FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

CERTIFICATE III IN ELECTRONIC ENGINEERING

CERTIFICATE IV IN ELECTRONIC ENGINEERING

EEC403- DIGITAL ELECTRONICS II

FINAL EXAMINATION – QUARTER 3, 2019

DATE: As per timetable **TIME:** As per timetable

TIME ALLOWED: 2 HOURS 10 MINUTES

INSTRUCTIONS TO STUDENTS

1. *You are allowed 10 minutes extra reading time during which you are NOT to write.*
2. *Begin each section on a new page and use both sides of the sheet.*
3. *Write your candidate-number at the top of each attached sheet.*
4. *Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with string.*
5. *For all sheets of paper on which rough/draft work has been done, cross each one through and ATTACH these to your answer scripts.*
6. *Write clearly the number(s) of the question(s) attempted on the top of each sheet.*
7. *Show all working clearly where necessary.*
8. *Programmable calculators are not allowed, especially the ones that does the conversions of number systems.*
9. *Always check your work before leaving the exam hall.*
10. *ANSWER ALL QUESTIONS.*

Section A – Multiple Choice [20 marks]

Choose the appropriate answer from each question by writing the alphabet beside the question number in your answer booklet.

1. The design of circuitry that translates voltages and currents between devices (such as TTL and CMOS) is called;
   A. Interlacing
   B. Sinking
   C. boundary scanning
   D. Interfacing

2. Which of the following converts an analog input to a digital output?
   A. DAC
   B. ADC
   C. Decoder
   D. Encoder

3. A ROM is a
   A. Volatile memory
   B. Non-volatile memory
   C. Read/write memory
   D. Electrically erasable memory

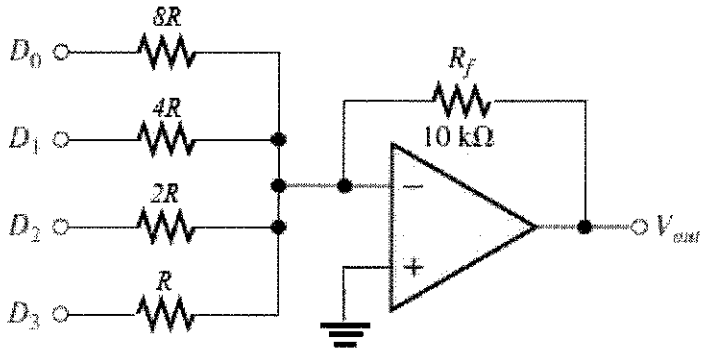
4. Two types of RAM semiconductor memories are the;
   A. SRAM and DRAM
   B. TRAM and SRAM
   C. BRAM and DRAM
   D. None of the above

5. According to the sampling theorem, the sampling frequency should be
   A. less than half the highest signal frequency
   B. greater than twice the highest signal frequency
   C. less than half the lowest signal frequency
   D. greater than the lowest signal frequency

6. Proper handling of a CMOS device is necessary because of its
   A. fragile construction
   B. high-noise immunity
   C. susceptibility to electrostatic discharge
   D. low power dissipation

Please Turn Over

7. Assume V_{REF} = 5V and R = R_f = 10kΩ. What is the resolution for this DAC. Assume that R_L is much smaller than R.



A. 62.5μA
B. 125μA
C. 250μA
D. 500μA

8. Data are stored in a random-access memory (RAM) during the
   A. read operation
   B. enable operation
   C. write operation
   D. addressing operation

9. In a binary weighted DAC, the highest-value resistor corresponds to
   A. the highest binary weighted input
   B. the lowest binary weighted input
   C. the first input
   D. the last input

10. If a 74HC85 magnitude comparator has A = 0100 and B = 1010, which output will be HIGH?
    A. A > B
    B. A < B
    C. A = B
    D. All of the above

11. A BCD-to-7 segment decoder has 0100 on its inputs. The active outputs are
    A. a, c, f, g
    B. b, c, f, g
    C. b, c, e, f
    D. b, d, e, g

Please Turn Over

12. The output of a 4-to-1 Multiplexer having 1010 on its $D_3D_2D_1D_0$ inputs and its Data Selectors $S_1 = 1$, $S_0 = 0$ would give an output as;
    A. 0101
    B. 1010
    C. HIGH
    D. LOW

13. The DAC converts digital input to;
    A. Analog Input
    B. Analog Output
    C. Digital Input
    D. Digital Output

14. The information page that shows, among other things, the logic diagram and packages, the recommended operating conditions, the electrical characteristics, and the switching characteristics is known as a;
    A. Service Manual
    B. Cover Page
    C. Logic Page
    D. Datasheet

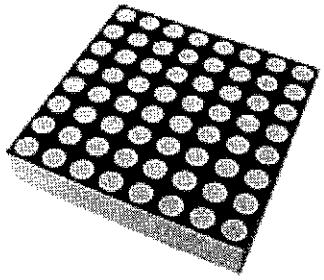
15. A 10-bit DAC has a step size of 10mV. What is the percentage resolution of this DAC?
    A. 0.1%
    B. 0.2%
    C. 10%
    D. 1mV

16. A 5-bit D/A converter produces an output of 0.2V for a digital input of 00001. What is the output voltage (V_{OUT}) for a digital input of 10001?
    A. 0.2V
    B. 1.0V
    C. 3.4V
    D. 10V

17. Which of the following is NOT a display device?
    A. Seven Segment
    B. Decoder
    C. DOT Matrix
    D. Liquid Crystal Display (LCD)

18. If the highest frequency component in an analog signal is 20 kHz, what should be the minimum sampling frequency?
    A. 10kHz
    B. 20kHz
    C. 40Hz
    D. 40kHz

19. What is the common name given to the component shown below?



    A. Seven Segment Display
    B. Dot Matrix Display
    C. LCD Display
    D. LED Display

20. One byte is equivalent to
    A. 8 bits
    B. 16 bits
    C. 8 nibbles
    D. 1 nibble

Section B – Short Answers & Calculations (80 marks)

There are 4 parts to this section. Answer ALL questions. Show your calculations clearly where required.

PART I – Digital Logic Families (25 Marks)

1. When the frequency of the input signal to a CMOS gate is increased, what happens to the average power dissipation? *(2 marks)*

2. What do you understand by the term 'Noise Immunity'? *(2 marks)*

3. There are two propagation delay times specified in the datasheets for logic circuits. Explain in your own words these terms;
   A. t_{PHL} *(1.5 marks)*
   B. t_{PLH} *(1.5 marks)*
4. Fan-out is expressed as unit loads. What is fan-out? *(2 marks)*

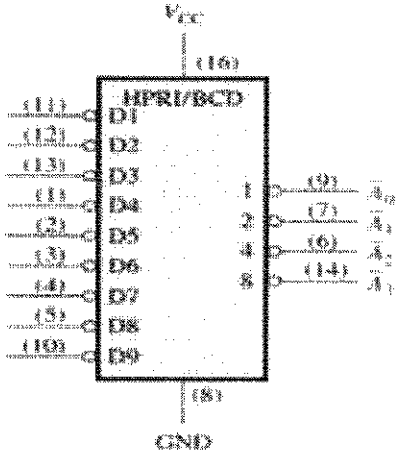
5. Refer to the attached datasheet for DM74LS08 and answer the following questions.
   A. What does '74LS' in DM74LS08 mean? *(2 marks)*
   B. What is the nominal operating voltage for this IC? *(1 mark)*
   C. Is this a CMOS or a TTL IC? *(1 mark)*
   D. Calculate the HIGH and LOW-level noise margins. *(2 marks)*
   E. Calculate the average maximum propagation delay time under $R_L = 2k\Omega$ and $C_L = 15pF$. *(2 marks)*
   F. What is the typical power dissipation in the LOW state? *(2 marks)*
   G. What is the average maximum power dissipation of the IC? *(3 marks)*
   H. How many gate inputs can be driven by the output of this DM74LS08? *(3 marks)*

PART II – MSI Combinational Logic Devices (25 Marks)

1. Summarize the operation of a 1-to-4 DEMUX. *(3 marks)*

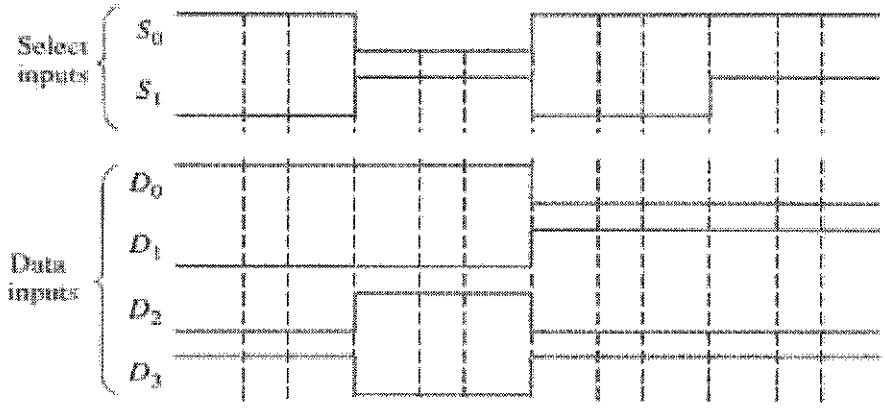
2. The magnitude of two 2-bit binary numbers – $A_1A_0 = 10$ and $B_1B_0 = 10$ are to be compared.
   A. With an aid of a diagram, show how you will compare and determine the equality status. *(5 marks)*
   B. Will the output show a high or a low? What does this indicate? *(2 marks)*

3. A 74HC147 priority encoder has LOW levels on pins 2, 5, 11 and 12. What BCD code appears on the outputs if all the other inputs are HIGH?

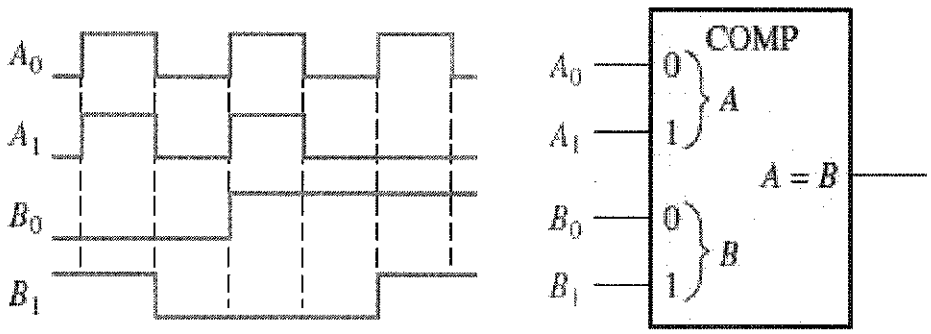


(2 marks)

4. The waveforms shown below are observed on the inputs of a 74HC153, a 4-to-1 multiplexer. Sketch the *Y* output waveform. *(5 marks)*



5. The waveforms are applied to the comparator as shown below. Determine the output (A = B) waveform. *(5 marks)*



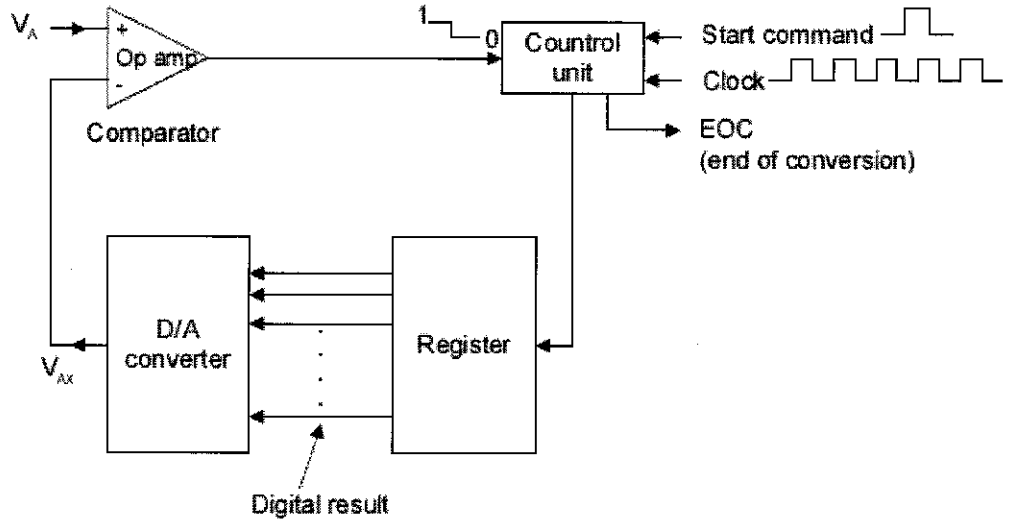
Please Turn Over

6. Name the device for the following purposes:
   A. A digital device that switches digital data from several input lines onto a single output line in a specified time sequence. *(1 mark)*
   B. A digital circuit that switches digital data from one input line to several output lines in a specified time sequence. *(1 mark)*
   C. A digital circuit that compares the magnitude of two quantities and produces an output indicating the relationship of the quantities. *(1 mark)*

PART III – DAC and ADC Conversion (20 Marks)

1. Define in your own words the following terms;
   A. Sampling *(2 marks)*
   B. Quantization *(2 marks)*

2. A basic block diagram of ADC is shown below.



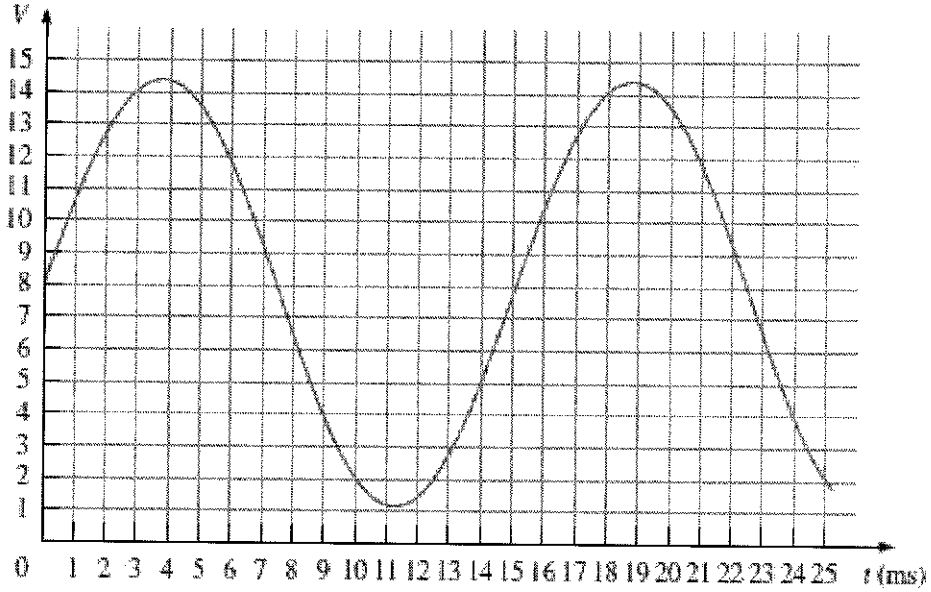
   Briefly explain its operation. *(5 marks)*

3. Determine the resolution expressed as a percentage, for a 5-bit DAC. *(2 marks)*
4. Give atleast one disadvantage of using a Flash ADC. *(2 marks)*

5. A 5-bit DAC has a current output. For a digital input of 10100, an output current of 10mA is produced. What will I_{OUT} be for a digital input of 11101? *(3 marks)*

Please Turn Over

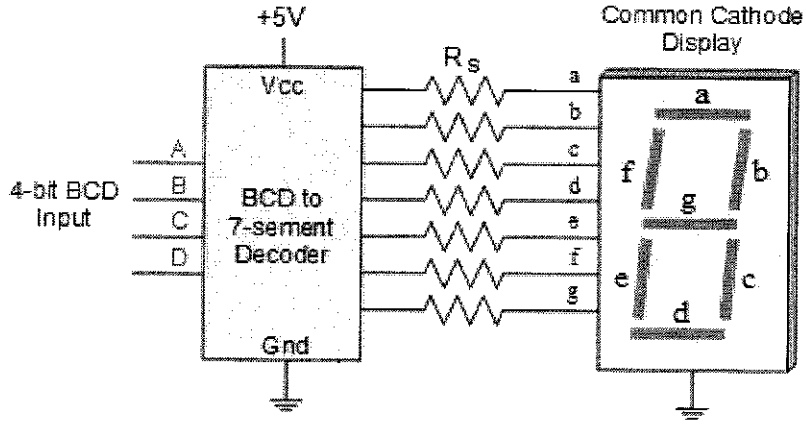
6. The waveform shown below is applied to a sampling circuit and is sampled every 2ms. Show the output of the sampling circuit. Assume a one-to-one voltage correspondence between the input and output. *(4 marks)*
(Draw the output waveform on the sheet attached)



PART IV – Display & Memory Devices (10 Marks)

1. What is the difference between a RAM and a ROM? (2 marks)

2. For your counter project, you were to connect the display circuit as shown below.



Please Turn Over

A. What is the purpose of connecting the resistors between the decoder and the seven segment display? *(2 marks)*

B. What value of the resistors will you use for R_S? Show calculations. Refer to the datasheet attached for the seven segment specifications. *(3 marks)*

C. How will a very small value of R_S as compared to what is calculated in part B above have an effect on the display? *(2 marks)*

D. What will the seven segment display if the BCD code applied to the decoder input is 0100? *(1 mark)*

The End

----------GOOD LUCK----------

Datasheet – DM74LS08

DM74LS08

Absolute Maximum Ratings(Note 1)

Supply Voltage	7V
Input Voltage	7V
Operating Free Air Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

Note 1: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

Recommended Operating Conditions

Symbol	Parameter	Min	Nom	Max	Units
V_{CC}	Supply Voltage	4.75	5	5.25	V
V_{IH}	HIGH Level Input Voltage	2			V
V_{IL}	LOW Level Input Voltage			0.8	V
I_{OH}	HIGH Level Output Current			−0.4	mA
I_{OL}	LOW Level Output Current			8	mA
T_A	Free Air Operating Temperature	0		70	°C

Electrical Characteristics

over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ (Note 2)	Max	Units
V_I	Input Clamp Voltage	V_{CC} = Min, I_I = −18 mA			−1.5	V
V_{OH}	HIGH Level Output Voltage	V_{CC} = Min, I_{OH} = Max, V_{IH} = Min	2.7	3.4		V
V_{OL}	LOW Level Output Voltage	V_{CC} = Min, I_{OL} = Max, V_{IL} = Max		0.35	0.5	V
		I_{OL} = 4 mA, V_{CC} = Min		0.25	0.4	
I_I	Input Current @ Max Input Voltage	V_{CC} = Max, V_I = 7V			0.1	mA
I_{IH}	HIGH Level Input Current	V_{CC} = Max, V_I = 2.7V			20	µA
I_{IL}	LOW Level Input Current	V_{CC} = Max, V_I = 0.4V			−0.36	mA
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 3)	−20		−100	mA
I_{CCH}	Supply Current with Outputs HIGH	V_{CC} = Max		2.4	4.8	mA
I_{CCL}	Supply Current with Outputs LOW	V_{CC} = Max		4.4	8.8	mA

Switching Characteristics

at V_{CC} = 5V and T_A = 25°C

Symbol	Parameter	R_L = 2 kΩ				Units
		C_L = 15 pF		C_L = 50 pF		
		Min	Max	Min	Max	
t_{PLH}	Propagation Delay Time LOW-to-HIGH Level Output	4	13	6	18	ns
t_{PHL}	Propagation Delay Time HIGH-to-LOW Level Output	3	11	5	18	ns

Note 2: All typicals are at V_{CC} = 5V, T_A = 25°C.

Note 3: Not more than one output should be shorted at a time, and the duration should not exceed one second.

Datasheet – Common Cathode Seven Segment Display

ABSOLUTE MAXIMUM RATING AT Ta=25°C

PARAMETER	MAXIMUM RATING	UNIT
Power Dissipation Per Segment	75	mW
Peak Forward Current Per Segment (1/10 Duty Cycle, 0.1ms Pulse Width)	100	mA
Continuous Forward Current Per Segment Derating Linear From 25℃ Per Segment	25 0.33	mA mA/℃
Reverse Voltage Per Segment	5	V
Operating Temperature Range	-35℃ to +85℃	
Storage Temperature Range	-35℃ to +85℃	
Solder Temperature: max 260℃ for max 3sec at 1.6mm below seating plane.		

ELECTRICAL / OPTICAL CHARACTERISTICS AT Ta=25°C

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
Average Luminous Intensity	Iv	870	2200		μcd	I_F=10mA
Peak Emission Wavelength	λp		635		nm	I_F=20mA
Spectral Line Half-Width	Δλ		40		nm	I_F=20mA
Dominant Wavelength	λd		623		nm	I_F=20mA
Forward Voltage Per Segment	V_F		2	2.6	V	I_F=20mA
Reverse Current Per Segment	I_R			100	μA	V_R=5V
Luminous Intensity Matching Ratio	Iv-m			2:1		I_F=10mA

Section B, Part III

Question 6

Draw the sampled waveform on this sheet and attach with your answer sheet.