

CS/EE 3720
Spring 2004
Myers

Midterm Exam 2

- Fill in your name:
- This exam is open book and open notes.
- The exam is 80 minutes and worth 100 points.
- Show all your work.

Question	Score
1	
2	
3	
4	
Total	

1. **Semaphores** (25 points)

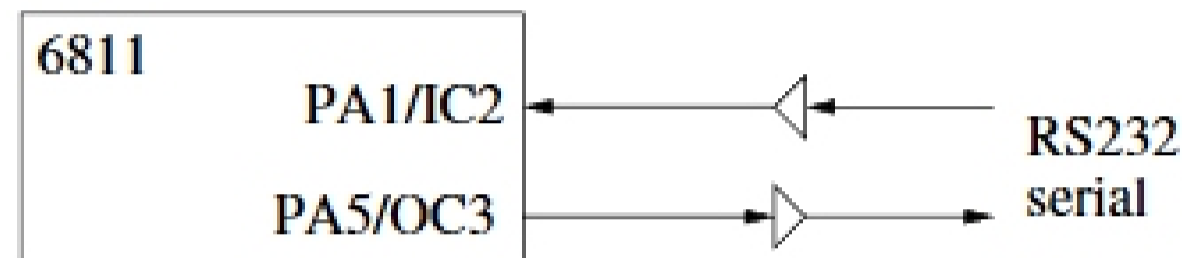
The spin-lock semaphore implementation in Program 5.8 on page 276 requires interrupts to be temporarily disabled while the semaphore S is being read and modified. Assume the existence of a new test-and-set instruction, `tset`. Using this instruction and a new `lock` variable, we can test that the lock is 0 and set it to 1 in one atomic operation. If the test finds that the lock is already 1, then it will clear the carry bit in the condition code register to indicate a failure. Otherwise, the carry bit will be set to 1. This new instruction allows us to implement `wait` and `signal` without disabling interrupts as follows:

```
S      fcb  1
lock   fcb  0
wait   tset  lock   sets carry to 1 if lock is successfully set to 1
      bcc  wait
loop   ldaa  S
      bhi  OK
      bra  loop
OK     deca
      staa S
      clr  lock
      rts
signal tset  lock
      bcc  signal
      inc  S
      clr  lock
      rts
```

- (a) The code above, unfortunately, can result in a deadlock. Give a detailed example demonstrating how deadlock can occur.
- (b) This problem can be eliminated by making a small modification to the code above. Show the modification on the above code.

2. Input Capture, Output Compare, and Serial I/O (50 points)

In this problem, you will use input capture and output compare to construct an SCI interface. A block diagram for this interface is shown below. Assume a baud rate of 1000 bits/s. Your interface should provide both transmit and receive functionality. You can assume the existence of the subroutines `InitFifo`, `PutFifo`, and `GetFifo`. `InitFifo` has no parameters and you can assume that it will save and restore any registers that it uses. `PutFifo` puts the 8-bit data in `RegA` into the FIFO. `GetFifo` takes a pointer in `RegX` to the place to put the 8-bit data taken from the FIFO. The main program (which you do not need to provide) will extract ASCII characters from the `RxFIFO`, and it will put ASCII characters into the `TxFIFO`. In the case of transmission, you can assume that it will arm an output compare interrupt handler to start the transmission.



- Draw the output signal when the ASCII character 'A' (41 in hex) is transmitted. Assume that `TCNT` is 2000 (decimal) at the start of transmission. Give the `TCNT` value for each transition of the output signal. Place arrows on the drawing to indicate where the IC and OC interrupts will occur, giving the `TCNT` value at each interrupt. Do the same thing for when an 'A' is received.
- Define all needed global variables.
- Show the ritual that initializes the global variables, input capture, and output compare interrupts.
- Show the input capture and output compare interrupt handlers.