Glasgow College, UESTC

Degrees of Bachelor of Engineering (BEng)

MICROELECTRONIC SYSTEMS (UESTC1008)

Final Exam

5 July 2018

10:30 - 12:30

Total 4 questions, each of which is worth 25 marks. Total 100 marks.

Attempt ALL questions

The numbers in square brackets in the right-hand margin indicate the marks allotted to the part of the question against which the mark is shown. These marks are for guidance only.

An electronic calculator may be used provided that it does not have a facility for either textual storage or display, or for graphical display.

Continued overleaf

Q1

a) Convert the following numbers as mentioned. To receive full credit, write the answer and show all your working.

i) Convert 8-bit signed number $(01011010)_2$ to hexadecimal number. [2]

ii) Convert $(-26)_{10}$ to signed binary value using 2's complement method. Use 8 bits to represent the result. [3]

b) With the aid of a circuit diagram, explain how a pull down resistor can be used to reduce the current flow when a switch is connected to the input pin of a microcontroller. [5]

c) When the code below is compiled to be run on an mbed microcontroller, a number of errors are flagged. Find and correct the errors. [5]

```
#include "mbed.h"
Digital Out myled(LED_1);
int main() {
        while(1) {
            myled = 1;
            pi==3.14;
            wait(0.2);
            myled = 0;
            wait(pi);
 }
```

d)

i) What output voltage will be read on a Digital Volt Meter (DVM) connected to pin 18 of an mbed microcontroller when the code below is run on it? [5]

```
 #include "mbed.h"
AnalogOut Aout(p18);
int main() {
   for (float i=0;i<1;i=i+0.2){
      Aout=i;
     wait(0.1);
   }
}
```

ii) When p18 is connected to an oscilloscope, sketch the waveform that is displayed on the oscilloscope? [5]

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Q2

(a) Make a circuit diagram (gate level representation) for a 2x4 binary decoder given by the truth table in Figure Q2a. [10]

Truth Table

A	B	Q_0	Q_1	Q_2	Q_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

Fig. Q2a

(b) Figure Q2b represents a 4x1 multiplexer. Provide the corresponding truth table. [10]

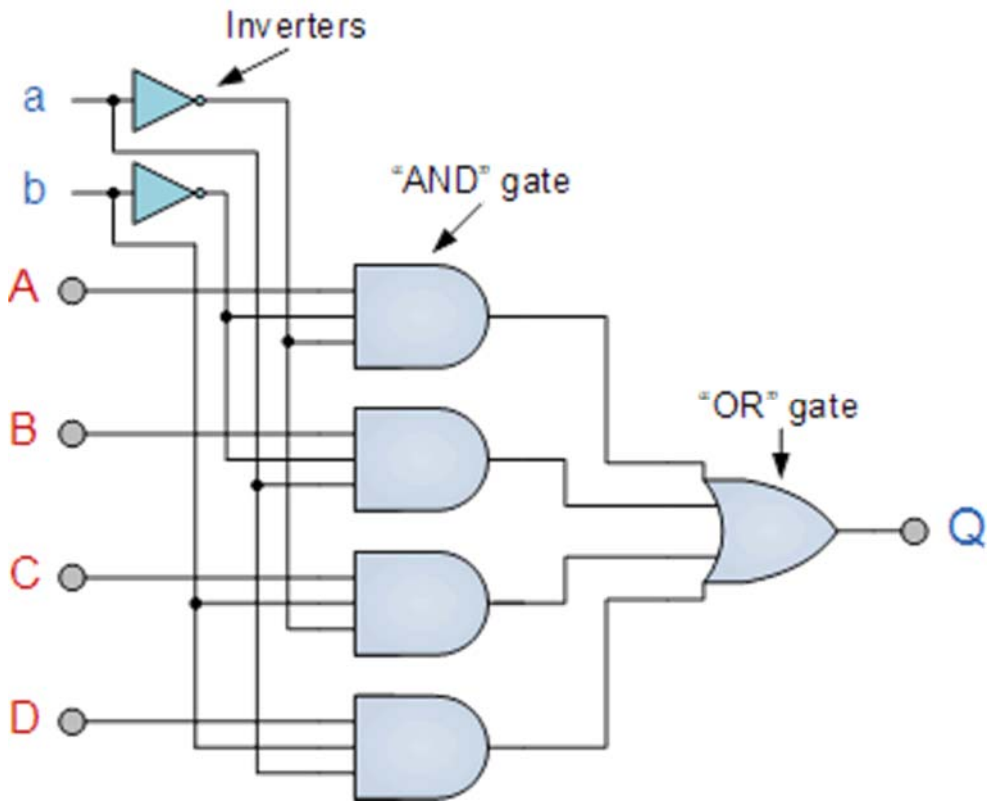

Fig. Q2b

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(c) An engineer designed the circuit of Figure Q2c:

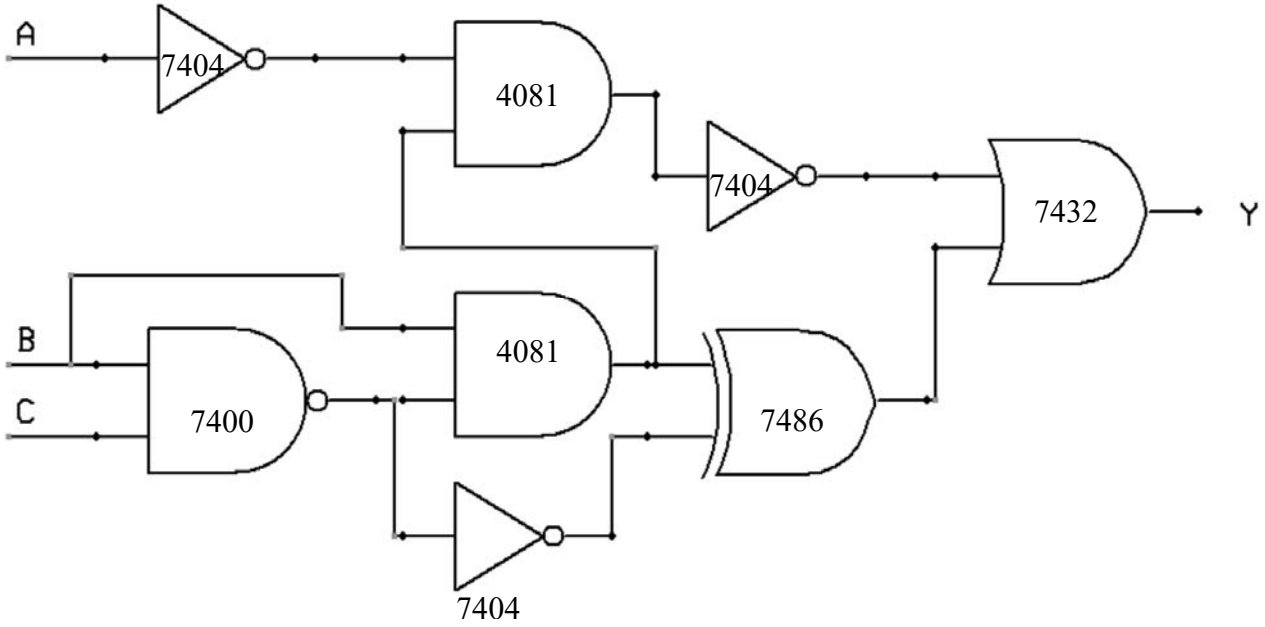

Fig. Q2c

i) Assuming all the gates in the circuit have equal propagation delay of 10 ms each, what will be the propagation delay of the circuit? [2]

ii) Which component in the circuit of Figure Q2c can be replaced by the part 7400 configured as shown in Figure Q2d. Hint: Think of the function performed by the component as configured in Figure Q2d. [3]

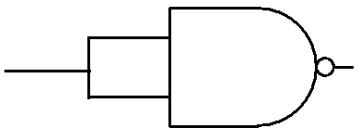

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Fig. Q2d

Q3

(a) Differentiate between Combinational and Sequential logic. Give one example of each type of logic circuit. [5]

(b) Fig. Q3a is a circuit composed of two flip flops. On Fig. Q3b, draw the outputs Q_0 and Q_1 as a function of time, for the given Clock. [10]

Assume the following:
The initial state of Q for all the flip-flops is 1.
There is no propagation delay time.

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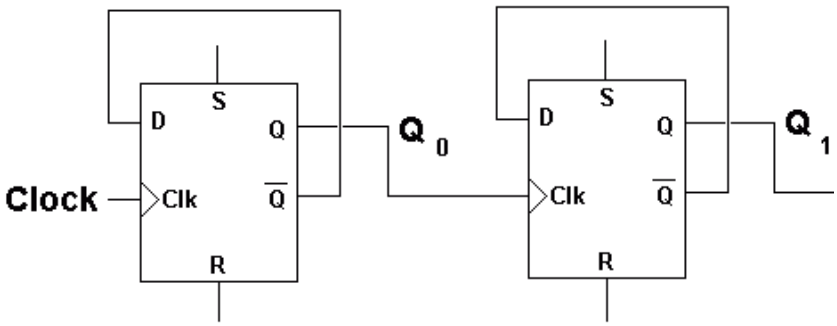

Fig. Q3a

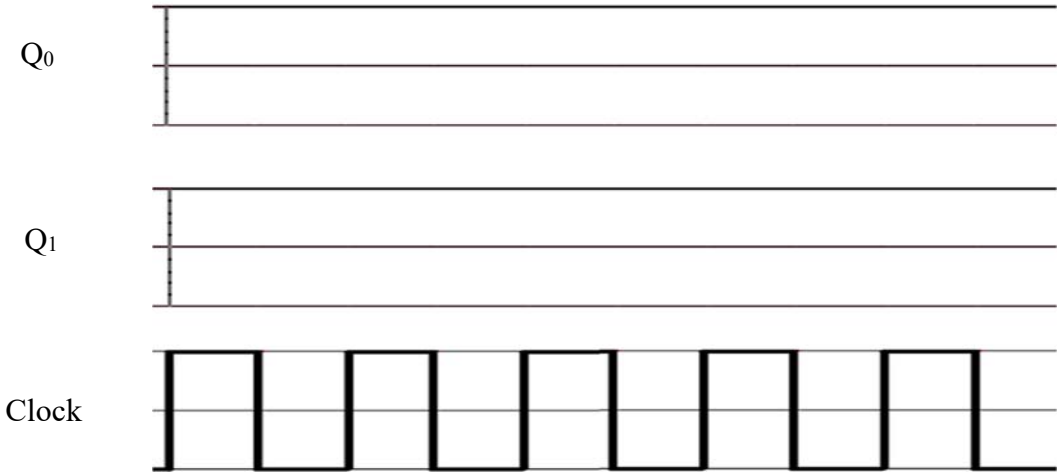

Fig. Q3b

(b) For the SR flip flop shown in Fig. Q3c, draw the outputs $Q$and $\overline{Q}$ on Fig. Q3d for given inputs and clock C.
Assume that the initial state of Q is 0 and there is no propagation delay time. [10]

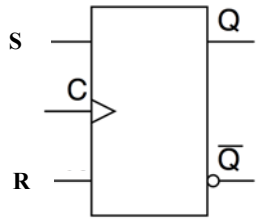

Fig. Q3c

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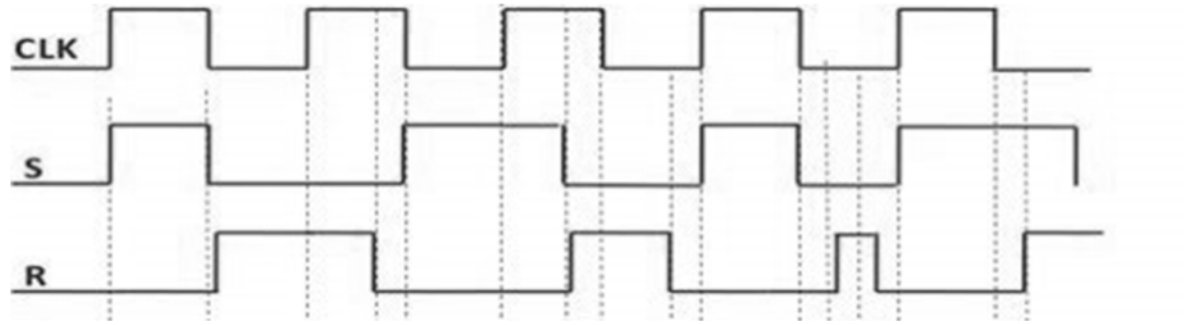

Q

$\overline{Q}$

Fig. Q3d

Q4

(a) One of the applications of a shift register is a Johnson counter. Shown in Fig. Q4a is a 4 bit shift register made of 4 D type flip flops.

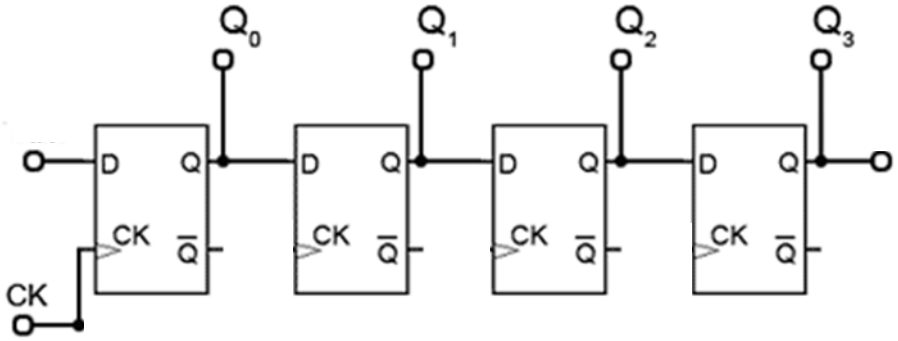

Fig. Q4a

i) Redraw the shift register of Fig Q4a to configure it as a Johnson counter. Do not forget to show the direction of data flow and draw the missing connections. [10]

ii) With reference to a 3 stage counter, explain how a Johnson counter can produce a longer sequence than a Ring counter. Hint: Compare the number of states in a cycle for both counters. [3]

iii) Write down a truth table showing the different state cycles of a 3 stage Johnson counter. [2]

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(b) An mbed microcontroller is used to produce an analogue signal that is sent to a speaker. The programmer by mistake considers only 7 bits instead of available 10 bits to generate the digital input for the digital to analog converter (DAC).

i) Given that the reference voltage is 3.3 V, what is the maximum mbed microcontroller analogue output voltage if a 7-bit digital input is used? [3]

ii) If all 10 bits of the digital input were used, what is the maximum analogue output voltage that could be generated by the mbed microcontroller? [2]

iii) Calculate the resolution of the 10-bit DAC. [2]

iv) What would the analogue output voltage be for a digital input 1101010110? [3]

End of question paper