

問答題，總共 100 分：

1. (8 分) The computer designer must decide how to handle arithmetic flow. However, programs will cause an exception or interrupt during execution. An exception or interrupt is essentially an unpredictable procedure call. When it occurs, computers must deal with it step by step.
 - a. (5 分) Give the steps to handle an exception or interrupt.
 - b. (3 分) In MIPS, we can use a special instruction *mfc0* to handle interrupt. Give the purpose of *mfc0*.
2. (8 分) Registers are primitive memory in hardware design that is also critical to the programmers when the computer is completed. Their importance can be revealed by “Smaller is faster”, which is a well-known design principle that means a small number of registers can be helpful to make performance of a program faster.
 - a. (4 分) Explain why a small number of registers in a computer will have better performance when executing programs.
 - b. (4 分) But for a compiler, in general, it can generate high-performance code easily for a program if the target computer has a larger number of registers.
3. (8 分) A system that has k -bit address with S bytes of cache memory stores data in B -bytes lines, where $B=2^b$. The cache memory is an A -way set associative cache. Please estimate the number of bits needed to implement the cache in terms of k , S , B , b , and A . (Each cache row entry has 1-bit valid bit, tag bits, and data blocks.)
4. (8 分) Finite State Machine (FSM) can be divided into two types, Moore machine and Mealy machine. Please use an example to demonstrate that which machine would have glitches or spikes at the output.
5. (8 分) Design a hardware block to multiply a 2-bit unsigned number and a 2-bit signed (represented in 2's complement) number.
 - a. (4 分) How many bits are required for the full-precision output (also represented in 2's complement)?
 - b. (4 分) Draw the block diagram of the hardware block using primitive logic elements such as AND, OR, multiplexor, or full adder (if necessary).
6. (5 分) An automotive event data recorder (EDR) can record a 4-hour high-definition (HD) video with a fully-charged 1700mAh Li-polymer battery @ 3.7V. A design team is requested to double the battery use time (i.e. for 8-hour HD video recording) by reducing the power dissipation of the SoC, which encodes HD video @ 1.3W. What is the target power dissipation of the new SoC? (Hint: Please calculate the power dissipation of the whole EDR first.)

7. (5 分) MIPS has three basic instruction formats. What instruction formats do the following five MIPS addressing modes use, respectively? (a) register addressing, (b) immediate addressing, (c) base addressing, (d) PC-relative addressing, and (e) pseudo-direct addressing.
8. (9 分) Please explain if each of the following questions is true or false.
 - a. (3 分) Kernel threads are absolutely better than user-level threads.
 - b. (3 分) The ideas of SSTF (shortest seek time first) for disk scheduling problems and SJF (shortest job first) for process scheduling problems are similar; both are greedy. SJF is an optimal algorithm, so is SSTF.
 - c. (3 分) The working set of a process can be changed in response to actions by other processes.
9. (5 分) If a system neither ensures that a deadlock will never occur nor provides a mechanism for deadlock detection and recovery, then the system will stop functioning and will need to be restarted manually. Please briefly discuss why most operating systems for average users, such as PC, do not adopt deadlock handling mechanisms?
10. (6 分) Please discuss the situations under which the least frequently used page-replacement algorithm generates fewer page faults than the most frequently used page-replacement algorithm. Also discuss under what circumstance does the opposite holds.
11. (5 分) The open-file table is used to maintain information about files that are currently open. Should the operating system maintain a separate table for each user or just maintain one table that contains references to files that are being accessed by all users at the current time? If the same file is being accessed by two different programs or users, should there be separate entries in the open file table?
12. (10 分) What is memory protection and why is it important? Would you still need memory protection in an operating system which only allows one program to execute on top of the operating system at a time?
13. (15 分) Slab allocation is a memory management mechanism intended for the efficient memory allocation of kernel objects which displays the desirable property of eliminating fragmentation caused by allocations and deallocations. Explain slab allocation algorithm in detail.