UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/10

SUBJECT'S NAME	:	DIGITAL ELECTRONICS
SUBJECT'S CODE	:	BEE 2233
COURSE	:	2 BEE
EXAMINATION DATE	:	NOVEMBER 2009
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

Q1 (a) Find the standard sum of products (SOP) from the following function:

$$F = (A + B + C) \cdot (A + B + D) \cdot (A + \bar{C} + D) \cdot (A + C + D) \cdot (B + C + \bar{D})$$

(4 marks)

(b) Implement the function in Q1(a) using one Unit of 8 line-to-1 line Multiplexer

(6 marks)

(c) (i) Illustrate and prove how two half adder can be combined to form a full adder?

(4 marks)

(ii) Figure Q1(c) shows logic symbol of 8 line-to-1 line multiplexer IC 74LS151. How many units of IC 74LS151 is needed to form a full adder?

(3 marks)

(iii) Design a 4-bit parallel adder using only IC 74LS151.

(8 marks)

Q2 (a) You wish to detect only the presence of the codes 1010, 1100, 0001 and 1011. An active-HIGH output is required to indicate their presence. Develop the minimum decoding logic with a single output that will indicate when any one of these codes is on the inputs. For any other code, the output must be LOW.

(5 marks)

(b) Show how the following expression can be implemented using only NOR gates:

(i) $X = A + B + \bar{C}$

(3 marks)

(ii) $X = \overline{ABC}$

(3 marks)

(c) Figure Q2(c) shows a music box system which plays 4 songs according to user selection. Once the user ON the system, the selection circuit will display number 1, and by pressing the switch continuously the selection number will be increased sequentially and back to number 1 after it reached number 4. The selection circuit which has active HIGH outputs is connected to another decoder circuit. Once the user determines the desired song, the active LOW output decoder will code the selection to the programmable music tones that produces the rhythm.

(i) By using K-Map approach, design the selection circuit and draw the logic design with a minimum number of gates.

(8 marks)

(ii) Design the decoder circuit which sill select code the music selection accordingly.

(6 marks)

Q3 (a) State the difference between Moore and Mealy state machine.

(4 marks)

(b) Figure Q3(b) show a state machine circuit. Analyze this circuit and find the state transition diagram.

(8 marks)

(c) One of a state machine application is for stepper motor control. A stepper motor is a motor that rotates in steps per step rather than in a continuous motion, thus offering a very precise movement. Magnetic coil or windings within the motor must be energized and de-energized in a specific sequence in order to produce this stepping action. Digital binary signal are usually used to control the current in each motor coils.

Figure Q3(c) show a typical stepper motor with four (4) coils. To control the motor, 2-bit binary inputs are feeds into the motor driver circuit. To rotate the motor clockwise, the sequences are 00, 01, 11, 10, 00 and so on. For anti-clockwise rotation, the sequences are 00, 10, 11, 01, 00 and so on. There is another input to control the rotation direction named, D.

Design the state machine using JK flip-flops to control the stepper motor. Show all steps and draw the circuit.

(13 marks)

Q4 (a) Using Boolean theorem, prove the following Boolean expression.

$$\overline{X \cdot \overline{Y} + \overline{X} \cdot Y} = \overline{X} \cdot \overline{Y} + X \cdot Y$$

(2 marks)

(b) Simplify the following equation.

$$f(A,B,C,D) = \Sigma\, m(4,8,9,12,13,14) + \Sigma\, d(0,5,10,15)$$

(3 marks)

(c) Prove that $(A + B + \overline{C}) \cdot (A + \overline{B} + C) \cdot (\overline{A} + B + C) \cdot (\overline{A} + \overline{B} + \overline{C}) = \overline{A \oplus B \oplus C}$.

(5 marks)

(d) Figure Q4(d) shows a relative magnitude detector that takes two 2-bit binary numbers; x_1x_0 and y_1y_0, and determines whether they are equal and if not, which one is larger. There are three outputs, defined as follows:

- M=1 only if the two input numbers are equal
- N=1 only if x_1x_0 is greater than y_1y_0
- P=1 only if y_1y_0 is greater than x_1x_0

(i) Build the truth table for this circuit.

(6 marks)

(ii) Obtain the simplest Boolean expression for M, N, and P.

(6 marks)

(iii) Draw the complete circuit using any logic gates.

(3 marks)

PEPERIKSAAN AKHIR

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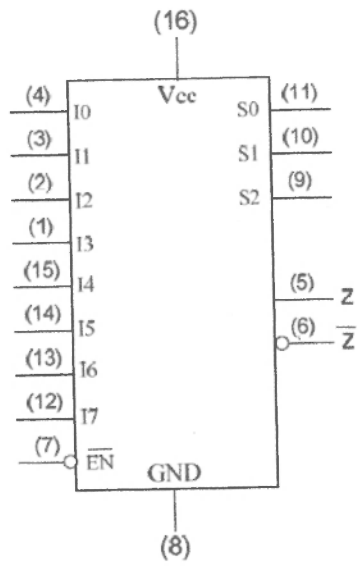

Figure Q1(c)

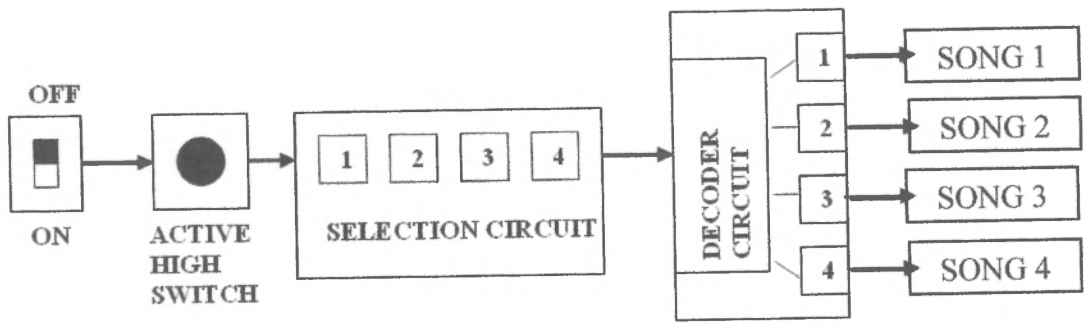

Figure Q2(c)

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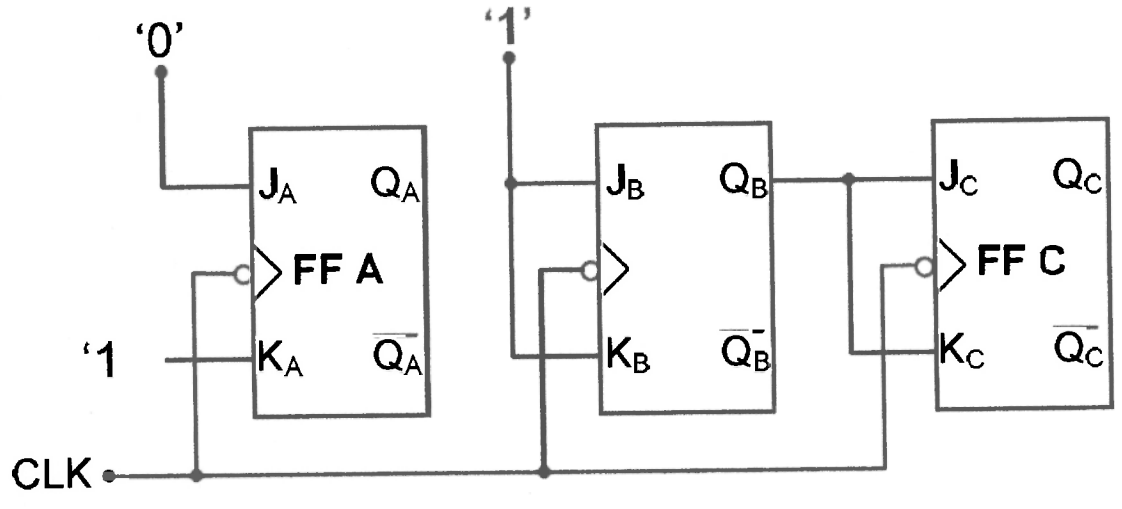

Figure Q3(b)

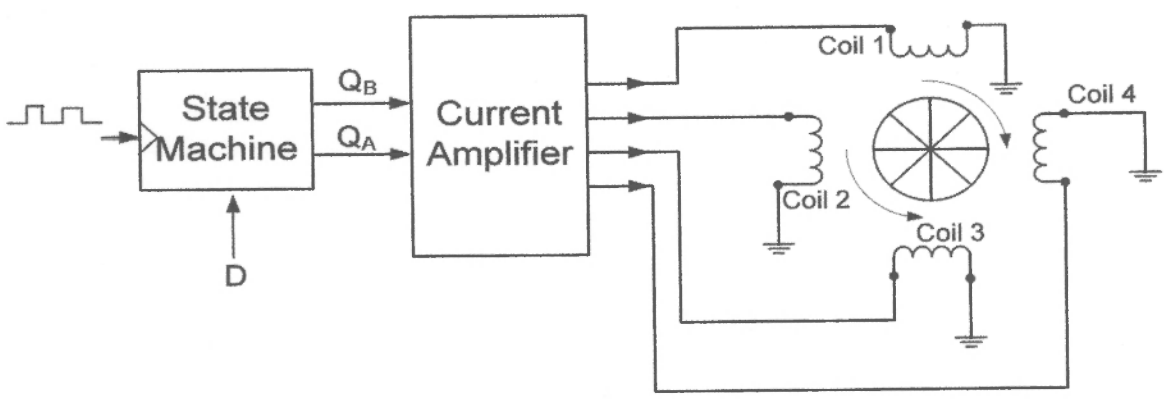

Figure Q3(c)

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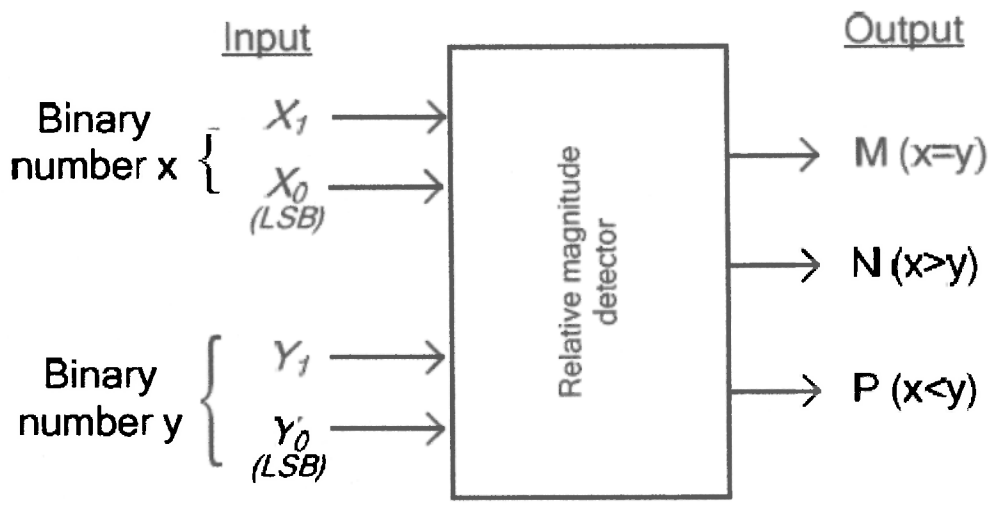

Figure Q4(d)