Principles of Computer Science
Summer 2004

EXAM II - SOLUTION GUIDE

These solutions are intended as a guide and do not show the computation involved or provide explanations. You should work through the problems on your own and check your solutions with the ones provided here.
Part I  Multiple Choice

PROBLEM 1
Consider the following code fragment:

```java
int a[] = new int[100];
for( int index = 0; index < a.length; index++ )
{
    /* ???????? */
}
```

When placed inside the for-loop, which of the following statements will assign each element of the array twice the value of its index?

A. index = 2*index;
B. a[2*index] = index;
C. a[index] = 2*a[index];
D. a = 2*index;
E. a[index] = 2*index; ✓

PROBLEM 2
For which of the following applications is an array not suitable?

A. Storing the scores on seven midterm exams
B. Storing the name, social security number, age, and income of one individual ✓
C. Storing the temperature readings taken every hour throughout one day
D. Storing the total sales a store made in each of twelve months
E. Storing the letters of the alphabet

PROBLEM 3
A symmetric-key cryptosystem with 200 users would require approximately how many keys?

A. 200
B. 400
C. 2000
D. 4000
E. 40000 ✓
PROBLEM 4
An asymmetric-key cryptosystem with 2000 users would require how many keys?

A. 2000
B. 4000 ✓
C. 20000
D. 40000
E. 400000

PROBLEM 5
The RSA encryption algorithm also works in reverse – that is, you can encrypt a message with the private key and decrypt it using the public key. This property is used in __________.

A. intrusion detection systems
B. digital signatures ✓
C. digital challenges
D. certification
E. phrenology

PROBLEM 6
The process of encoding data so that it takes less storage space or transmission time is called __________.

A. serialization
B. encryption
C. compression ✓
D. enumeration
E. divination

PROBLEM 7
How many bytes are used in the ASCII character representation of the string PROTOPLASM?

A. 1
B. 8
C. 10 ✓
D. 40
E. 80
PROBLEM 8

Which of the following codes have the prefix property?

<table>
<thead>
<tr>
<th>Code I</th>
<th>Code II</th>
<th>Code III</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>011</td>
<td>01</td>
</tr>
<tr>
<td>11</td>
<td>110</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>0011</td>
<td>0001</td>
</tr>
<tr>
<td>011</td>
<td>1100</td>
<td>0010</td>
</tr>
<tr>
<td>010</td>
<td>1010</td>
<td>0100</td>
</tr>
</tbody>
</table>

A. code I ✓
B. code II
C. code III
D. codes I and II
E. codes II and III

PROBLEM 9

The binary representation of the value 28 is ________.

A. 010111
B. 101100
C. 011110
D. 011100 ✓
E. 111000

PROBLEM 10

What is the base 10 equivalent of the binary representation 001010101?

A. 8
B. 15
C. 85 ✓
D. 127
E. 170
PROBLEM 11
Which of the following is not a function of an operating system?

A. finding additional memory for program execution
B. handling input and output to and from attached hardware devices
C. sending error messages to applications or users
D. interpreting program instructions and performing computations
E. providing a secure computing environment

PROBLEM 12
What term is used to measure the data capacity of a communication channel?

A. broadband
B. bandwidth
C. protocol
D. latency
E. kilograms

PROBLEM 13
The physical arrangement or configuration of a computer network is called the ________ of the network.

A. domain
B. routing
C. protocol
D. topology
E. hierarchy

PROBLEM 14
Which of the following is not a valid IP address?

A. 152.4 233.17
B. 125.168.255.121
C. 152.168.265.9
D. 1.0.0.0
E. none of the above
PROBLEM 15
Packetization of messages

A. is an encryption method for maintaining network security
B. prevents a sender from monopolizing a shared communication link for an arbitrary amount of time ✓
C. is a method of data compression in computer networks
D. is necessary for establishing secure communication channels
E. guarantees the message is received in its entirety

PROBLEM 16
Which of the following tools is used to get a general layout of a computer network?

A. nmap
B. traceroute ✓
C. ping
D. smtp
E. nslookup

PROBLEM 17
Which of the following is used for user authentication and may employ scans of fingerprints, irises, or voices?

A. passwords
B. hieroglyphics
C. countersignatures
D. biometrics ✓
E. isomorphisms

PROBLEM 18
An organization that designs their information system to make its data available to those who are authorized to use it is protecting the __________ of the system.

A. confidentiality ✓
B. availability
C. authorization
D. integrity
E. feasibility
PROBLEM 19
The first program that a computer runs when it is powered up or rebooted called the

A. operating system
B. TCP/IP
C. kernel
D. bootstrap program  ✔
E. API

PROBLEM 20
When defining a Java method (subroutine), what is true about the return type?

A. the return type must be of type int
B. the value returned by the method must be the same type as the return type, or be of a
type that can be converted to the return type without loss of information  ✔
C. the return value can be any type, as it is automatically converted to the return type when the method
returns to the caller
D. the return type void allows a method to return a value without specifying a type
E. it is only necessary to specify a return type if the method returns a value to the caller
Part II  Computation

PROBLEM 1
A fully connected network topology is a network topology in which there is a direct link between all pairs of nodes. Given a fully connected network with \( n \) nodes, express the number of direct links as a function of \( n \). [4 points]

Solution: \( \frac{n(n - 1)}{2} \)

PROBLEM 2
If we encrypt a message using the public key \((5, 299)\) and know that the RSA algorithm was used in generating the keys, what private key can be used for decryption? [5 points]

Solution: \((53, 299)\)

PROBLEM 3
Determine the Huffman code for the string **STEREOTELEMETER** by building a Huffman coding tree. Your solution must show both the Huffman tree and the corresponding Huffman code. Label the nodes and edges of your tree. You do not have to encode the string. [6 points]

![Huffman tree and code]

<table>
<thead>
<tr>
<th>Huffman code</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
</tr>
<tr>
<td>T</td>
</tr>
<tr>
<td>R</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>O</td>
</tr>
<tr>
<td>S</td>
</tr>
</tbody>
</table>
**PROBLEM 4**

Consider the following code fragment:

```c
int A[] = { 3, 5, -1, 2, 5, 0, 6 };

int t;
int p = 0;
int q = A.length - 1;

while(p < q)
{
    t = A[p];
    A[q] = t;

    p = p+1;
    q = q-1;
}
```

Show the arrangement of elements in A after this code is executed by filling in the boxes below. [7 points]

```
6 0 5 2 -1 5 3
```

**PROBLEM 5**

Perform the following computations:

a. Add the **binary** numbers below and express their sum in **binary** representation. [2 points]

```
1 1 0 1 0 0 1 1
+ 0 0 0 1 1 0 1 1
-----------------
1 1 1 0 1 1 1 0
```

b. Add the **ternary** numbers below and express their sum in **ternary** representation. [3 points]

```
1 1 0 2 2
+ 2 0 1 2 1
---------
1 0 1 2 2 0
```

c. Convert the **base 5** representation **1111** to **base 10** representation. [3 points]

*Solution: 156*