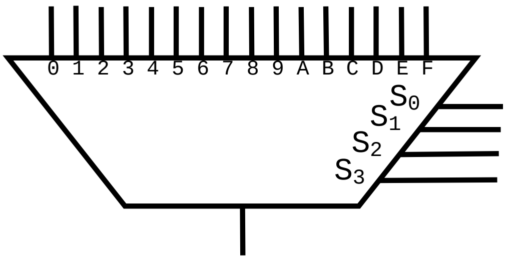


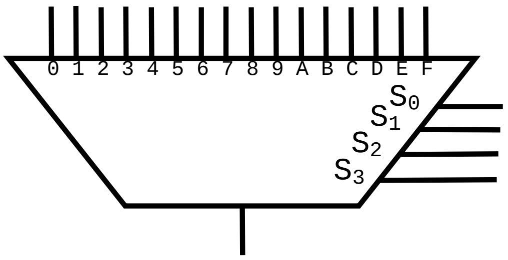
3) Draw the circuit representation of the VHDL code below using D-type flip-flops. (15 marks)

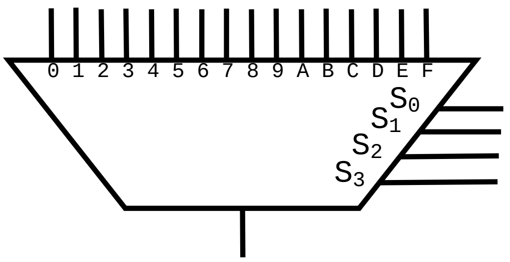
```
LIBRARY ieee;
USE ieee.std_logic_1164.all;

ENTITY xyz IS
    PORT (  Clock   : IN        STD_LOGIC ;
            M       : IN        STD_LOGIC ;
            Rn      : IN        STD_LOGIC ;
            D0      : IN        STD_LOGIC_VECTOR(3 DOWNTO 0) ;
            D1      : IN        STD_LOGIC_VECTOR(3 DOWNTO 0) ;
            Q       : OUT       STD_LOGIC_VECTOR(3 DOWNTO 0) )
;
END xyz;

ARCHITECTURE a OF xyz IS
BEGIN
    PROCESS
    BEGIN
        if Rn = '0' then
           Q <="0000";
        else
           if falling_edge(Clock) then
              if M = '0' then
                 Q <= D0;
              else
                 Q <= D1;
              end if;
           end if;
        end if;
    END PROCESS;
END a;
```

4) Use four 16-to-1 multiplexers to implement a 2-bit by 2-bit multiplier. For example, multiplying 2 x 3 = 6, or in binary 10_B x 11_B = 0110_B. (15 marks)









5) The elevator in a six storey building in Vancouver needs a counter to keep track of its position. As is common in Vancouver there are neither floors ‘0’ nor ‘4’. Design an up/down counter using ‘D’ flip-flops to count the floor position. Two signals are provided: the clock ‘CLK’ and the direction ‘X’. The counter should be sensitive to the clock’s rising edge. When X=’1’ the elevator is going up. When X=’0’ the elevator is going down. Obtain the state diagram, the transition table, and the Boolean equations. (20 marks)

6) Demonstrate both using Boolean algebra and a truth table, that the circuit below implements the XNOR function Y= AB+A'B'. Briefly explain the steps you follow when expanding/simplifying the equations. (20 marks).