

April, 2007

**Software Design and Development Engineer Examination
(Afternoon, Part 1)**

Questions must be answered in accordance with the following:

Question Nos.	Q1 – Q6
Question Selection	All questions are compulsory
Examination Time	13:30 - 15:30 (120 minutes)

Instructions:

1. Use a pencil. If you need to change an answer, erase your previous answer completely and neatly. Wipe away any eraser debris.
2. Mark your examinee information and test answers in accordance with the instructions below. Your test will not be graded if you do not mark properly. Do not mark or write on the answer sheet outside of the prescribed places.
 - (1) **Examinee Number**
Write your examinee number in the space provided, and mark the appropriate space below each digit.
 - (2) **Date of Birth**
Write your date of birth (in numbers) exactly as it is printed on your examination admission card, and mark the appropriate space below each digit.
 - (3) **Answers**
Write each answer in the space specified for that question.
Write your answers clearly and neatly. Answers that are difficult to read will receive a lower score.

**Do not open the exam booklet until instructed to do so.
Inquiries about the exam questions will not be answered.**

Company names and product names appearing in the test questions are trademarks or registered trademarks of their respective companies. Note that the ® and ™ symbols are not used within.

Q1. Read the following description of Internet IP addresses and connection of an in-house network to the Internet, and then answer Subquestions 1 through 3.

The increase in the number of persons using the Internet has resulted in a shortage of IP addresses. Therefore, in place of the fixed system which limited the length of the network portion to a multiple of **A**, classless inter-domain routing (CIDR) which allows the length of the network portion to be set in **B** units has been introduced, and small numbers of addresses are distributed to households and small and medium-sized enterprises.

When the number of terminals is greater than the number of distributed IP addresses, network address translation (NAT) is generally used. NAT assigns **C** IP addresses to the terminals, and establishes a correspondence between multiple terminals and a single **D** IP address using a router or other device. When NAT is used, terminals can access servers on the Internet, but communication from other terminals on the Internet to a terminal using NAT is not possible unless individually set by a router. This makes end-to-end applications, such as IP telephone service, difficult to use, so widespread adoption of the next generation protocol **E** is hoped for.

Company A has been assigned the IP address 233.x.255.0/29 from its Internet service provider (ISP). In addition, Company A's network configuration uses a firewall as shown in Figure 1, with the mail server, DNS server and Web server located on an open network, and 50 client terminals located on a local network. Internet is accessed from the client terminals only for the purpose of accessing Web contents.

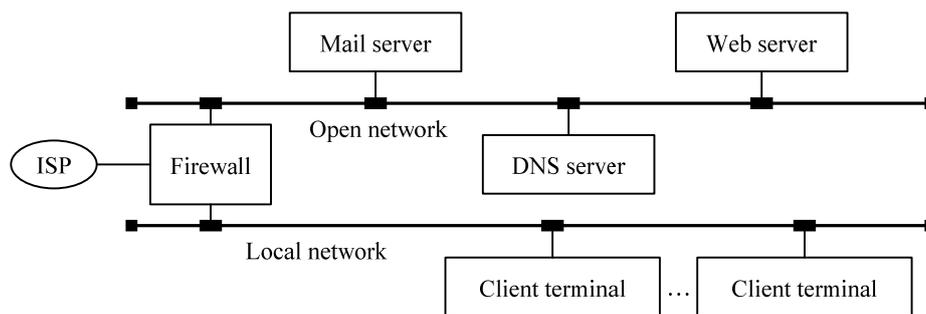


Fig. 1 Company A's Network Configuration

The IP address assignments in Fig. 1 are as follows.

- (i) The IP address of the open network is 192.168.0.0/24.
- (ii) The IP address of the local network is 192.168.10.0/24.
- (iii) The IP address of each firewall interface is as follows.
 - ISP side interface: 233.x.255.1
 - Open network side interface: 192.168.0.1
 - Local network side interface: 192.168.10.1
- (iv) The IP address of each server on the open network and each client terminal on the local network are as follows.
 - Mail server: 192.168.0.2
 - DNS server: 192.168.0.3
 - Web server: 192.168.0.4
 - Client terminals: 192.168.10.129 to 192.168.10.178

Subquestion 1

From the answer group below, select the correct answers to be inserted in blanks

through in the above text.

Answer group:

- a) 1 bit
- b) 4 bits
- c) 8 bits
- d) global
- e) internal
- f) IPv4
- g) IPv6
- h) private

Subquestion 2

The firewall performs NAT-based address conversion to enable the servers on the open network and the client terminals on the local network to connect to the Internet. Give the correct addresses to be inserted in blanks and in "Company A's Address Conversion Table" below.

When multiple answers are possible, give the address with the lowest number.

Table 1 Company A's Address Conversion Table

Conversion subject	Conversion source address	Conversion destination address	Conversion type
Mail server	192.168.0.2	233.x.255.2	One-to-one
DNS server	192.168.0.3	<input type="text" value="F"/>	One-to-one
Web server	192.168.0.4	233.x.255.4	One-to-one
Client terminal	<input type="text" value="G"/> /26	233.x.255.6	Many-to-one

Subquestion 3

Company A further installed a proxy server (cache server) as shown in Figure 2 in order to increase the speed of repeat access to Web contents on the Internet. The Web browsers of the client terminals were set for the proxy server so that they access the Internet via the proxy server. Fig. 2 and Table 2 below show Company A's network configuration and address conversion table after this change. Give the correct addresses to be inserted in blanks and in Table 2.

When multiple answers are possible, give the address with the lowest number. Note that blanks and contain the same addresses as inserted in Table 1.

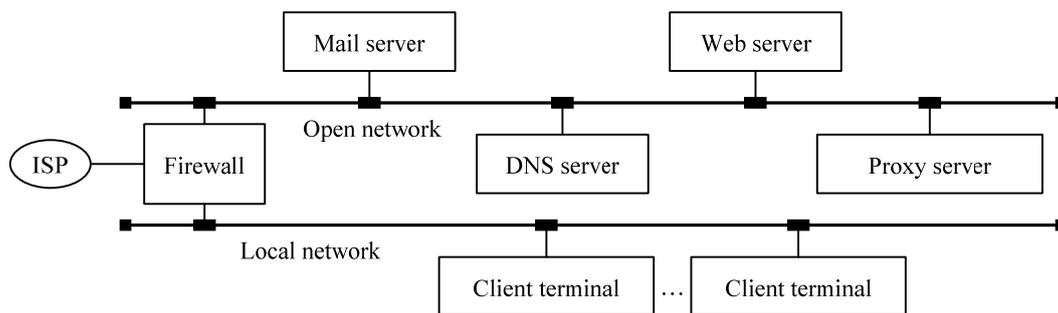


Fig. 2 Company A's Network Configuration After the Change

Table 2 Company A's Address Conversion Table After the Change

Conversion subject	Conversion source address	Conversion destination address	Conversion type
Mail server	192.168.0.2	233.x.255.2	One-to-one
DNS server	192.168.0.3	<input type="text" value="F"/>	One-to-one
Web server	192.168.0.4	233.x.255.4	One-to-one
Proxy server	192.168.0.5	<input type="text" value="H"/>	One-to-one
Client terminal	<input type="text" value="G"/> /26	<input type="text" value="I"/>	Many-to-one

Q2. Read the following description of a state chart, and then answer Subquestions 1 and 2.

When a cellular phone (hereinafter, "terminal") is turned on, it searches for the nearest base station. When the terminal finds a base station, it registers its ID code with that base station (hereinafter, "position registration") and waits for incoming calls (hereinafter, "idle state").

The channels used by base stations and terminals are the Broadcast Control Channel (BCCH), which are used to broadcast to all terminals that have registered its position, and the Traffic Channel (TCH) which are used only by that terminal during a call. In the idle state, the terminal monitors the BCCH and receives instructions from the base station.

The terminal can activate the voice-mail setting and also the call-blocking setting that uses the caller's phone number as the key.

[Terminal State Transitions]

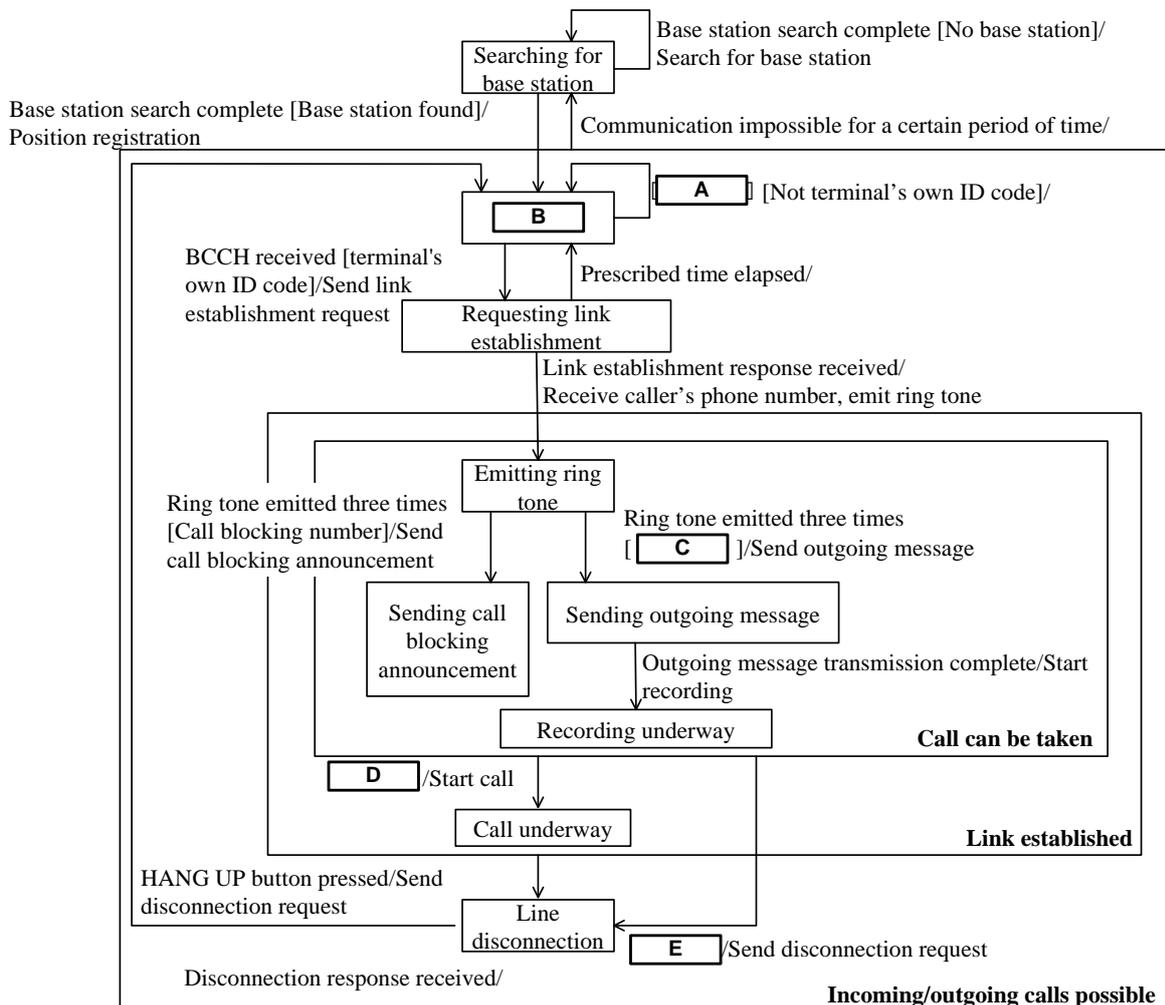
- When a call is received at the base station for a terminal that has registered its position with the base, the base station transmits the ID code of the terminal at fixed intervals over the BCCH. The terminal constantly monitors this channel and if its own ID code is called, recognizes this as an incoming call. It maintains the idle state if its own ID code is not called.
- When the terminal recognizes an incoming call, it sends a Link Establishment Request to the base station. If a Link Establishment Response is received from the base station within the prescribed time after the request was sent, a link is established. If Link Establishment Response is not received within the prescribed time, the terminal repeats the Link Establishment Request until it no longer detects its own ID code being called on the BCCH.
- When a link is established, the base station assigns a TCH for the call to the terminal, and notifies it of the caller's phone number. The terminal emits the ring tone.
- When the voice-mail setting is activated, the terminal emits the ring tone for three times, sends the outgoing message to the caller, and then records the caller's voice for 15 seconds.
- When the caller's phone number has been registered beforehand in the terminal's call-blocking list, the terminal emits the ring tone three times and then sends the call-blocking announcement to the caller.
- When the voice-mail and call-blocking processes (hereinafter, "auto response") are complete, the terminal sends a Release Order to the base station.
- Incoming calls can be accepted by pressing the CALL button while the terminal is emitting the ring tone. Also, transmission of the voice-mail outgoing message or

call-blocking announcement can be stopped and the call can be accepted like a normal call by pressing the CALL button during the auto response.

- After a link has been established, the terminal sends a Release Order when the HANG UP button is pressed or a hang up request is received from the base station.
- When the terminal receives a Disconnect response from the base station after sending a Release Order, it returns to the idle state.

In all cases, the terminal searches for the base station whenever communication from the base station has broken down for a certain period of time.

The following figure shows the terminal state chart (partial).



Legend: Arrows \longrightarrow indicate state transitions, and follow the pattern of "event [guard condition]/action." Note that the [guard condition] is not noted when there is no guard condition.

- xxx indicates a state. Here, XXX is the state name.
- indicates a super state which includes multiple states. Here, XXX is the super state name.

Fig. Terminal State Chart (Partial)

Subquestion 1

Fill in the blanks in the above figure with the correct word or words. Answer in 4 words or less for each blank.

Subquestion 2

One of the state transitions mentioned in **[Terminal State Transitions]** is missing from the state chart shown in the above figure, and the state may not change in response to a certain event.

- (1) Give the state names (including super state names) that correspond to the start point and end point of the missing state transition.
- (2) Give the combination of event, action and guard condition for the missing state transition. Use the same notation method as that in the state chart shown in the figure.

Q3. Read the following description of computer viruses, and then answer Subquestions 1 through 3.

Company X is a software development firm that has been infected by the network infection-type virus Y and the e-mail infection-type virus Z. The company Information Systems Department, which is in charge of security management, has prepared a profile overview of each virus, investigated possible causes of infection, and proposed countermeasures as follows.

[Virus Profiles]

- Network infection-type virus Y

Y infects by targeting on a [A] vulnerability in the OS, however, infection does not occur if the latest OS update information has been installed. When a personal computer (PC) becomes infected by Y, the virus searches for neighboring PCs based on the infected PC's IP address. If the neighboring PCs also have similar vulnerability in their OS, it infects them at once, thus spreading the infection.

Y replicates itself in the memory and commences infection activities. At the same time, Y creates a file to be used during PC startup so that the virus can re-activate itself using this file the next time the PC is started up.

If anti-virus software with a real-time search function, updated with the latest virus pattern file is installed, the files created by the virus can be detected and eliminated.

Y has [B] a function that sends large amounts of data to a specific server to create an excessive load, causing an extreme drop in the server's performance or even causing the server to stop at a certain time and date.

- E-mail infection-type virus Z

Z is a virus that infects when a file attached to an e-mail is executed. It has an eye-catching title, and the sender is often an acquaintance, so users inadvertently open the attached file and as a result, are infected.

Z is a relatively old type of virus, so it can be detected using the virus pattern file contained in the anti-virus software when it was initially installed.

Z has been made so that when a PC becomes infected, it sends e-mails with a replica of Z attached to all the addresses registered in the address book, one after another. Z also has [C] a function that allows login to infected PCs from a specific PC or server after infection.

[Investigation of Causes]

The causes of the current virus infection have been investigated and summarized as follows.

- D: A PC has been assigned to each employee, and it has been recommended that employees periodically change their passwords. However, many employees have not changed their passwords for a long time.
- E: The Information Systems Department has sent e-mails to all employees instructing that important OS updates should be installed immediately when released; however, the updates have not been installed in some PCs because of the time required for installation and concerns about operation following the installation.
- F: Anti-virus software has been installed and used by all employees. This software has a function that searches for viruses when data is written into a file, and this function can eliminate viruses when found. However, the heavy processing load has caused the performance of some PCs to drop, so this function has been removed from a number of PCs.
- G: The latest virus pattern file is now downloaded automatically from a server immediately after a PC is started up. Even though the LAN had sufficient capacity, poor server performance resulted in heavy access concentration immediately after the start of work; so many PCs have experienced timeouts and failed at downloading the latest pattern files.

[Proposed Countermeasures]

The Information Systems Department proposed the following countermeasures in consideration of the lessons learned from the current virus infection. However, it was pointed out that one of these countermeasures contains a potential problem, and was not implemented.

- (i) Increase the performance of the server that distributes the virus pattern file so that timeout does not occur and the file can be downloaded even during concentrated access.
- (ii) When an e-mail with a virus is detected, a separate e-mail warning that a suspicious e-mail has been received is sent back using the reply function.
- (iii) Make sure all employees understand that suspicious e-mails should not be read and attached files should not be opened, even if those e-mails are received from acquaintances.
- (iv) Establish a system to ensure that all employees are made aware of important OS updates as soon as it is released, and to confirm that such updates are promptly installed.
- (v) Promptly delete the login accounts and e-mail accounts of employees who have left the company.

Subquestion 1

From the answer group below, select the items which are described by the underlined portions [A] through [C] in the above text.

Answer group:

- | | |
|-----------------------------|-------------------|
| a) Back door | b) DDoS |
| c) DMZ (DeMilitarized Zone) | d) Influenza |
| e) Security hole | f) Security patch |
| g) SSL | h) TCP/IP |
| i) Trojan horse | j) Vaccine |
| k) Virus | l) Worm |

Subquestion 2

PCs corresponding to any cause **D** through **G** in the **[Investigation of Causes]** have a security problem or are highly vulnerable to virus threats. Problem descriptions (1) through (4) below correspond to aforementioned causes **D** through **G**. Select which causes **D** through **G** correspond to cases (1) through (4).

- (1) This is a security problem, but it is not related to the current Y and Z infections.
- (2) If the virus detection function operates when writing a file, Z can be detected when it replicates itself, but files created by Y cannot be detected.
- (3) Detection may not be possible even if a PC is infected by Y or Z and the virus creates files.
- (4) The PC may become infected by Y even if anti-virus software has been installed. The installation of the anti-virus software is unrelated to Z infection.

Subquestion 3

Select which of **[Proposed Countermeasures]** (i) through (v) poses a problem if implemented. Explain in 10 words or less.

Q4. Read the following description of estimating a development workload, and then answer Subquestions 1 through 4.

Company B is a software development firm that has traditionally used the number of lines of code to estimate the development workload for projects. However, there have been increasing deviations in staff members' workload estimates, so the company has decided to perform estimates using the function point method in order to provide an objective basis for estimating development workloads and reduce those deviations. Thus, the development workload for a library management system that Company B is currently planning to develop is to be estimated using the function point method. The figure below shows an overview of the library management system (hereinafter, "this system").

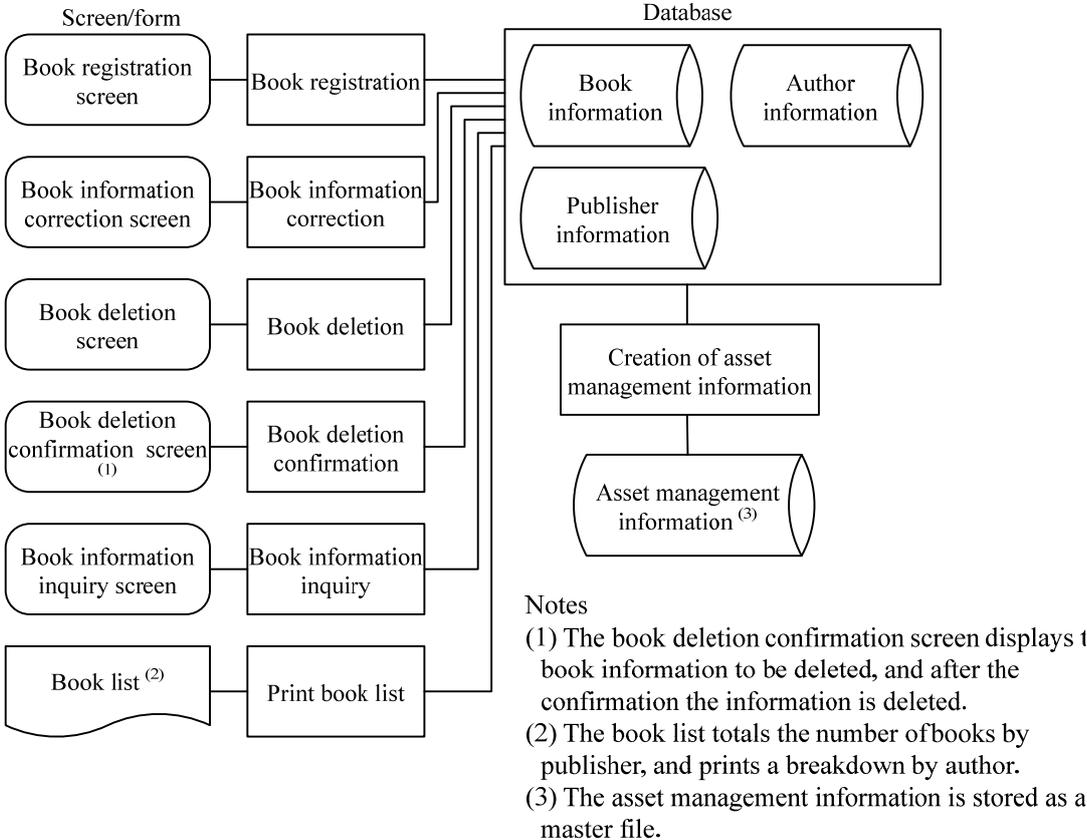


Fig. Overview of Library Management System

Table 1 below lists the function types needed to obtain the function points, and Table 2 through Table 4 show the complexity criteria for each function type. Note that the publisher and author information registration and correction functions and some of the form creation functions are omitted in the above figure. These functions do not need to be taken into account when obtaining the function points in the subquestions.

Table 1 List of Function Types

Symbol	Function type	Description
E1	External input	Process for data imported from outside the application. This updates one or more ILFs.
EO	External output	Process for exporting data outside the application. This provides information to the user through process logic other than data extraction.
EQ	External inquiry	Process for exporting data outside the application. This extracts and provides data to the user. The process logic does not include calculations or the derivation of new data elements.
ILF	Internal logic file	Logically coherent data set. This holds data that is created and updated through one or more processes.
EIF	External interface file	Logically coherent data set. This is data held by one or more processes within a different application, and this application only marks references.

**Table 2 Data Function Complexity Criteria
(Function types: ILF, EIF)**

Number of data items \ Number of record types	Number of data items		
	1-19	20-50	51 or more
1	Low	Low	Medium
2-5	Low	Medium	High
6 or more	Medium	High	High

**Table 3 Transaction Function Complexity Criteria
(Function type: EI)**

Number of data items \ Number of record types	Number of data items		
	1-4	5-15	16 or more
0, 1	Low	Low	Medium
2	Low	Medium	High
3 or more	Medium	High	High

**Table 4 Transaction Function Complexity Criteria
(Function types: EO, EQ)**

Number of data items \ Number of record types	Number of data items		
	1-5	6-19	20 or more
0, 1	Low	Low	Medium
2, 3	Low	Medium	High
4 or more	Medium	High	High

Subquestion 1

The data functions of this system are organized in Table 5 below. Select the correct answers to be inserted in blanks and in the table. Here, use one of the symbols in Table 1 for .

Table 5 List of Data Functions

Function name	Function type	Number of record types	Number of data items	Complexity
Book information	ILF	1	60	<input type="text" value="A"/>
Publisher information	ILF	1	25	Low
Author information	ILF	1	55	Medium
Asset management information	<input type="text" value="B"/>	1	15	Low

Subquestion 2

The transaction functions related to book information in this system are organized in Table 6 below. Give the correct answers to be inserted in blanks , , , and in the table. Here, use the symbols in Table 1 for and .

Table 6 List of Transaction Functions

Function name	Function type	Related files	Number of data items	Complexity
Book registration	EI	Book information Publisher information Author information	15	High
Correct book information	<input type="text" value="C"/>	Book information Publisher information Author information	22	High
Book deletion	EI	Book information	6	<input type="text" value="D"/>
Confirm book deletion	EO	Book information	10	Low
Book information inquiry	EQ	Book information Publisher information Author information	20	<input type="text" value="E"/>
Print book list	<input type="text" value="F"/>	Book information Publisher information Author information	35	High

Subquestion 3

Unadjusted function points for this system are calculated based on Table 7 below. Give the correct numbers to be inserted in blanks G through K in the table. Here, calculate K by filling in the appropriate numbers in the underlined blanks in the table.

Table 7 Unadjusted Function Point Calculation Table

Complexity Function type	Low complexity items	Medium complexity items	High complexity items	Total
External input	<u>G</u> × 3 +	<u>H</u> × 4 +	<u>I</u> × 6	<u>J</u>
External output	<u> </u> × 4 +	<u> </u> × 5 +	<u> </u> × 7	<u> </u>
External inquiry	<u> </u> × 3 +	<u> </u> × 4 +	<u> </u> × 6	<u> </u>
Internal logic file	<u> </u> × 7 +	<u> </u> × 10 +	<u> </u> × 15	<u> </u>
External interface file	<u> </u> × 5 +	<u> </u> × 7 +	<u> </u> × 10	<u> </u>
Unadjusted function points				<u>K</u>

Subquestion 4

Assuming that the total degree of influence on the system is 18, obtain the function points for this system based on Table 8 below. Round off the first decimal place to obtain an integer answer. Use the value calculated in Table 7 for K.

Table 8 Function Point Calculation Method

Calculation item	Calculation method
Unadjusted function points	Refer to Table 7
Adjustment coefficient	$0.01 \times \text{total degree of influence}^{(1)} + 0.65$
Function points	<u>K</u> × adjustment coefficient

Note ⁽¹⁾

Total degree of influence: The value obtained by evaluating each of 14 general system characteristics from 0 (no influence) through 5 (strong influence), such as data communication, distributed processing, and performance, is called the “degree of influence of the respective characteristic”. The total of these values is called the “total degree of influence”.

Q5. Read the following description of lists, and then answer Subquestions 1 through 3.

A list refers to a finite number (0 or more) of elements of a certain type arranged in a certain order. Lists are used in many fields such as information retrieval, domain management, and programming language processing. Here, a list is represented by arranging the elements in parentheses, separated by commas from the first element. For example, the list of prime numbers that are 10 or less is represented as (2, 3, 5, 7). In addition, the number of elements is called the list length, and a list with a length of 0 is called a null list. Operations performed on lists are defined as shown in Table 1 below.

Table 1 Definitions of List Operations

Operation	Definition
Init ()	Sets the list length to 0.
Insert (x, p)	Inserts the element x into p th position of the list.
Delete (p)	Deletes the element in p th position from the list.
Retrieve (p)	Returns the element in p th position of the list.
Length ()	Returns the list length.

Note: An appropriate position is assumed to be designated for the operation position.

Subquestion 1

The operations in order of numbers (i) through (vi), shown in Table 2 are performed on the list. Give the list contents and the list length after these operations are performed.

Table 2 List Operations

Number	Operation
(i)	Init ()
(ii)	Insert (10, 1)
(iii)	Insert (20, 2)
(iv)	Insert (30, 1)
(v)	Insert (40, Length())
(vi)	Delete (1)

Subquestion 2

A Purge operation that deletes all elements equal to the designated value x from the list has been created as shown in Figure 1, but there are cases where it may not be possible to delete all the target values.

From the answer group below, select the element arrangement of the list that corresponds to such case.

```
function Purge(x)
    Set i to 1
    while (i is Length() or less)
        if (Retrieve(i) is equal to x)
            Delete(i)
        endif
        Add 1 to i
    endwhile
endfunction
```

Fig. 1 Purge Algorithm

Answer group:

- a) When the elements to be deleted are located alternately.
- b) When the elements to be deleted are located at the end of the list.
- c) When the elements to be deleted are located at the start of the list.
- d) When the elements to be deleted are located consecutively.

Subquestion 3

In order to determine the memory size required to implement a list, the following method was considered :

A list is implemented using array *A* that consists of two (2) variable entries, variable *data* which holds the list element, and variable *next* which holds the array index (subscript), as shown in Figure 2.

The variables in the k^{th} array entry are represented as $A[k].data$ and $A[k].next$, respectively. The *next* value indicates the index of the entry that holds the next element in the list, and when this value is 0, it indicates that the list ends with the current entry.

In addition, $A[0].next$ represents the index of the entry that contains the first element of the list. When $A[0].next$ is 0, this indicates that there are no list elements.

$A[0].data$ is not used. *MAXENTRY* in Fig. 2 is the maximum value for the number of elements that can be handled by this array.

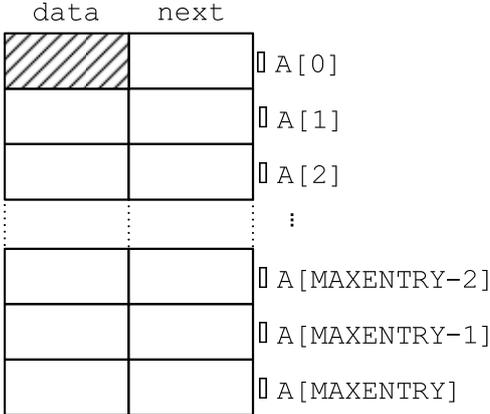


Fig. 2 Implementation of a List Using an Array

The two variables shown in Table 3 are defined to manage the list and unused entries.

Table 3 Definition of Variables

Variable	Definition
<i>len</i>	Current list length
<i>avail_head</i>	Index of the first entry when unused entries are arranged. When 0, this indicates that there are no unused entries.

Unused entries in array *A* are also arranged and managed using *next*. In this case, the variable *avail_head* in Table 3 indicates the start of the unused entry arrangement. For example, Figure 3 shows the case where array *A* has a *MAXENTRY* of 5 and holds the list (13, 20, 18).

len	3		data	next	
avail_head	5		/ / / / /	2	A[0]
			18	0	A[1]
			13	4	A[2]
				0	A[3]
			20	1	A[4]
				3	A[5]

Fig. 3 Example of List Management

Answer the following questions (1) and (2).

Note that MAXENTRY is assumed to be sufficiently large, and elements do not overflow from the array.

- (1) Figure 4 shows the algorithm for the `Init` operation defined in Table 1. This operation places all entries in the unused entry arrangement. Select the correct character strings to be inserted in blanks and in Fig. 4.
- (2) Figure 5 shows the algorithms for the `Insert` operation defined in Table 1 and the `find_prev` function that is used within `Insert`. Select the correct character strings to be inserted in blanks through in Fig. 5.

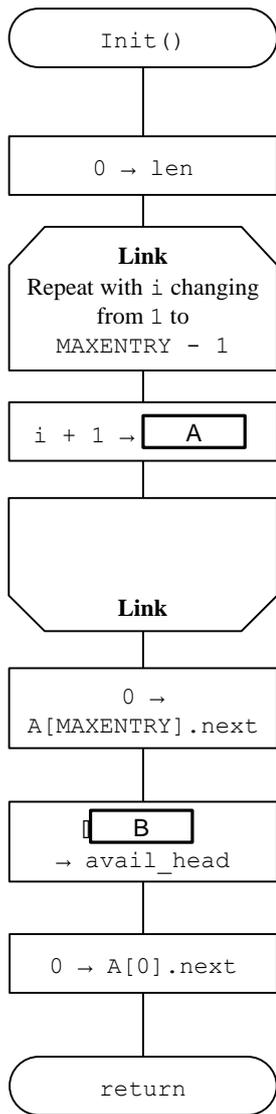


Fig. 4 Init Algorithm

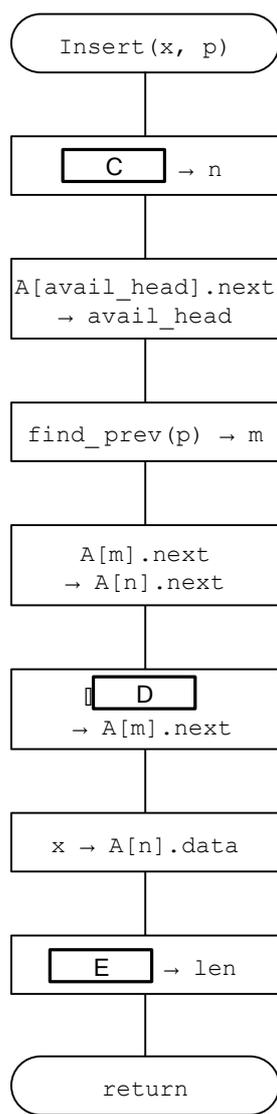
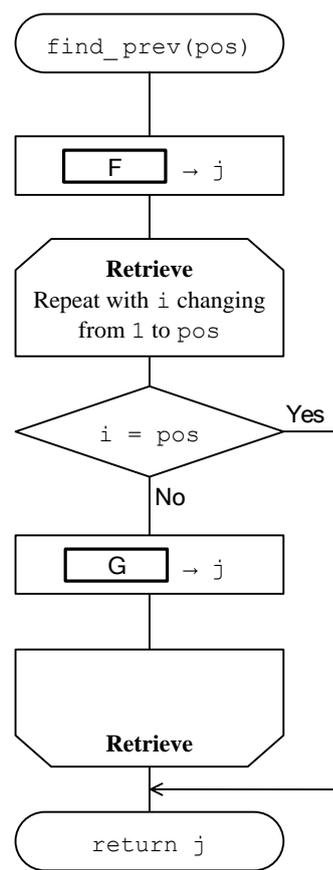


Fig. 5 Insert and find_prev Algorithms



Q6. Read the following description of a health checkup results management system, and then answer Subquestions 1 through 5.

Company E conducts periodic health checkups (hereinafter, "checkups") to oversee the health of its employees, and has decided to introduce a system (hereinafter, "this system") to manage the checkup results. The results to be managed are those of regular, follow-up, and detailed checkups, which are performed according to the schedule shown in the table below.

Table Checkup Schedule at Company E

Checkup	Month performed
Regular checkup	May
Detailed checkup after regular checkup	June
Follow-up checkup	November
Detailed checkup after follow-up checkup	December

Checkups comprise of multiple examination items, and the examination items vary or each checkup and each employee.

The examination items have a normal upper limit value, normal lower limit value, follow-up upper limit value, and follow-up lower limit value. Each examination item is assessed as normal, "follow-up required," or "detailed checkup required," as follows, based on the examination results value.

(1) Normal

Normal lower limit value \leq Examination results value \leq Normal upper limit value

(2) "Follow-up required"

Follow-up lower limit value \leq Examination results value $<$ Normal lower limit value

-or-

Normal upper limit value $<$ Examination results value \leq Follow-up upper limit value

(3) "Detailed checkup required"

Examination results value $<$ Follow-up lower limit value

-or-

Follow-up upper limit value $<$ Examination results value

An overall checkup evaluation is made for each employee based on the individual examination item assessments. When all of the examination items comprising the checkup are assessed as normal, the employee's health is evaluated as normal. When the assessment of an examination item is "follow-up required" and no other items are assessed as "detailed checkup required", the employee's health is evaluated as "follow-up required." When the assessment of an examination item is "detailed checkup required", the employee's health is evaluated as "detailed checkup required."

Company E's health management staff instructs employees evaluated as requiring follow-up checkups on how to return to normal, and sees to it that those employees undergo the follow-up checkups six months later. The staff also sees to it that employees evaluated as requiring detailed checkups as a result of a regular or a follow-up checkup undergo their detailed checkups.

This system outputs the following forms.

(1) Checkup results form given to each employee, with the following content:

(i) Items printed in the header

- Employee code
- Employee name
- Current checkup date and designation
- Last 2 checkup dates and designation

(ii) Items printed in the detailed portion

The following information is provided for each examination item in the current and the two previous checkups.

- Examination item designation
- Examination results value
- Assessment (normal, "follow-up required," "detailed checkup required")

(2) A checkup results form distributed to health management personnel, with the following content:

(i) Items printed in the header

- Fiscal year
- Checkup designation
- Form type (follow-up checkup employee list or detailed checkup employee list)

(ii) Items printed in the detailed portion

The following information is provided for each employee in ascending order of employee codes and examination item codes.

- Employee code
- Employee name
- Date of birth
- Designations and examination results values of examination items assessed as other than normal

Subquestion 1

Answer questions (1) and (2) below concerning the E-R diagram for this system.

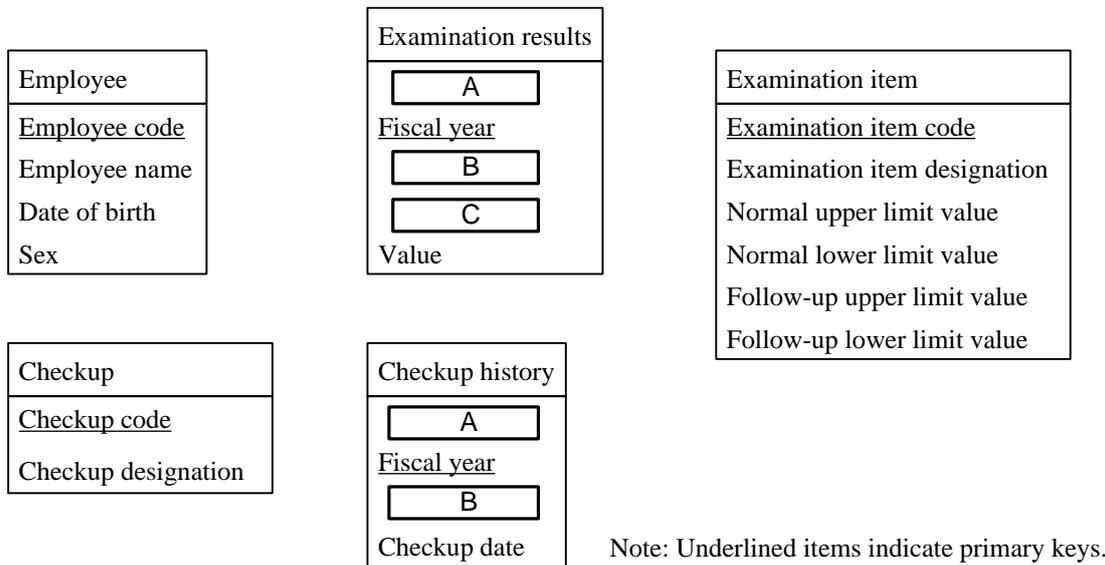
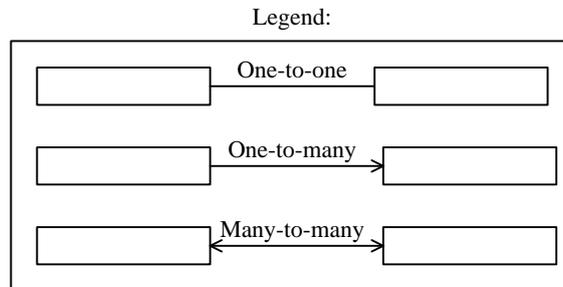


Fig. E-R Diagram

- Give the correct attribute names to be inserted in the blanks in the above figure. If these attributes are primary keys, indicate this by underlining them.
- Indicate the relationship between each entity in the E-R diagram as shown in the legend below.



Subquestion 2

The SQL statement shown below obtains the details of the detailed checkup employee list for a designated checkup of a designated fiscal year, which are included in the checkup results form distributed to health management personnel. The fiscal year is stored in the host variable ":Fiscal year," and the checkup code is stored in ":Checkup code."

```

 Examination_results.█, Employee.Employee_name,
Employee.Date_of_birth, Examination_item.Examination_item_designation,
Examination_results.Value
 Employee, Examination_results, Examination_item
 Examination_results.█  Employee.█
 Examination_results.Fiscal_year  :Fiscal_year
 Examination_results.█  :Checkup_code
 Examination_results.█  Examination_item.█
 (  )
 Examination_results.█,
Examination_results.█
  
```

Here, the table definition is made using the appropriate data type with the entity names in the E-R diagram as the table names and the attribute names as the column names. In addition, the blacked-out locations █ are assumed to be filled with the appropriate attribute names shown in the E-R diagram.

- (1) Give the correct word or words to be inserted in blanks through in the above SQL statement.
- (2) Give the correct formula to be inserted in blank in the above SQL statement.

Subquestion 3

Information from previous checkups must be included in the checkup results forms that are given to employees. The cursor "current and previous checkups" is defined in order to obtain the required checkup information. This cursor obtains the information for the designated checkup in the designated fiscal year and for checkups undergone previously in ascending order of employee code and descending order of checkup dates. The fiscal year is stored in the host variable ":Fiscal_year," and the checkup code is stored in ":Checkup_code."

Give the correct word or words to be inserted in blanks through in the SQL statement below that defines this cursor.

Note that blanks through contain the same word or words as inserted in Subquestion 2.

```

DECLARE  
FOR 
 , Employee.Employee_name, .Fiscal_year,
 , Checkup.Checkup_designation, .Checkup_date
 Checkup, Checkup_history AS Checkup_history_1, Checkup_history AS Checkup_history_2, Employee
 Checkup_history_1.Fiscal_year = :Fiscal_year
 Checkup_history_1. = 
 Checkup_history_1. = .
 Checkup_history_1. >= .
 Checkup. = .
 Checkup_history_2. = Employee.
 .Employee_code,
.Checkup_date 

```

Subquestion 4

It has become necessary to apply different evaluation criteria depending on sex for “normal”, "follow-up required" and "detailed checkup required" assessments for certain examination items. How can this be handled without changing the current tables and columns? Answer in 10 words or less.

Subquestion 5

The process that prepares the checkup results forms that are given to each employee is very time-consuming when using the current table configuration, so decision was made to study whether an increase in procedural efficiency could be achieved through denormalization. Explain what columns should be added to which tables when the denormalization policies are as follows. A maximum of two rows may be added.

- (1) The examination results evaluation is made when the examination results are input, not when preparing the forms.
- (2) The examination item tables are not referenced when preparing the forms.