UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

DIGITAL ELECTRONICS I

COURSE CODE – E362

MAY 2009 EXAMINATION

DURATION OF THE EXAMINATION - 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Answer any FOUR questions only.

2. Each question carries equal marks.

3. Show all your steps clearly in any calculations.

4. Start each new question on a fresh page.

Question 1

a) In digital systems, arithmetic and logic manipulations are carried out, mainly, using 2's and 1's complements. Discuss the relative merits of the 2's and 1's complements.

[6]

b) The following are a few examples of various binary codes used in storing and representing data:
   i.   Error Detection Codes;
   ii.   Gray Code and;
   iii. Alphanumeric Codes.

   Giving examples explain how each code-system works.

[9]

c) What logic gate function is implemented by the circuit in figure 1 below? Summarize its function in a truth table.
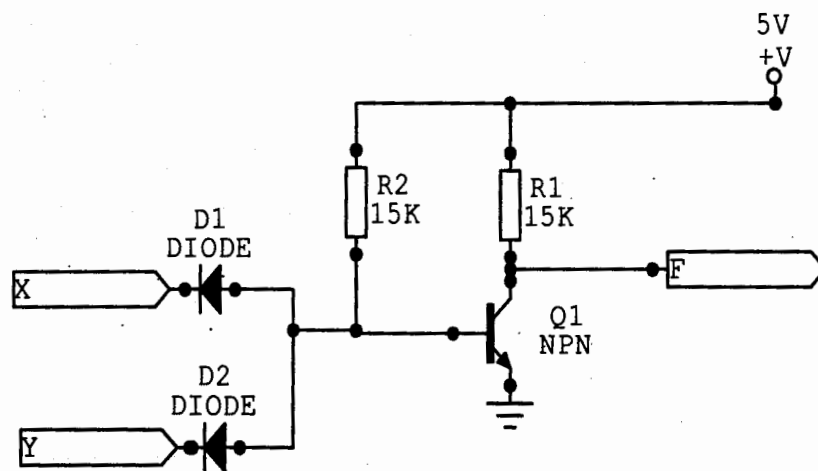

Fig. 1

[5]

d) Draw a NOR gate equivalent circuit and describe how it works. Also, explain why the NOR gate is called the "universal gate".

[5]

Question 2

a) With reference to Boolean functions, answer the following questions:

   i.   What is the difference between *canonical form* and *standard form*?
   ii. Which form is preferable when implementing a Boolean function with gates?
   iii. Which form is obtained when reading a function from a truth table?

[6]

b) Table 1 shows the truth table for two functions F_1 and F_2.

Table 1

x	y	z	F1	F2
0	0	0	1	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	0	1

   i.   Simplify the functions F_1 and F_2 to a minimum number of literals.
   ii. Draw logic circuits that can implement these functions.

[8]

c) The circuit in figure 2 shows a BCD to 7-segment LED decoder connected to the 7-segment LED. In order to light a particular segment of the 7-segment LED, a logic 1 must be applied to the respective segment: a, b, c,....g. The purpose of the decoder is to convert a binary coded decimal (BCD) input applied at A0, A1, A2 and A3 into corresponding output on: a, b, c, d, e, f and g such that an appropriate decimal value is displayed on the 7-sement LED. Design a logic circuit to implement the decoder function.
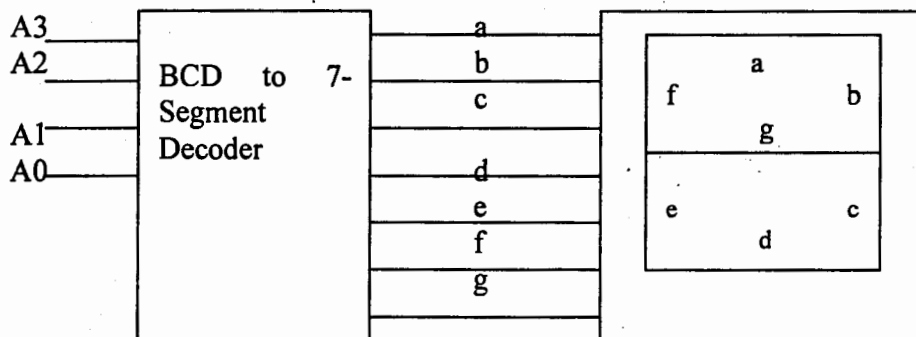

[11]

Fig. 2

Question 3

a) Define the following terms as used in digital electronics:

    i.   Half-Adder circuit;
    ii.   Full-Adder circuit.

[4]

b) Design a *full-adder* circuit and show how *full-subtractor* can be derived from the *full-adder* logic.

[8]

c) What is the purpose of *error-detection code*s in digital data communications? Explain briefly how *Parity-bits* are used as error-detection codes.

[4]

d) A *three bit word* communication system requires an *odd-bit parity generator*. Design the necessary *odd-bit parity generator*.

[9]

Question 4

a) The way we design digital logic circuits has changed immensely in last two to five decades. State and explain the factors that have lead to this shift in the design approach.

[5]

b) Using MSI integrated circuits, design a BCD-to-excess 3 code converter.

[8]

c) In parallel adders, the *carry propagation* delay is a cause for serious concern. Explain why the *carry propagation delay* is a cause for concern. One technique used in minimizing problem of *carry propagation delay* is the *look-ahead carry generator*. Design a simple look-ahead carry generator.

[12]

Question 5

a) What do you understand by the following terms as used in digital electronics:

    i.   Decoder;
    ii.   Demultiplexer;
    iii. Encoder and
    iv. Multiplexer.

[8]

b) An engineer designing a closed loop temperature control and a display unit using PIC16F876A Microcontroller has finished designing the rest of the control section except the display unit. The display unit should have four (4) seven segment LEDs for displaying the temperature. But, the design engineer finds that, there are only six (6) unused pins on the PIC16F876A.

Using SSI or MSI chips, suggest how the engineer can complete this design. Draw the necessary block diagram(s) of the system and a basic flow chart for the display routine running on the PIC16F876A.

[17]

Question 6

a) A light dependant resistor (LDR), R_1, is connected in a potentiometer arrangement with a resistance, R_2. The potential difference across the LDR is fed to a 4-bit analogue to digital converter (ADC). The output of the ADC is then compared to a reference 4-bit binary input applied to a circuit that compares two 4-bit numbers.

Design the circuit that compares two 4-bit numbers. If the LDR 4-bit number is less than the reference 4-bit number, the circuit should turn OFF a 5V relay that is connected to a heater. If the LDR 4-bit number is greater than or equal to the reference 4-bit number, the circuit should turn ON a 5V relay that is connected to a heater. State clearly any assumptions made in this design.

[15]

b) Digital IC gates are classified not only by their logic operation, but also by the specific logic-circuit family to which they belong. By giving relevant examples of logic families, discuss their salient features and explain how these features influence the choice of ICs used in various applications.

[10]

END OF PAPER