Name: _____

Problem	Points	Score
1	10	
2	10	
3	10	
4	10	
5	10	
6	10	
7	10	
8	10	
9	10	
10	10	
Total	**100**	

Notes:

1. The exam is closed book / closed notes. You are allowed a copy sheet — only **one** side of **one** standard US-size (8.5” x 11”) sheet of paper — on which you can write relevant information such as equations. You are allowed to bring copy sheets from previous exams.

2. Please show **all** work. Incorrect answers with no supporting explanations or work will be given no partial credit.

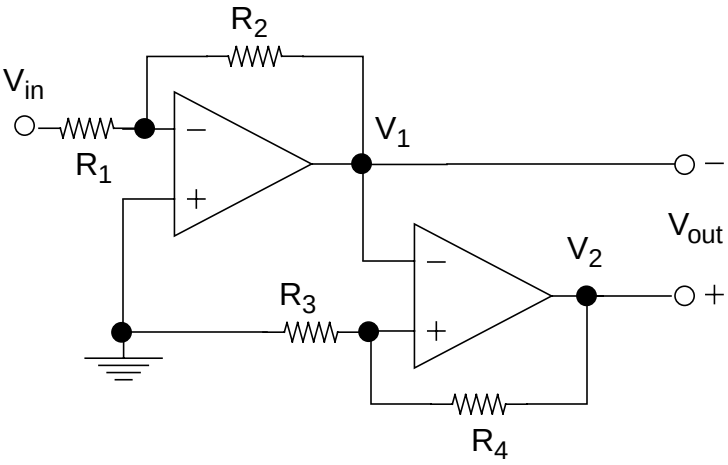
3. If I cannot read or follow your solution, it is wrong; and no partial credit will be given — **PLEASE BE NEAT**!

4. Please indicate clearly your answer to every problem.

5. There is sufficient space after each problem to write your solution. In case you need extra paper please see the instructor.

6. If specified, do **not** use calculators. Show complete work and detailed steps for proper credit.

Problem No. 1:



Find the voltage gain

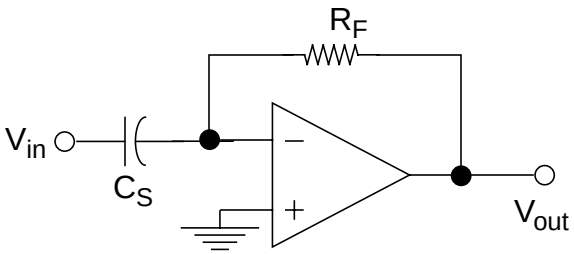
$$A_v = \frac{V_{out}}{V_{in}}$$

for the adjacent op-amp circuit. Use

$R_1 = 10k\Omega$ $R_2 = 33k\Omega$

$R_3 = 1.2k\Omega$ $R_4 = 10k\Omega$.

Problem No. 2:



Identify the adjacent op-amp circuit (is it a differentiator or an integrator?).

The input signal is given by $V_{in} = 10\sin(4000\Pi t)$ V.

Calculate the output voltage V_{out} if $R_F = 10k\Omega$ and $C_S = 0.01\mu F$.

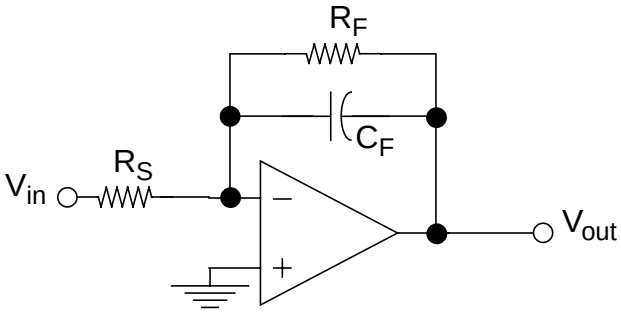
Problem No. 3:

The relationship between the force $f(t)$ on the piston of an engine, and the displacement $x(t)$ of the piston is given by

$$\frac{d^2x}{dt^2} + 100\frac{dx}{dt} + 5x = -10\,f(t)$$

Construct an analog computer simulation (i.e. draw a circuit diagram for the analog computer) that implements the above differential equation.

Problem No. 4:



Identify the adjacent op-amp filter (low-pass, band-pass or high-pass?).

The cut-off frequency of the filter is $\omega_0 = 100Hz$. Also, $R_S = 10k\Omega$ and $C_F = 0.5\mu F$.

Find R_F and the voltage gain $A_V(j\omega)$.

Problem No. 5:

Convert the following number from decimal to binary. Then convert it to hexadecimal.

$$631.3125_{10}$$

Do not use calculators of any kind. Show in detail all the steps involved.

Problem No. 6:

a) Perform any *one* of the following binary arithmetic operations (assume unsigned numbers). **Do not use calculators of any kind.**

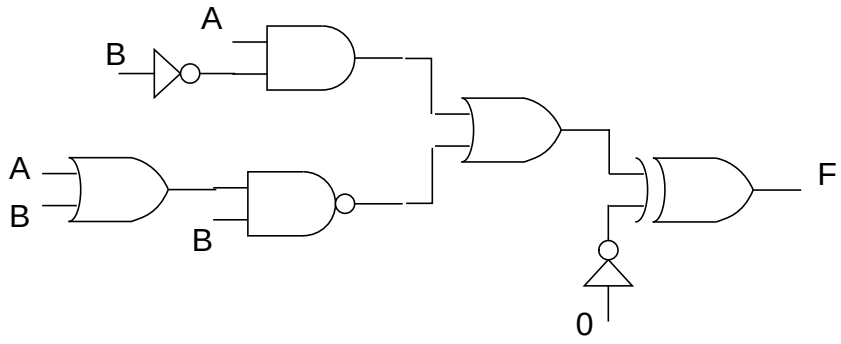
1. 10101×110
2. $110101 \div 101$

b) Assume 6 bit signed binary arithmetic with 2's complement representation of negative numbers. Perform the following subtraction and indicate whether there is an overflow. **Do not use calculators of any kind.**

$$010110 - 111011$$

Problem No. 7:

Find the minimum expression for the output of the logic circuit shown below.



Problem No. 8:

Using only the laws of Boolean algebra, simplify the following expression to its minimum sum-of-products form.

$$(\overline{A} + B)(\overline{A} + C)(C + D)(B + D)$$

Problem No. 9:

A game machine at the Digital Casino consists of four slots ABCD. You throw four darts simultaneously towards the slots. If any two of the slots are hit, you win a dollar. Having all slots empty or filled with darts is not allowed. Otherwise, you lose a dollar.

Draw a truth table for a digital circuit that simulates this game, with inputs ABCD and output F indicating a win. Derive a minimum expression for F using Karnaugh maps. Account for the don’t care terms appropriately.

Problem No. 10:

Draw a block diagram of a 32x8 ROM. What is the number of address bits required? What is the largest value that can be stored in this ROM?