UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	PROGRAMMABLE ELECTRONICS
COURSE CODE	:	MEE 10203
PROGRAMME CODE	:	MEE
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **OPEN BOOK**

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 **(a)** A PLD is a general-purpose chip for implementing logic circuits. It contains a collection of logic circuit elements that can be customized in different ways. Discuss the advantage of FPGA as compared to PLA/PAL/CPLD.

(6 marks)

(b) The Verilog code in **Listing Q1(b)** is written using the dataflow modelling style. Rewrite the full Verilog code to describe the same circuit by using the structural modelling style.

(7 marks)

(c) Write the Verilog code for the sequential circuit in **Figure Q1(c)**.

(10 marks)

Q2 **Figure Q2** shows a block diagram of a serial adder.

(a) Explain the operation of the circuit by using a suitable example. Assume that the operation is 4-bit.

(5 marks)

(b) Derive a state diagram for the finite state machine (FSM) to implement the serial adder in **Figure Q2**.

(10 marks)

(c) Write a Verilog code to model the FSM in Q2(b).

(10 marks)

Q3 A digital system is modelled by the RTL code in **Listing Q3**. Assume that signal *p* and *q* are never '1' simultaneously, and the registers are positive-edge triggered, and are already initialized with data. You are to use an ALU with the functions shown in the **Table Q3**. Note that Y* denotes Y bitwise inverted.

(a) From the RTL code in **Listing Q3**, derive the functional block diagram (FBD) of the datapath unit (DU).

(10 marks)

(b) Write the Verilog code describing the DU in Q3(a). Name the module as *Circuit_Q3b*. Assume that the operation is in 8-bit.

(10 marks)

(c) Consider the situation if, in state S2 of the control sequence, signal *p* and *q* are allowed to be '1' simultaneously. What will be the problem? Suggest how would you overcome this problem.

(5 marks)

Q4. **Figure Q4** shows a data flow graph (DFG) to build a fully dedicated architecture (FDA).

(a) From the DFG, obtain the schedule and resource allocation applying as-late-as-possible (ALAP) scheduling. The design must use only one adder and one multiplier.

(10 marks)

(b) Derive the RTL codes for the design

(6 marks)

(c) Draw the functional block diagram of the datapath unit.

(6 marks)

(d) It is given that the propagation delay of the components are as follows: adder is 30 ns, multiplier is 200 ns and register is 10 ns. Perform the performance analysis by determining the maximum operating frequency and total execution time of your design.

(5 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION	:	SEMESTER I 2021/2022	PROGRAMME CODE	:	MEE
COURSE NAME	:	PROGRAMMABLE ELECTRONICS	COURSE CODE	:	MEE 10203

```
module Q3(a, b, c, d, f, g);
    input a, b, c, d;
    output f, g;
    assign f = ~ ((a & b) | (c & d));
    assign g = (a | c) & (b | d);
endmodule
```

Listing Q1(b): Verilog code

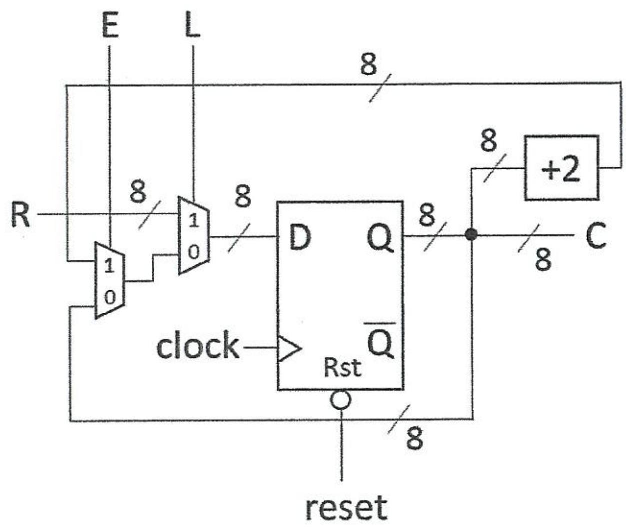

Figure Q1(c): A simple sequential circuit

FINAL EXAMINATION

SEMESTER/SESSION	:	SEMESTER I 2021/2022	PROGRAMME CODE	:	MEE
COURSE NAME	:	PROGRAMMABLE ELECTRONICS	COURSE CODE	:	MEE 10203

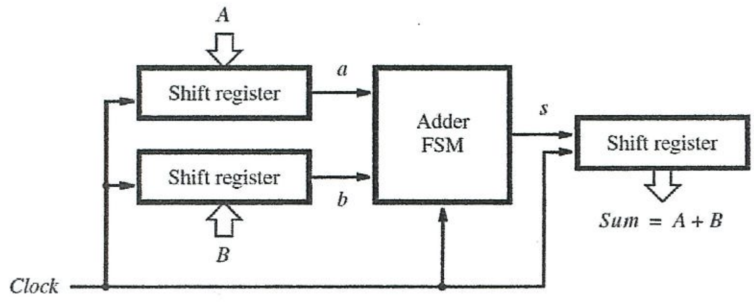

Figure Q2: A serial adder

```
S0:   (p)    / A ← B;
      (p*)   / A ← B*;
S1:   (p)    / A ← 0;
      (p*q)  / A ← A*;
S2:   (p)    / B ← 2A;
      (q)    / B ← A – B;
      ( )    / done = 1;
      ( )    / goto S0;
```

Listing Q3: RTL code

Table Q3: ALU operation

f_1f_0	output	function
00	X + Y	ADD
01	X – Y	SUB
10	Y*	complement Y
11	Y	PASS Y

FINAL EXAMINATION

SEMESTER/SESSION	: SEMESTER I 2021/2022	PROGRAMME CODE	: MEE
COURSE NAME	: PROGRAMMABLE ELECTRONICS	COURSE CODE	: MEE 10203

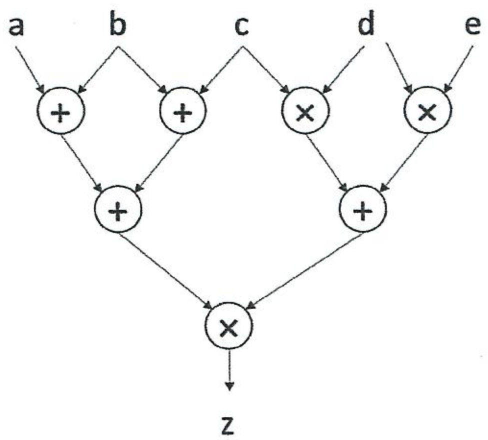

Figure Q4: The data flow graph (DFG)

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	COMPUTATIONAL INTELLIGENCE
COURSE CODE	:	MEE 10403
PROGRAMME CODE	:	MEE
EXAMINATION DATE	:	JANUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **OPEN BOOK.**

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 The adaptive predictor ADALINE, is typically modeled as shown in the **Figure Q1**. Consider that $y(k)$ as a stationary process with autocorrelation function as $C_y(n)$ where, $C_y(n) = E[y(k)(y(k+n))]$.

(a) (i) With regard to the ADALINE model shown in **Figure Q1**, derive the expression that represent $a(k)$ of the diagram.

(4 marks)

(ii) State **FIVE (5)** characteristics of the ADALINE predictor.

(5 marks)

(iii) Determine the expression for mean square error of the network in terms of $C_y(n)$.

(6 marks)

(b) The input $y(k)$ is given as $y(k) = \sin\left(\frac{k.\pi}{6}\right)$. Analyze the network and determine the eigenvalues, eigenvectors, minimum point (x*) and maximum stable learning rate (∝) for the LMS algorithm.

(10 marks)

Q2 **(a)** Describe **TWO (2)** applications of multilayered perceptron using back propagation algorithm.

(4 marks)

(b) Describe all the steps to perform backpropagation algorithm.

(8 marks)

(c) Design a two layers, 1-2-1 neural network that will approximate the following trigonometric function,

$$g(p) = 1 + \sin\left(\frac{\pi}{5}\cdot p\right) \qquad for \ -2 \le p \le 2.$$

The transfer function for the first layer is given as, $f^{(1)}(n) = \frac{1}{(1+e^{-n})}$ whereas the transfer function for the second layer is linear. The following are the initial values:

$$\text{weight, } w^{(1)}(0) = \begin{bmatrix} -0.21 \\ -0.42 \end{bmatrix}; \ w^{(2)}(0) = [0.03 \quad -0.2]$$

$$\text{biases, } b^{(1)}(0) = \begin{bmatrix} -0.44 \\ -0.13 \end{bmatrix}; \ b^{2}(0) = [0.35]$$

initial input, $a^0 = p = 1$

learning rate, ∝= 0.12

In the design it is required to produce a complete architecture of the network by including the necessary labels, forward calculations, sensitivities at all layers and finally the weight and bias updates. You are only required to perform up to the first iteration.

(13 marks)

Q3 **(a)** Consider a network problem of finding the best route to transmit data packets from node A to node J as depicted in **Figure Q3(a)**. The system designer has decided that the best route calculation is to be implemented using binary genetic algorithm in which each chromosome consists of 10 genes, operating with crossover rate of 70% and mutation rate of 5%. Produce a complete procedure detailing the technique of solving this optimization problem using genetic algorithm.

(9 marks)

(b) A number of chromosomes, N_{good} = 8, are placed in the mating pool for the process of reproduction. The list of N_{good} chromosomes and their cost are given below:

ID	CHROMOSOMES	COST
1	1 0 1 1 1 0 1 1 1 0 1 0	1321
2	1 0 1 0 0 1 0 1 1 1 1 1	1332
3	1 0 0 1 1 1 0 1 0 0 0 1	1335
4	0 1 1 1 1 1 1 0 1 0 0 1	1348
5	1 0 0 0 1 1 0 0 1 1 0 0	1351
6	1 1 0 0 1 1 0 0 1 0 1 0	1354
7	0 1 1 1 1 0 1 1 1 0 0 0	1359
8	1 0 0 1 1 0 1 1 1 1 0 1	1364

(i) Two chromosomes are selected from the mating pool of N_{good} chromosomes to produce new offsprings. Generate **FOUR (4)** mating pairs using the technique of rank weighting with random pairing. Show all the steps and you are given eight random numbers: 0.3934 , 0.7120 , 0.1635 , 0.7228 , 0.0873 , 0.5404 , 0.2196 , 0.4128 .

(8 marks)

(ii) Choose only mating pairs where its partner only occurs once, obtained in Q3(b)(i) above, generate **EIGHT (8)** new offsprings, by the process of two-point crossovers. You are given the following pairs of random numbers:

PAIRS	RANDOM NUMBERS
1	[0.3934 , 0.5404]
2	[0.1635 , 0.4128]
3	[0.3624 , 0.7120]
4	[0.0873 , 0.6781]

(8 marks)

Q4 **(a)** Using the appropriate mathematical expressions, explain the following terms:

(i) Fuzzy Cartesian product;

(3 marks)

(ii) Fuzzy Composition Techniques.

(4 marks)

(b) Consider the problem of analyzing a DC shunt motor system. The parameters of concern are the series resistance R_{se} , armature current I_a and motor speed, N . If R_{se} is decreased step by step from its high value, then I_a value will increase. As I_a increased, the motor speed, N will also increase. Find the relations between R_{se} and I_a , the relations of I_a and N and the compositions among these fuzzy relations. The membership functions for both series resistance R_{se} and armature current I_a are given in terms of percentage of their respected values as follows,

$$\mu_{R_{se}}(\%se) = \frac{0.3}{30} + \frac{0.8}{60} + \frac{1.0}{100} + \frac{0.4}{120} \quad \text{and} \quad \mu_{I_a}(\%a) = \frac{0.2}{20} + \frac{0.5}{40} + \frac{0.6}{60} + \frac{0.7}{80} + \frac{1.0}{100} + \frac{0.2}{120}$$

The membership value for N is given in units of motor speed, in rpm,

$$\mu_N \ (rpm) = \frac{0.33}{500} + \frac{0.67}{1000} + \frac{1.0}{1500} + \frac{0.15}{1800}$$

You are required to show the sample calculation for only one element from each resulted relations.

(18 marks)

-END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM I /2021/2022 PROGRAMME CODE : MEE
COURSE NAME : COMPUTATIONAL INTELLIGENCE COURSE CODE : MEE 10403

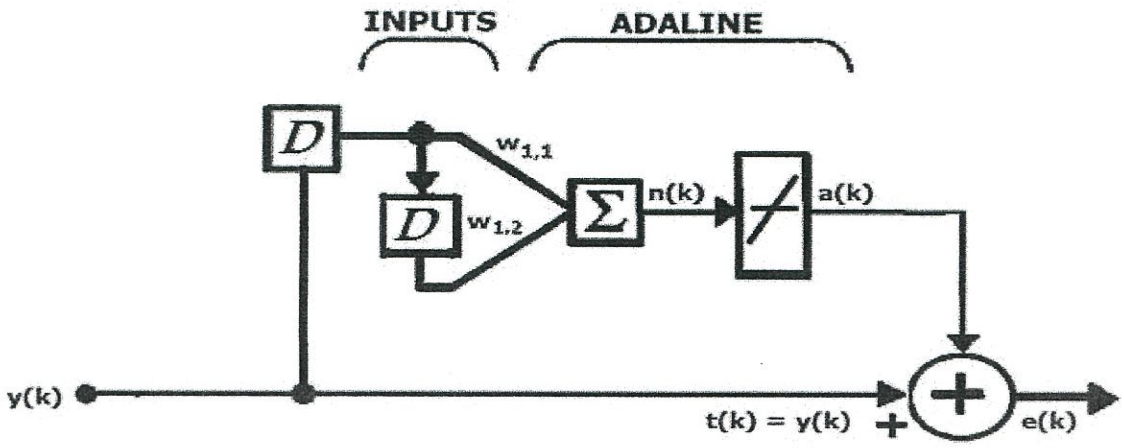

Figure Q1. A model of an Adaptive Predictor

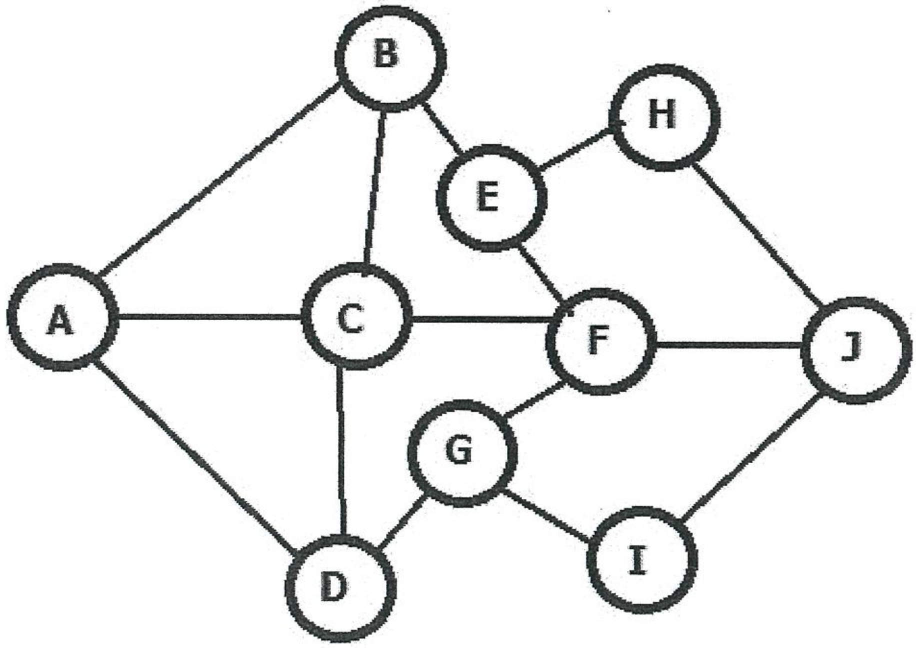

Figure Q3(a) A network routing model.