

1. (image coding) (10%)
 - (a) What characteristic of the human eye does JPEG's baseline standard exploit? Explain.
 - (b) What kind of application is most suited to GIF image format? Explain.
2. (algorithm time complexity) (10%) An algorithm that does cn^2 units of work for any constant c is order of magnitude n^2 , denoted as $\Theta(n^2)$.
 - (a) An algorithm that is $\Theta(n)$ takes 10 seconds to execute on a particular computer when $n=1000$. How long would you expect it to take when $n=10000$?
 - (b) An algorithm that is $\Theta(n^2)$ takes 10 seconds to execute on a particular computer when $n=1000$. How long would you expect it to take when $n=10000$?
 - (c) An algorithm that is $\Theta(\lg n)$ takes 10 seconds to execute on a particular computer when $n=1000$. How long would you expect it to take when $n=10000$? (\lg is defined to be \log_2)
 - (d) An algorithm that is $\Theta(2^n)$ takes 10 seconds to execute on a particular computer when $n=1000$. How long would you expect it to take when $n=10000$?
3. (Operating systems) (10%)
 - (a) Explain an important use for the test-and-set instruction found in many machine languages. Why is it important for the entire test-and-set process to be implemented as a single instruction?
 - (b) Why a time-sharing normally allows another process to run while the first process is waiting for the services of a peripheral device?
4. (CPU and I/O) (10%)
 - (a) What is the maximum speedup for a CPU designed with a 3-stage pipeline technique compared to a CPU without the pipeline technique? Suppose the two CPUs are operated in the same clock rate and are of using similar circuit technology.
 - (b) How Direct Memory Access (DMA) technology can speedup the mass data transfer in a computer system?
5. (2's complement) (10%) Perform the subtraction $19-56$ using 2's complement arithmetic. That is, complete the following

19	19	00010011
<u>- 56</u>	<u>+ - 56</u>	<u>+ 10010</u>
- 37	-37	
6. (Network) (15%)
 - (a) What is the OSI reference model?
 - (b) How is a token-based protocol different to the CSMA/CD protocol?
 - (c) Do you think which transport layer protocol, TCP or UDP are suited for telnet and ftp applications in a network environment ? Explain.
7. (Floating point format) (15%) Assume we have a 16-bit floating point format as shown below:
 Format: representing number $(-1)^s 1.f \times 2^{e-127}$ in the following formats, where exponent is in excess-127 codes.

s (sign bit): 1 bit	e (exponent): 8 bits	f (fraction): 7 bits
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(a) What does the number (in decimal) correspond to the following bit string?

1100 0010 0101 1010

Convert the following decimal numbers into floating-point representation. Which of the following values cannot be represented accurately in the floating-point format if any?

(b) 9 (c) $1\frac{3}{10}$ (d) $\frac{17}{32}$ (e) $\frac{15}{16}$

8. (Data storage) (10%) What are the outputs generated by the following program? (setw is a manipulator that set output width; setfill('0') set leading filling with 0 if necessary.)

```
#include <iostream>
#include <iomanip>
using namespace std;

void main()
{
    for (int i=0; i < 16; i++) {
        cout.setf(ios::uppercase);
        cout << hex << setw(2) << setfill('0') << i << ' ';
        cout << dec << setw(2) << setfill('0') << i << ' ';
        cout << oct << setw(3) << setfill('0') << i << '\n';
    }
}
```

9. (binary search) (10%)

- (a) Write a recursive binary search function for searching an element in a sorted array in C++.
(b) Use the binary search algorithm to decide whether 35 is in the following array.

1, 2, 4, 8, 12, 15, 17, 20, 25, 31, 48

What numbers will be compared to 35?

- (c) What is the time complexity (in order notation) of the binary search algorithm for the search of an item in an n-element array?