

UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

DIGITAL ELECTRONICS II

COURSE CODE - E441

DECEMBER 2008

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. State clearly any assumptions made.
5. Start each new question on a fresh page.

Question 1

- a) The diagrams shown in figure 1 and figure 2 show block diagrams of basic *combinational circuit* and *sequential circuit* respectively. What do you understand by the terms *combinational circuit* and *sequential circuit*. Give simple circuit examples of *combinational circuits* and *sequential circuits*.

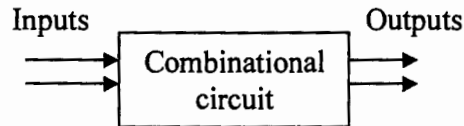


Fig. 1 Combinational circuit

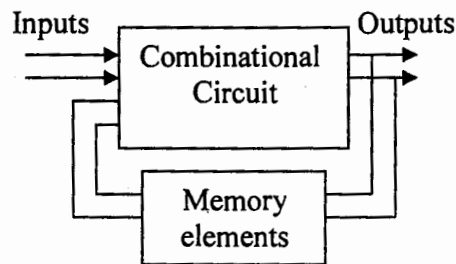


Fig. 2 Sequential circuit

[8]

- b) Draw circuit diagrams of clocked R-S Flip-Flop and clocked J-K Flip-Flop and explain the following:
- Why it is necessary to have clocked circuits?
 - Illustrating with a characteristic table, explain how a clocked R-S Flip-Flop works.
 - Explain how a clocked J-K Flip-Flop is said to be an improvement to R-S Flip-Flop.

[17]

Question 2

- a) Explain why *triggering* and *synchronization* is very important in digital circuits? Illustrate your answer with the operation of a relevant circuit.

[7]

- b) A *master-slave* connection has been found to be one of the circuits that can achieve reliable synchronization in sequential circuits. Draw a circuit diagram of a J-K *master-slave flip-flop* and explain how the circuit functions.

[11]

- c) Synchronization of sequential circuits can also be achieved by using *AC-coupled edge triggered flip-flop*. Figure 3 below shows a simple *AC-coupled edge triggered flip-flop*. Explain in simple terms how this circuit functions.

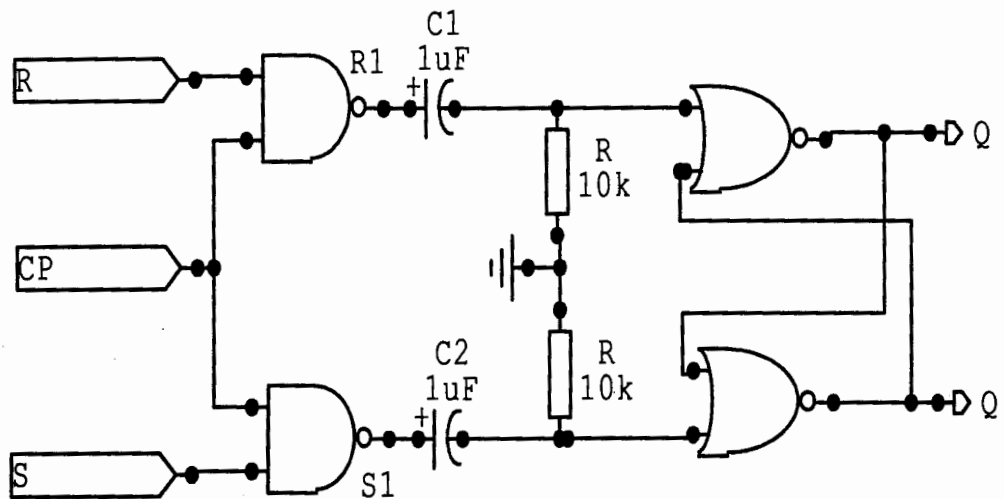


Fig. 3

[7]

Question 3

a) *Registers* play an important role in electronic systems. They allow data to be transmitted in *parallel* format or in *serial* format. Using suitable diagram(s) describe and explain how shift registers function.

[9]

b) Figure 4 below shows a circuit diagram of a versatile register. Show that, this register is able to function in the following ways:

- i. Function as a shift register capable of shifting data from left to right and from right to left.
- ii. Capable of accepting parallel input of data.
- iii. Capable of outputting parallel data.
- iv. Allows clearing of the registers through a clear line.

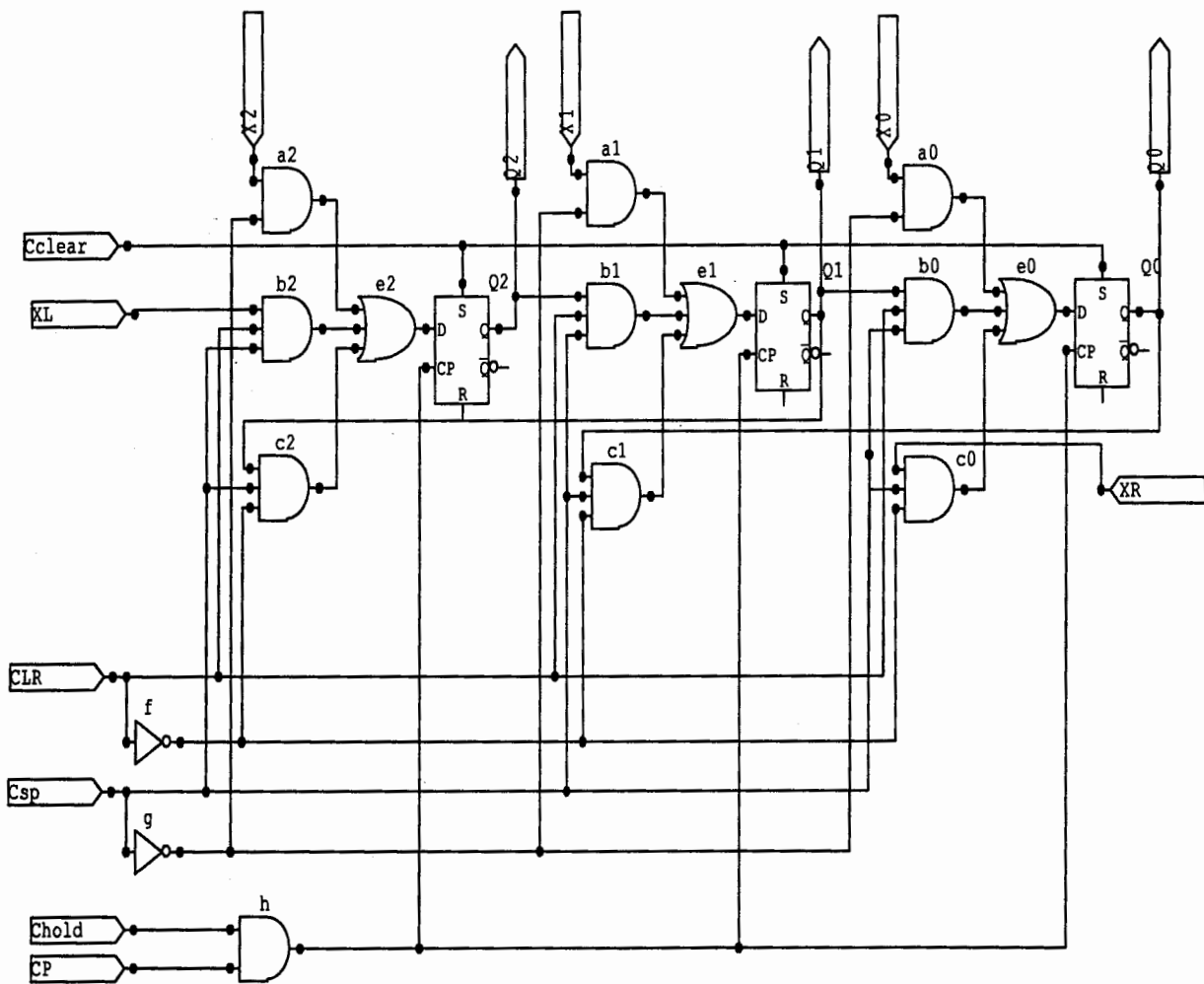


Fig. 4

[16]

Question 4

- a) Figure 5 shows a simple 4-bit ripple counter. What is a ripple counter? With reference to figure 5 explain how a ripple counter functions.

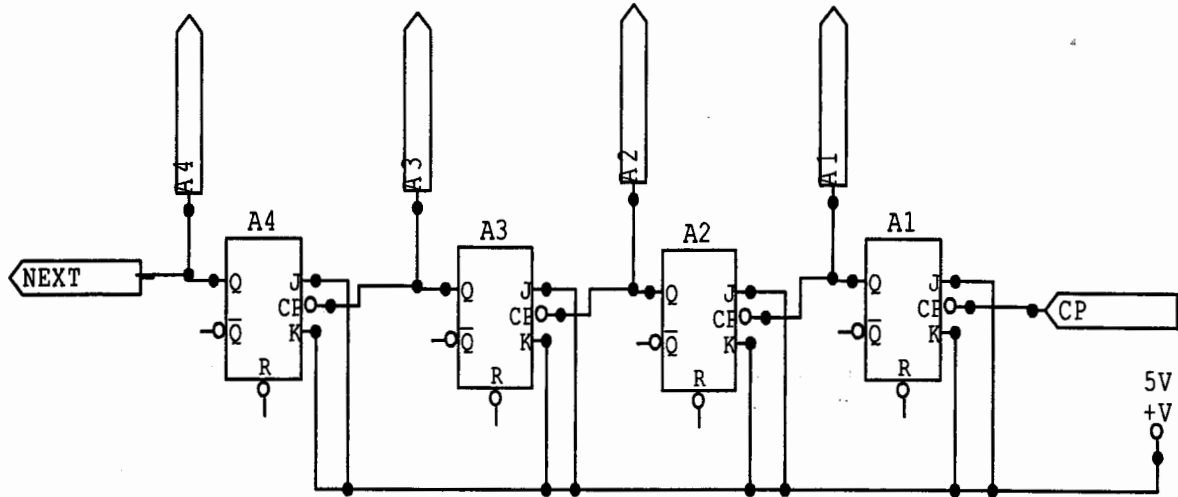


Fig. 5 A 4-bit binary ripple counter

[7]

- b) The circuit in figure 6 shows a Modulo 10 or decade counter. Write down the truth table for the counter and show how it is possible to arrive at the circuit shown in figure 6.

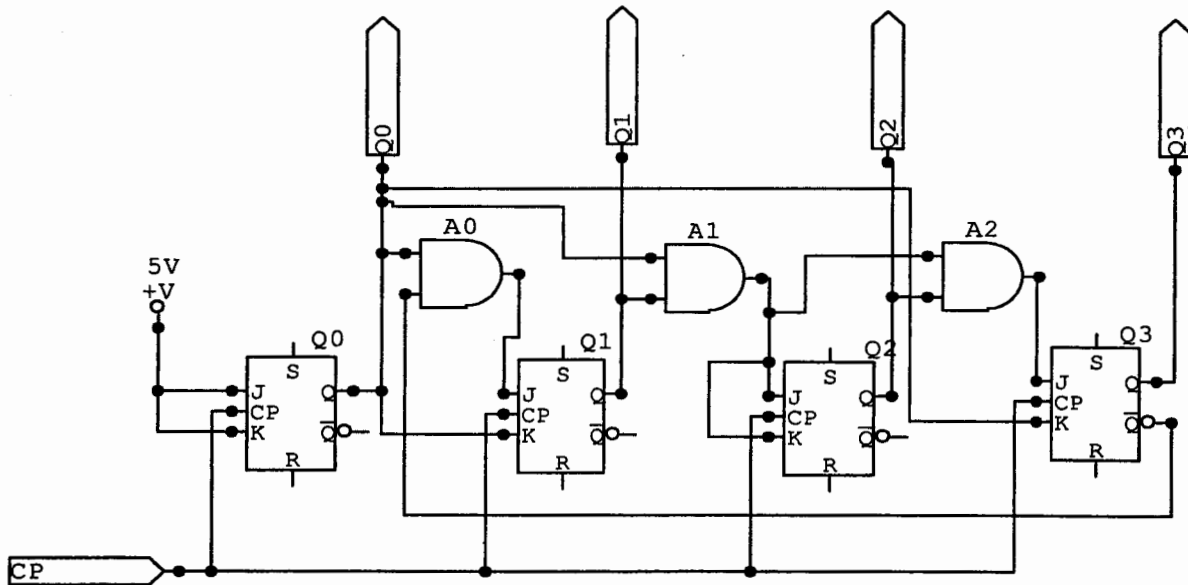


Fig. 6 Decade counter

[9]

- c) Design a J-K flip-flop based *up-down counter* capable of counting from 0 to 7 then down to 0. The candidate is recommended to draw all relevant diagrams.

[9]

Question 5

- a) What are the differences between sequential access memories and random access memories?

[5]

- b) Draw a basic memory cell that uses a flip-flop and gates and explain how the memory cell functions.

[8]

- c) Figure 7 below shows a block diagram of a memory cell. Starting from this memory cell answer the following questions:

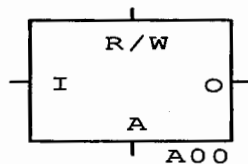


Fig. 7 Memory Cell

- i. Draw a block diagram of a four-word and four-bit memory unit.
- ii. Explain how the reading and writing of a word into this memory unit is achieved.

[12]

Question 6

- a) Figure 8 below shows the basic architecture of a Microprocessor based microcomputer system. Give an account of the function of each module.

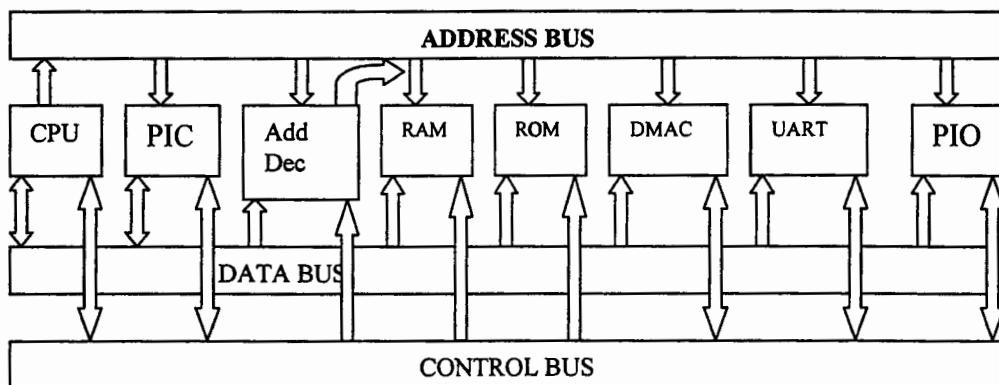


Fig. 8 Microcomputer basic architecture

[12]

b) What are the salient features of Microcontrollers when compared to Microprocessors?

[6]

c) PIC16F84 is an example of a microcontroller. Design a simple temperature control system which uses the PIC16F84. The system should be able to READ IN temperature from a suitable temperature sensor then turn ON a fan and OFF heater if the temperature is above 28°C . If the temperature is below 22°C the heater is turned ON and the fan turned OFF. If the temperature, T, is within the range $28^{\circ}\text{C} \geq T^{\circ}\text{C} \geq 22^{\circ}\text{C}$ no action should be taken. The solution should be limited to the following:

- i. Stating any assumptions made.
- ii. Drawing a labeled circuit diagram.
- iii. Program flow chart only.

[7]

END OF PAPER