1. True/False. Circle the appropriate choice on this sheet. There are no trick questions.

(a) T  F  A disk interrupt is generated when the disk controller has satisfied a disk read request.

(b) T  F  The TLB is a cache used to store the most recent data retrieved from RAM.

(c) T  F  A blocked process may be unblocked and put onto the ready queue when its quantum expires.

(d) T  F  A thread implemented in user space does not rely on being scheduled by the OS.

(e) T  F  One goal of process scheduling, for efficiency, is to allow two processes to be in a critical section for the same shared structure at the same time.

(f) T  F  The goal of batch scheduling (such as shortest job first) is to reduce the response time for interactive processes, such as word processing programs.

(g) T  F  An application program is a program that performs a function for a user, as opposed to providing services required by the computer.

(h) T  F  A daemon is a process that runs in the background to provide a service required by the computer.

(i) T  F  A separate page table is required for each running thread.

(j) T  F  Assuming a fixed address space size, the page table size in a virtual memory system grows inversely with the page size.

2. Fill in the answers on this sheet

(a) \(\frac{3}{2^n} + \frac{1}{2^n} = \) \(\_\) \(\_\) (to add fractions, the denominators have to be the same).

(b) A \(\_\) \(\_\)-bit address is required to reference all the bytes in a 16GB memory.

(c) \(2^{29} = \) \(\_\) \(\_\) (you can leave the answer in terms of K, M, etc.)

3. Answer these questions in the blue book

(a) Describe how the TSL (test-and-set-lock) instruction works and give an example of its use.

(b) Suppose several processes are sharing a stack data structure that support push() and pop() operations (for integers). The data structure is implemented as a fixed-size integer array, \(A\), and an index, \(top\), into the array that defines the top of the stack (and whose value is initially 0). Write the code for push() and pop() that (1) prevents race condition bugs, (2) causes a process that tries to perform a pop on an empty stack to block, and (3) prevents stack overflow by causing a process that tries to perform a push on a full stack to block. You can use any IPC mechanism for this that we have studied in this class, be sure to state any assumptions and any initialization that is needed.

(c) When implementing a round robin scheduler, what are the advantages and disadvantages of choosing a long quantum time over a short one? Give a brief answer.
4. Answer these questions in the blue book

(a) In a swapping memory manager, where each process in memory must be in one contiguous block, briefly explain why the Best-Fit method for determining the placement of a process being swapped in from disk will often perform more poorly than the First-Fit method.

(b) Suppose you have a 16-bit computer (i.e. addresses are 16 bits) that supports virtual memory, where the page size is 8KB. Suppose also that a process is running, for which the page table looks like:

```
1 ... 7
0 ... 1
1 ... 4
1 ... 1
0 ... 2
0 ... 3
0 ... 0
1 ... 3
```

where the leftmost column is the present/absent bit, the rightmost column is the page frame number, and the first entry of the table appears in the top row of the drawing. Furthermore, suppose the TLB looks like:

```
1 ... 3 1
0 ... 2 5
1 ... 7 3
```

where the leftmost column is the valid bit, and the rightmost two columns (from left to right) are the page number and the page frame number.

i. If the running process issues the virtual address 7A18 (expressed here in hex), what is the corresponding physical address (in hex) generated by the MMU? Consider the individual bits carefully and show your work.

ii. In the translation process for the above virtual address, was there a TLB miss? Explain.

iii. In the translation process for the above virtual address, was there a page fault? Explain.

iv. Give a virtual address for which there would be both a TLB miss and a page fault. Explain.

v. Give a virtual address for which there would be a TLB miss, but not a page fault, and show the corresponding physical address. Explain.

(c) How does the OS become involved when a page fault occurs and what does it do to handle the page fault?