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UNIVERSITY EXAMINATIONS 2023/2024

THIRD YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN (PHYSICS), BACHELOR OF SCIENCE IN PHYSICS AND BACHELOR OF EDUCATION SCIENCE

SPH 3353: ELECTRONICS II

DATE: APRIL 2024 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) i. Differentiate between AND and OR gates using truth tables. (2 Marks)

ii. Convert the decimal number 27 to binary and octal. (2 Marks)

iii. Perform the following binary addition: 1011+0101=? (2 Marks)

iv. Convert the hexadecimal number A5 to binary and decimal. (2 Marks)

v. Briefly explain the purpose of Karnaugh maps in logic minimization. (2 Marks)

b) i. Explain the function of a 555 timer and give one example of its use. (2 Marks)

ii. What is the difference between an ADC and a DAC? (2 Marks)

iii. Briefly explain how DRAM and SRAM memories work. (2 Marks)

iv. What are the advantages and disadvantages of using flip-flops in digital circuits? (2 Marks)

v. Describe the basic operation of a ring counter. (2 Marks)

c) i. Design a simple combinational circuit using only NAND gates to implement the exclusive-OR (XOR) function. (3 Marks)

ii. Explain the concept of metastability in flip-flops and how it can be mitigated.

iii. Briefly describe the main differences between CMOS and bipolar transistor logic families. (2 Marks)

iv. What are the key features and applications of Field-Programmable Gate Arrays (FPGAs)? (2 Marks)

QUESTION TWO (20 MARKS)

a) Define the following terms
   i. Analog signal (2 Marks)
   ii. Digital signal (2 Marks)

b) Briefly explain two key differences between analog and digital signals. (1Mark)

c) Using a truth table, describe the operation of the following logic gates:
   i. OR gate
   ii. AND gate
   iii. NOT gate

d) Draw the logic symbol for each of the gates mentioned above (2 Marks)

e) Design a simple logic circuit using only AND, OR, and NOT gates that outputs a 1 only when both inputs A and B are 0 Draw the circuit diagram and explain its operation. (4 Marks)

f) Simplify the f8110wing Boolean expression using De Morgan's Law. (4 Marks)

g) Express the following logic function using basic Boolean operators (AND, OR, NOT) Output = 1 only when A and B are different (XOR operation) (4 Marks)

QUESTION THREE (20 MARKS)

a) i. Define a multiplexer and describe its basic operation (2 Marks)

b) ii. Briefly explain how a 4:1 multiplexer can be used to implement any two-input logic function. Draw a logic diagram demonstrating this concept for the XOR function. (3 Marks)

c) iii. Design a combinational logic circuit using only a 4:1 multiplexer and additional logic gates (e.g., AND, OR, NOT) to convert a 4-bit Gray code to a 4-bit binary code. Draw the circuit diagram and explain its operation. (3 Marks)

b) i. Briefly describe the main functions performed by an Arithmetic Logic Unit (ALU) (2 Marks)

ii. Provide an example of how a 4-bit ALU can be used to perform addition of two 4-bit binary numbers (2 Marks)

iii. Provide an example of how a 4-bit ALU can be used to perform subtraction of two 4-bit binary numbers (2 Marks)

c) i. Define the purpose of a digital comparator and explain its basic operation (2 Marks)

ii. Give an example of how a 4-bit comparator can be used to determine if two 4-bit binary numbers are equal (2 Marks)

iii. Briefly describe the function of a decoder/driver in the context of displaying information on devices like seven-segment displays (2 Marks)

QUESTION FOUR (20 MARKS)

a) i. Compare and contrast the functionalities of SR and JK flip-flops, including their truth tables and triggering conditions (4 Marks)

ii. Design a circuit using an SR flip-flop and additional logic gates (e.g., AND, OR, NOT) to create a T-flip-flop (2 Marks). Draw the circuit diagram and explain its operation.

iii. Briefly explain the concept of race-around condition in JK flip-flops and suggest a method to prevent it (2 Marks)

b) i. Define a shift register and explain its basic operation, including the difference between left shift and right-shift registers (2 Marks)

ii. Describe a situation where a 4-bit left-shift register would be useful in a digital circuit (2 Marks). Draw a simple example of its operation with an initial data value.

iii. Briefly explain the difference between serial-in/parallel-out (SIPO) and parallel-in/parallel-out (PIPO) shift registers (2 Marks)

c) i. Define a counter and explain its basic operation, including the concept of modulus in counters (2 Marks)

d) ii. Design a 3-bit synchronous counter using JK flip-flops that counts from 0 to 7 and then repeats (modulus 8) (2 Marks). Draw the circuit diagram and explain its operation.

e) iii. Briefly describe the difference between synchronous and asynchronous counters and give an example of each (2 Marks)