CMPSCI 145 MIDTERM #1

Solution Key

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CMPSCI 145 – Spring 2019 – In-Class Midterm Exam #1 Solution Key
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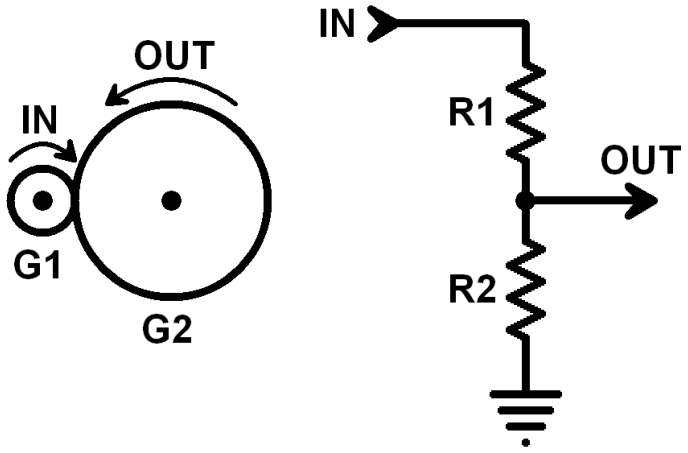
<1> 10 Points – Examine the following diagram of two systems, one involving gears and the other involving resistors. Resistor **R1** is 6000 Ohms, and resistor **R2** is 2000 Ohms. Gear **G1** has 20 teeth.



A. (5 points) What is the output voltage of the circuit if the input voltage was 100 volts?

The output voltage will be ¼ of the input voltage, so **25 volts.**

B. (5 points) How many teeth must gear **G2** have so that the division ratio of the gears matches the division ratio of the resistors? (Ignoring differences in sign.)

80 teeth.

<2> 10 Points – Convert the following numbers:

A. (5 points) Convert 67 (decimal) to unsigned binary.

67 ÷ 2 = 33 R 1
33 ÷ 2 = 16 R 1
16 ÷ 2 = 8 R 0
8 ÷ 2 = 4 R 0
4 ÷ 2 = 2 R 0
2 ÷ 2 = 1 R 0
1 ÷ 2 = 0 R 1
So, the final answer is **`1000011`**

B. (5 points) Convert 10011111 (binary) to hexadecimal (base 16).

Partition number into groups of 4 bits, convert each one separately.
1001 = 9
1111 = 15 = F
So, the final answer is **`9F`**

<3> 15 Points (1 point each box) – Solve each sum below, and then tell me, ***yes or no***, if it exhibits ***unsigned overflow*** or ***signed overflow***. For problems that use ***four-digit decimal*** arithmetic (base 10), the left-most digit is the sign digit, and you are to write down only the right-most four digits of the sum even if a carry to a fifth digit is generated. For problems that use ***eight-bit binary*** arithmetic (base 2), the left-most bit is the sign bit, and you are to write down only the right-most eight bits of the sum, even if a carry to a ninth bit is generated.

Problem	Sum (in four decimal digits or eight binary bits)	Unsigned Overflow?	Signed Overflow?
Decimal: 4972 + 1974	6946	NO	YES
Decimal: 7259 + 2022	9281	NO	NO
Decimal: 8416 + 8980	7396	YES	NO
Binary: 11100001 + 01101011	01001100	YES	NO
Binary: 11110000 + 11011010	11001010	YES	NO

<4> 18 Points (1 point each box) – Show the ***decimal*** (base 10) value of the eight-bit binary numbers interpreted in each of the following ways. For signed interpretations, the left-most bit is the sign bit.

The Number	01000101	11111111	10010010
Unsigned Binary	69	255	146
Sign & Magnitude Signed Binary	+69	-127	-18
One's Complement Signed Binary	+69	-0	-109
Two's Complement Signed Binary	+69	-1	-110
BCD (if illegal answer ERROR)	45	ERROR	92
Excess-3 (if illegal answer ERROR)	12	ERROR	ERROR

<5> 10 Points – (5 points each) An analog computation system can continuously represent any number between 0 and 10 (inclusive), but the scale markings are only good to one digit to the right of the decimal point (that is, 0.0, 0.1, 0.2, …, 9.9, 10.0).

A. What happens when the computation 1.5×2.3 is attempted?

The result, 3.45 is between scale markings 3.4 and 3.5, so the **exact answer can't be computed.**

B. What happens when the computation 6.9×7.2 is attempted?

The result is larger than 10.0, so there is an **overflow**.

<6> 10 Points – (2 points each) Which of the following are analog and which are digital?

A. A mechanical cam to compute logarithms **Analog**

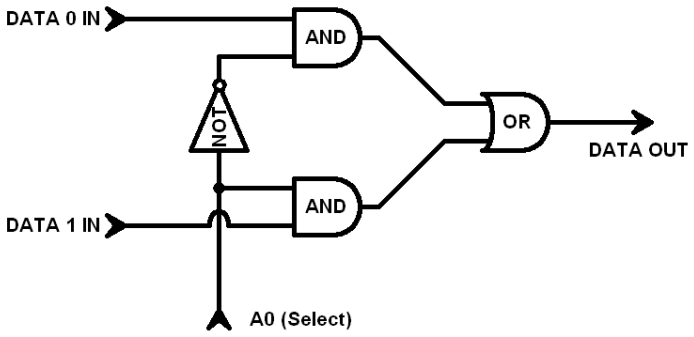
B. Magnetic core memory **Digital**

C. A NOR-gate **Digital**

D. A hydraulic press **Analog**

E. A flip-flop **Digital**

<7> 16 Points – (2 points each) Trace the following circuit and show the outputs for all given inputs.



Data 0	Data 1	Select	Out
0	0	0	0
0	1	0	0
1	0	0	1
1	1	0	1
0	0	1	0
0	1	1	1
1	0	1	0
1	1	1	1

5 Points Extra Credit: What function does this circuit perform?

2:1 multiplexer. When Select = 0, the DATA 0 input is passed to the output; when Select = 1 the DATA 1 input is passed to the output. See page 101 of the Companion.

<8> 11 Points – SHORT ANSWER – In radio A, a knob controls a variable resistor used as the volume control. In radio B, a switch is used to select low volume versus high volume. Which is analog and which is digital? What are the advantages and disadvantages of each system? Use the back of the page for your answer.

Radio A is controlled by an **analog** volume control,

Radio B is controlled by a **digital** volume control.

The analog version has an **infinite number of legal positions**, and can smoothly control the volume from minimum to maximum, but **returning to an exact previous setting is nearly impossible**.

The digital version has only two settings, so **cannot have as many possible volumes** as the analog system, but **those two settings are absolutely repeatable**.