PHYS345 Second Midterm Exam November 24, 1998

This is a closed book exam. One 3"x5" note card is permitted; this card should be turned in with your exam papers.

Programmable calculators and graphing calculators may be used during this exam.

Since this exam booklet may be separated for grading; it is important to:

*Show ALL work on problem sheet and only on that sheet.*

Please read questions carefully.

Credit may be lost inadvertently if solutions are not neat and orderly.

Be careful with units, signs, and significant figures.

1. (20 points) Use Karnaugh mapping to find a suitable combination of two-input gates for this truth table.

<table>
<thead>
<tr>
<th>BA</th>
<th>00</th>
<th>01</th>
<th>11</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC \</td>
<td>00</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
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<td>1</td>
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<td>10</td>
<td>0</td>
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</tr>
</tbody>
</table>

Green supercell: B’D’
Pink supercell: A’C’
Blue Supercell: AB’

\[ f(A, B, C, D) = \overline{B}D + \overline{A}\overline{C} + A\overline{B} \]
2. (20 points) What does the following circuit do? That is, find an expression for the gain and give the circuit a suitable name.

\[
V_+ = \frac{1k}{1k + 1k} V_2
\]
\[
= \frac{V_2}{2} = V_-
\]
\[
\frac{V_1 - V_+}{1k} = -\frac{V_0 - V_+}{1k}
\]
\[
V_0 = V_2 - V_1
\]

Subtracting circuit

3 (20 points) Design an op-amp circuit to convert the triangular waveform \(v_1\) in the following Figure into the square wave \(v_o\) shown. Use 0.1 µF capacitor. (Hints: First quantitatively determine the mathematical expression of \(v_o\) in terms of \(v_1\).)

replace \(v_s\) with \(v_1\) in the figure

\[
V_0 = -R_F C_S \frac{dV_1}{dt}
\]
\[
-0.5 = -R_F \times 0.1 \times 10^{-6} \frac{0.2}{1 \times 10^{-3}}
\]
\[
R_F = 25k\Omega
\]
4. (20 points)

Using D-type flip-flops and a single two-input logic gate, design a 2-bit state counter that will execute the sequence in this state diagram:

Show the type of gate and the connections to the flip-flops needed for this counter on the schematic below:

<table>
<thead>
<tr>
<th>Q2</th>
<th>Q1</th>
<th>D2</th>
<th>D1</th>
</tr>
</thead>
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</tbody>
</table>

Karnuagh map for D₂

<table>
<thead>
<tr>
<th></th>
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<td>1</td>
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</table>

D₂=Q₁'Q₂' , use and AND gate and Q₁’ and Q₂’ as inputs.
5 (20 points) Use you own language to describe the mechanism of generator and motor. (I want to see clearly from your description how current and force are generated).