Solutions - Quiz 2
(October 14th @ 5:30 pm)

PROBLEM 1 (40 pts)
- Given a 25 MHz bus clock, provide a set of instructions to generate a time delay of 40 ms. Consider that pusha takes 2 cycles, pula 3 cycles, nop one cycle and dbne 3 cycles.

<table>
<thead>
<tr>
<th>40 ms delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>( n \times n_{\text{times}} \times \frac{1}{25 \times 10^6} = \frac{4}{10^3} \rightarrow n \times n_{\text{times}} = 100000 )</td>
</tr>
<tr>
<td>( n_{\text{times}} = 50000 &lt; 65535, n = 20 )</td>
</tr>
</tbody>
</table>

```assembly
ldx #50000
loop:  psha          ; 2 cycles
       pula          ; 3 cycles
       psha          ; 2 cycles
       pula          ; 3 cycles
       psha          ; 2 cycles
       pula          ; 3 cycles
       nop           ; 1 cycle
       nop           ; 1 cycle
       dbne X, loop  ; 3 cycles
```

PROBLEM 2 (20 pts)
- Complete the Assembly Program below so that the state of the four rightmost bits on the DIP Switch is only displayed on the bits 6, 5, 4, and 3 of PORTB (the LEDs). The figure shows an example on the Dragon12-Light Board: the number 1110 is shown on the bits 6, 5, 4, and 3 while the other LEDs are off.

```assembly
ROMStart  EQU  $4000
; code section
ORG   ROMStart
Entry:
_Startup:
LD  #4000
movb #$FF, DDRB
movb #$00, DDRH
showDIPSW: ldaa PTH
           /* Write instructions here */
           anda #$0F
           sla
           sla
           sla
           staa PORTB  ; Contents of register A are written on PORTB
           bra showDIPSW
```

DIP SWITCH

<table>
<thead>
<tr>
<th>PTH7</th>
<th>PTH6</th>
<th>PTH5</th>
<th>PTH4</th>
<th>PTH3</th>
<th>PTH2</th>
<th>PTH1</th>
<th>PTH0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

LEDS

<table>
<thead>
<tr>
<th>PORTB7</th>
<th>PORTB6</th>
<th>PORTB5</th>
<th>PORTB4</th>
<th>PORTB3</th>
<th>PORTB2</th>
<th>PORTB1</th>
<th>PORTB0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
PROBLEM 3 (40 PTS)

- Given the following Assembly code, specify the SP and the Stack Contents at the given times (right after the colored instruction has been executed). SP and the Stack Contents (empty) are specified for the first instruction (LDS #$4000).
- Specify a value in the instruction addb that would make the branch instruction bcs branch to mloop.

```
ROMStart EQU $4000
; code section
ORG ROMStart
Entry:
_Startup:
LDS  #$4000
mloop:      movb #$7C,1,-SP
           movw #$FE,2,-SP
           ldd #$BEEF
           bsr myfun
           leas 3,SP
           addb #$11
           bcs mloop
forever:    bra forever

; Subroutine
myfun:      pshb
            psha
            leas -2,SP;
            movw #$BED, SP
            leas 2,SP;
            pula
            pulb
            rts
```

<table>
<thead>
<tr>
<th>SP</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3FF9</td>
<td></td>
</tr>
<tr>
<td>$3FFD</td>
<td></td>
</tr>
<tr>
<td>$4000</td>
<td></td>
</tr>
<tr>
<td>$3FF7</td>
<td></td>
</tr>
</tbody>
</table>

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SP: $3FF9

ROMStart EQU $4000
; code section
ORG ROMStart
Entry:
_Startup:
LDS  #$4000
mloop:      movb #$7C,1,-SP
           movw #$FE,2,-SP
           ldd #$BEEF
           bsr myfun
           leas 3,SP
           addb #$11
           bcs mloop
forever:    bra forever

; Subroutine
myfun:      pshb
            psha
            leas -2,SP;
            movw #$BED, SP
            leas 2,SP;
            pula
            pulb
            rts

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