

SCHOOL OF ELECTRICAL ENGINEERING & TELECOMMUNICATIONS

ELEC2141 – DIGITAL CIRCUIT DESIGN

ASSIGNMENT I

DUE DATE: 29th MARCH 2020, 11:55 PM

Your assignment solutions are to be submitted in pdf format on Moodle. Combine all scanned copies of your handwritten work and electronic documents into one pdf file for the submission.

In your submission file include a scanned copy of a completed and signed assignment submission form as the front page.

Your design for each question should aim at achieving optimized implementation. It should include your design procedure, choice of technology implementation, and simulation results. The gate input cost must be also calculated. Use Xilinx ISE or any other appropriate CAD tool to simulate and verify your design.

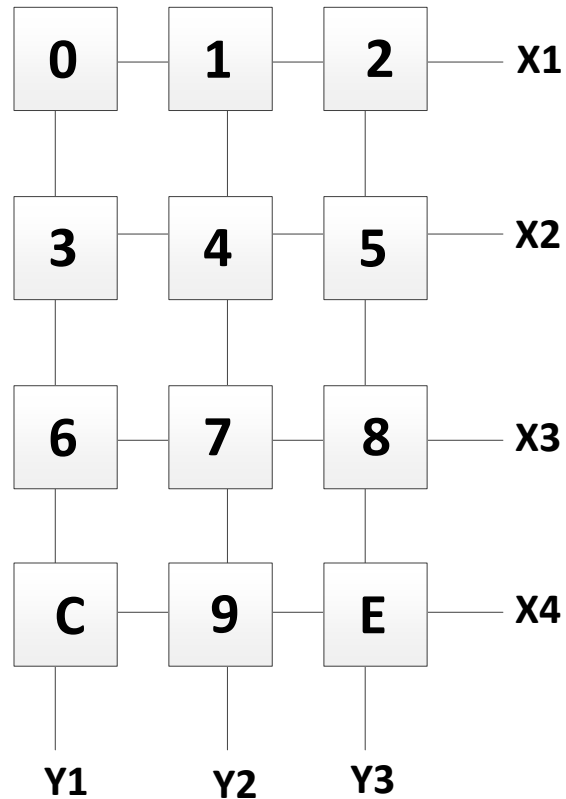
Attach all design and simulation materials such as schematic diagram (or HDL), simulation outputs and testing fixtures.

Question 1

Design a combinational circuit that decodes a button pressed on a keypad and displays the button pressed on a seven segment display. The keypad is shown in the figure below. Each button is identified by a row (X_i) and a column (Y_i) signals. You may assume that

- Two buttons may not be pressed at the same time.
- When no button is pressed, nothing is displayed on the seven segment display.

Your design should include your design procedure, choice of implementation, simulation. The gate input cost must be calculated.



Question 2

Design a combinational circuit that controls an automated irrigation system. The inputs to the system include:

- *CLOCK*: a 1-bit signal that becomes 1 when the system time is between the user defined/programmed times, otherwise 0.
- *TSWITCH*: a 1-bit signal that becomes 1 when toggle switch is on, otherwise 0.
- *SALINE*: a 1-bit signal that becomes 1 when the soil salinity level becomes too high, otherwise 0.
- *DRY*: a 1-bit signal that becomes 1 when the soil is too dry, otherwise 0.
- *RAIN*: a 1-bit signal that is 1 when it is raining, otherwise 0
- *HUMIDITY*: a 2-bit signal that indicated the level of humidity in the air according to the following encoding:
 - 00: Very dry
 - 01: Dry
 - 10: Humid
 - 11: Very humid

The system has two mutually-exclusive operation modes:

- *STANDBY*: normal *OFF* condition; water is not flowing
- *PUMPING*: normal *ON* condition; water is flowing

The normal *ON* condition should occur when either *CLOCK* or *TSWITCH* are true unless it is raining. The *ON* condition is also activated whenever both the soil salinity becomes too high and soil is too dry. When in the *PUMPING* mode, the water flow rate depends on the air humidity and soil conditions as per:

Soil condition	Air Humidity	Flow Rate
Dry and saline	-	Very High
Neither dry nor saline	Very dry	High
Neither dry nor saline	Dry	Normal
Neither dry nor saline	Humid	Low
Neither dry nor saline	Very humid	Very low
Dry and not saline	-	Normal
Not dry but saline	-	Low

The system has these outputs:

- *PUMP*: a 1-bit signal that turns the water pump on so water flows through the sprinklers
- *FLOW*: a 3-bit signal that controls the water flow rate
- *DISPLAY1*: a 7-bit signal used to indicate the operation mode on a 7-segment display. The letter S on the display indicates *STANDBY*, P indicates *PUMPING*
- *DISPLAY2*: a 7-bit signal used to indicate the flow rate number on a 7-segment display. Where the number corresponding to the flow rate are given below:

0: No flow	3: Normal
1: Very low	4: High
2: Low	5: Very high

Your design should include your design procedure, choice of implementation, simulation. The gate input cost must be calculated.