IS2935 Introduction to Computer Security
Final Examination
Thursday, December 11, 2003

Name:

Email:

Total Time : 2:30 Hours
Total Score : 100

The questions have been grouped into four parts. These parts roughly correspond to the different sets of chapters as I had indicated in the class.

Part 1: (Total Score 20)
Part 2: (Total Score 20)
Part 3: (Total Score 30)
Part 4: (Total Score 30)

Note that scores for each question may be different – *so spend time accordingly on each question*. Be precise and clear in your answers.

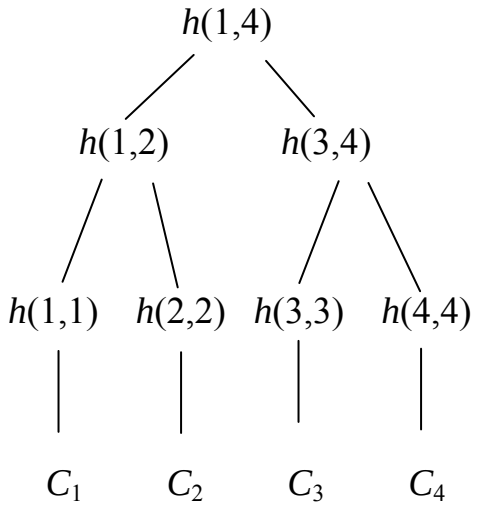
Score

Part 1 (20)	Part 2 (20)	Part 3 (30)	Part 4 (30)
Total =			

***Best of Lucks*!!**

Part I: Certificates, Authentication and Identity (Total Score 20)

1. Refer to the Merklee's tree shown below. [1, 3]
   a. Indicate the hash values that need to be *computed* (use *circles*) and that need to be *obtained* (use *rectangular* boxes) to validate C_3



   b. At the time C_3 is being evaluated, suppose that C_1 gets corrupted. How does it affect the validation of C_3? Assume that the hash values are all available in the same file, but the certificates are not. Provide enough arguments to substantiate your point.

2. Recall that *X*<<*Y*>> represents *Y*'s certificate signed by *X*. Consider the following certificates and answer (a) and (b) below. [2, 2]
   - *Dan*<<*Alice*>>
   - *Cathy*<<*Bob*>
   - *Dan*<<*Cathy*>>
   - *Cathy*<<*Dan*>>

   (a) Show steps (or just write the *signature chain*) that Alice takes to validate Bob's certificate:

(b) Show steps (or just write the *signature chain*) that Bob takes to validate Alice's certificate:

3. What is a *dictionary* attack? Briefly describe the two types of *dictionary* attacks. [4]

4. Provide argument(s) *for* or *against* the following statement: [2]
"*Use of salt increases the effort needed to launch a dictionary attack on passwords.*"

5. For the *S/Key* scheme for password authentication, write the following: [2, 2].
   a. If *h* is the hash function used,
      (i) the *n* keys, k_1, k_2, .., k_n are generated as follows:

      _____

      (*ii*) the keys are used in the following sequence:

      _____

   b. Assuming that *h* cannot be inverted, the attacker cannot determine the next password the user will use because of the following reason:

6. Identify two *biometric* authentication systems and give examples of attacks on them. [2]
(*Provide answer on the back of the adjacent page*)

Part II: Design Principles, Assurance (Total Score 20)

1. Write what the following *design principles* mean. [6]

   Fail-safe defaults

   Economy of mechanisms

   Psychological acceptability

2. What do you mean by *operational assurance*? State its importance. [2]

3. What are the three required properties of a *reference validation mechanism*? [2]

4. Five two characteristic of each of the following models of software development: [4]

   a. *Extreme programming*

b. *System assembly from reusable components*

5. Briefly write about two ways checking that *design meets requirements* specified for a system. [2]

6. Indicate *true* or *false* for the following. [4]
   a. The following are desirable implementation considerations for *operational* assurance:
      i. Modularity [ ] True [ ] False

      ii. Low level language for implementation [ ] True [ ] False

   b. One weakness of *TCSEC* is that it is based heavily on *integrity* requirements and ignores *availability*.
      [ ] True [ ] False

   c. *Common Criteria* has a component that addresses country specific security evaluation needs of some nations.
      [ ] True [ ] False

Part III: Network Security, Auditing, Risk Management, Legal/Ethical Issues (Total Score 30)

1. What are the functions of the following components of the *Secure Socket Layer* protocol? [1, 1]

    d. SSL Record Protocol

    e. SSL Handshake protocol

2. Provide argument(s) *for* or *against* the following statement: [2]
   "*IPSec is strictly independent and strictly an end-to-end protocol between two application level entities*"

3. Differentiate between the following [2, 2]

    a. The two IPSec protocols.

    b. The two IPSec modes

4. State what you understand by the following: [2]

   a. *Security Association Bundle*

   b. *Demilitarized zone* (DMZ)

5. Name *four* goals of auditing. [2]

6. Recall that we use constraint p_i: *action* $\Rightarrow$ *condition*. Show these constraints and identify what should be logged for a system employing the following Biba's integrity model. Do you strictly need to log subject (S) and object (O)? [4]

   Biba's Model: *Strict Integrity Policy*

   - s **r** $o \Leftrightarrow i(s) \leq i(o)$ (no read-down)
   - s **w** $o \Leftrightarrow i(o) \leq i(s)$ (no write-up)
   - $s1$ **x** $s2 \Leftrightarrow i(s2) \leq i(s1)$

7. Let U be a set of user, P be a policy that defines a set of information $C(U)$ that U cannot see. What do you mean by the following? [2]

   P is such that "$C(U)$ can't leave site"

8. One way to *sanitize* information is to replace each piece of information with random pseudonyms. What would be a problem with that? [2]

9. Enumerate the key *Risk Assessment* steps [3]

10. For the risks and the security mechanism indicated below, calculate and insert the values as per the given data: [4]
    - Risks:
        - disclosure of company confidential information,
        - computation based on incorrect data
    - Cost to correct data: $3,000,000
        - @20% liklihood per year: _____
        - Effectiveness of access control software: 60%: -$60,000
        - Cost of access control software: +$45,000
        - Expected annual costs due to loss and controls: _____
        - Savings: _____

11. Answer *only one* of the following: [3]

    a. Differentiate between spatial domain and frequency domain watermarking.
    b. Write differences among *copyright*, *patent* and *trade secret*.
    c. Briefly explain two tools that are useful for forensic analysis of Computer intrusions.

Part IV: Malicious code, Vulnerability, Intrusion Detection, Physical Security & Disaster Recovery (30)

1. Define the following terms [2]

   Polymorphic virus:

   Worm:

2. Recall the following example of a Trojan horse [3]

   - *Perpetrator*

     1. cat >/homes/victim1/ls <<eof
     2. cp /bin/sh /tmp/.xxsh
     3. chmod u+s,o+x /tmp/.xxsh
     4. rm ./ls
     5. ls $*
     6. eof

     That is, the perpetrator creates a file called ls in *Victim1*'s home directory

   - *Victim1*
     ls

     That is, when *Victim1* executes the file ls, he will be running a Trojan horse created by the *Perpetrator.*

   Suppose *Perpetrator* wants to make sure that once *Victim1* executes the Trojan horse ls, it propagates to *Victim2*. How may he change the above script to achieve it? You can write *pseudo code* and indicate where the additional code needs to be inserted in the script above.

3. Recall the simple virus code: [3]

```
1. BeginVirus
2.     If spread condition then
2.         For target files
3.             if not infected then
                   alter to include virus (lines 1-6)
4.     Perform malicious action
5.     Goto to beginning of the infected program
6. EndVirus
```

   Modify the *pseudo-code* to make it a *stealth* virus.
   (*Provide your answer on the back of the adjacent page*)

4. What are the steps involved in the *Flaw Hypothesis* methodology. [3]

5. Recall the problem that we discussed in the class regarding the problem with *xterm* program. As a solution to the problem, the following check is done when *xterm* writes to the log_file – i.e., the process checks if the user running the *xterm* program can access the log_file; if yes, then the log_file is opened for writing. [1, 2]

```
if (access("log_file", W_OK) == 0)
        fd = open("log_file", O_WRONLY|O_APPEND)
```

   a. State what is the cause of the problem with *xterm* that we are referring to.

   b. Briefly describe why the above check still makes *xterm* vulnerable to "race condition".

6. *NRL taxonomy* of software vulnerability includes three schemes. These are: [2]

   a. _____

b. _____

c. _____

7. Differentiate between Aslam's *Coding faults* and *Emergent faults*. [2]

   Coding faults

   Emergent faults

8. Write three practical goals of an Intrusion Detection System. [2]

9. What are the two types of *intrusion detection* systems? Differentiate between them by writing their characteristics. [4]

10. What is the TEMPEST program? Name two ways of protecting against emanations. [2]

11. Identify two natural disasters and state how one may protect information system resources against them. [2]

12. Enumerate two key elements that a security plan should address and state what they mean. [2]