This is a open book, open notes, closed neighbor, closed teammate exam. Partial credit is available, so where ever possible, Show Your Work. When writing code, it is NOT necessary to comment the code on this exam, however, you should use meaningful labels to make your code readable.

This exam consists of 6 numbered pages, including this cover sheet. You are advised to quickly look over the entire exam first to PLAN YOUR TIME.
1. Conversions.

(a) (26 Points). Fill in the following table of conversions:

<table>
<thead>
<tr>
<th>binary</th>
<th>hex</th>
<th>decimal</th>
<th>ASCII</th>
<th>BCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2B5</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(unsigned)</td>
<td></td>
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</tr>
<tr>
<td>$97</td>
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<td></td>
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</tr>
<tr>
<td>(signed)</td>
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<td></td>
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</tr>
<tr>
<td>-95</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(8 bits)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>00110101001110111</td>
<td>///</td>
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<td>///</td>
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<td>///</td>
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<tr>
<td>'R' 'x'</td>
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<td>///</td>
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</tbody>
</table>

01101000
(b) (14 Points). Consider the following 6811 instructions:

```
ldaa  #151
adda  #$E3
```

What is the value in the A register upon completion of these instructions?

What are the values in the Condition Code Register bits NZVC?

(c) (10 Points). We have an 8 bit ADC with analog input from 0 to 10 Volts. Using decimal fixed point representation with $\Delta = 0.01$, the representation of one sample is $\$013A$. What is the input voltage corresponding to this sample? What was the output from the ADC (i.e. N) to produce this reading?
2. Consider the following C program. It’s purpose is to compute a decimal CRC for a string of
digit characters and turn on an LED device if the string passes the CRC, i.e. if the sum of
all of the digit values is 0, mod 10. The LED device is attached to bit 3 of Port C on the
HC6811 microcontroller being used for this application. Your job is to compile this code into
HC6811 assembly language on the next page, provide the device driver for the LED device
by implementing the Init_Port() and Out_Port() functions in assembly, and then answer the
questions on the following page. Be sure to be a good port and stack citizen.

```c
#define PORTC (*(unsigned char volatile *) 0x1003)
#define DDRC (*(unsigned char volatile *) 0x1007)

int conv( char);
void Init_Port(void);
void Out_Port(int);

char s[] = "271";

main()
{ int num = 0;
  char *a = s;

    Init_Port();
    while(*a)
    {
        num += conv(*a);
        if(num > 9) num -= 10;
    }

    if(num) Out_Port(0);
    else Out_Port(1);
}

int conv( char c)
{ int x;
  x = c - '0';
  return x;
}

void Init_Port(void)
{
    // You fill in the code in assembly
}
void Out_Port(int x)
{
    // You fill in the code in assembly
}
```
(a) (30 Points). Assembly Code
(b) (10 Points). Calculate the size of your object code in bytes. Show your work.

(c) (10 Points). Estimate the running time, in cycles, for the above example. Show your work.