

New FE Exam Preparation Book

Vol. 1

Keywords &
Exam Questions



Preparation for

Fundamental

Information

Technology

Engineer

Examination

IPA

Information-technology Promotion Agency, Japan

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How to use this book

This book is compiled for those who try Fundamental Information Technology Engineer Examination, abbreviated as 'FE', covering all fields of the scope of the exam.

The book consists of two volumes. Volume 1 mainly contains the keywords and questions, and Volume 2 contains the answers and explanations to the questions given in Volume 1.

In Volume 1, the learning objectives for each section are shown in the section cover page. The level of importance, learning objectives, and keywords for the section are shown in the following pages, and then the pages of the questions follow for Morning Exam. For Afternoon Exam, learning objectives for each section are shown in the section cover page only, and the pages of the questions follow.

When you start studying for FE Exam, first you need to read the leading pages of each section, which includes the level of importance, learning objectives and keywords and obtain an overview of the section and whole FE Exam.

Chapter 1 Basic Theory

1.1 Discrete mathematics ★★★ ← (1)

[Learning Objectives] ← (2)

- Understand and apply numeric representation that is used in a computer such as radices, conversion of radices, as well as arithmetic operations and precisions.
- Understand and apply the fundamental laws and techniques of sets and logical operations.

□ Keywords ✎ ← (3)

- | | | |
|-----------------------|--------------------------------------|-----------------|
| □ Fixed point number | □ Floating point number | □ Radix |
| □ Fraction (Mantissa) | □ Exponent | □ Logical shift |
| □ Arithmetic shift | □ Cancellation of significant digits | |

▶ Q1-1 through Q1-12 ← (4)

(1) The levels of the importance are indicated as follows.

- ★★★: Extremely important, appears as a question extremely often. This must be thoroughly studied.
- ★★: Does not frequently appear in questions in the examination, but an awareness of it must be gained.

- (2) The learning objective gives a guide to the level of attainment and study time.
- (3) Check the ☐ of the keywords you understand. For those that you don't understand, use a textbook or reference work to learn about it. The keywords that are noted here were compiled in consideration of the Fundamental Information Technology Engineer Examination (Level 2) Syllabus released by the examination center.
- (4) This indicates which question the learning objective or keyword corresponds to.

Questions in learning areas with an importance of ★★ must be tackled. Areas that have few checks in the keyword boxes should be focused on for study.

After you have checked the keywords, try to answer the questions.

Q1-5 ☐☐☐ **Mandatory question** (5) ←

Which of the following is the absolute value of the negative value 10101110 represented in 2's complement? (6)

a) 01010000 b) 01010001 c) 01010010 d) 01010011

- (5) **Mandatory question** represents a question from the morning examination that should be answered even if sufficient study time cannot be set aside.
- (6) Practicing answering questions with the following method is effective.
 - a. On the right side of the question number, there are three checkboxes (☐☐☐). Use these to mark your level of confidence in answering the question. There are three check boxes, so you can check the question three times.
 - b. When you answer a multiple choice question, checking your level of confidence is extremely effective. Use the following marks to record your level of confidence (you can also check by using your own marks if they are easier for you to use).

<input type="checkbox"/>	Have confidence
<input checked="" type="checkbox"/>	Selected an answer by eliminating apparently incorrect answers, or selected one from the last two most likely answers
<input checked="" type="checkbox"/>	Have no confidence. Just picked up one answer.

- c. After you answer all questions, check the answers. The table below summarizes a learning method based on the confidence level check performed in b.


<input type="checkbox"/>	Correct answer	You thoroughly understand the question. But do not sit back and relax. Make sure again that you also understand the related questions.
	Incorrect answer	In spite of the confidence, your answer was incorrect. You should immediately correct your knowledge. Thoroughly studying and clarifying unclear points on the spot will help you never make a mistake again. It is certain that you will be able to improve your knowledge on this area.
<input checked="" type="checkbox"/>	Correct answer	It is important to look into the last two options that have been narrowed down. Gaining thorough knowledge will improve your ability significantly.
	Incorrect answer	
<input checked="" type="checkbox"/>	Correct answer	<p>Regardless of whether the answer was correct or incorrect, it is necessary to study this area entirely because you have little knowledge about it. There are following two ways of learning:</p> <ul style="list-style-type: none"> • First study throughout the corresponding field (chapter and subchapter levels), and then answers the question again. • Examine the options of the corresponding question one by one using materials and text books, and determine if they are correct or incorrect. As a result, this will also enable you to study whole of the corresponding field. Select whichever the suitable method for you.
	Incorrect answer	

The check method presented here is just a single example. You should make use of these checkboxes (☐☐☐) with the method that you think is most effective for yourself.

The relation between the source abbreviation and the test name is as below.

After confirming basic knowledge, you can move on to the Afternoon Exam questions. Since Afternoon Exam questions are testing your practical abilities, you should take time and study this part thoroughly.

For the expression rules, programming language specifications, and other necessary items for the questions, see the appendix at the back of this book.



Technology

Morning Exam

Section 1

Basic Theory

Learning Objectives

1. Be able to explain the data representations in a computer.
2. Calculate logical operations.
3. Be able to explain the characteristics of data structures.
4. Trace algorithms and estimate computational complexity.
5. Understand basic algorithms such as for sorting/searching and character string processing.

Chapter 1 Basic Theory

1.1 Discrete mathematics ★★★

[Learning objectives]

- Understand and apply numeric representation that is used in a computer such as radices, conversion of radices, as well as arithmetic operations and precisions.
- Understand and apply the fundamental laws and techniques of sets and logical operations.

□ Keywords

<input type="checkbox"/> Fixed point number	<input type="checkbox"/> Floating point number	<input type="checkbox"/> Radix
<input type="checkbox"/> Fraction (Mantissa)	<input type="checkbox"/> Exponent	<input type="checkbox"/> Logical shift
<input type="checkbox"/> Arithmetic shift	<input type="checkbox"/> Cancellation of significant digits	
<input type="checkbox"/> Loss of trailing digits	<input type="checkbox"/> Overflow	<input type="checkbox"/> Underflow
<input type="checkbox"/> Union set	<input type="checkbox"/> Product set (intersection set)	<input type="checkbox"/> Complement set
<input type="checkbox"/> Subset	<input type="checkbox"/> True	<input type="checkbox"/> False
<input type="checkbox"/> Propositional logic	<input type="checkbox"/> Negation	<input type="checkbox"/> Logical sum
<input type="checkbox"/> Logical product	<input type="checkbox"/> Exclusive logical sum	<input type="checkbox"/> Negative logical sum
<input type="checkbox"/> Negative logical product	<input type="checkbox"/> Logical function	<input type="checkbox"/> Distributive property

► Q1-1 through Q1-12

1.2 Applied mathematics

[Learning objectives]

- Understand and apply calculations and analysis techniques for probability and statistics.
- Understand and apply fundamental mathematical principles such as numerical analysis, graph theory, and queueing theory.

□ Keywords

<input type="checkbox"/> Factorial	<input type="checkbox"/> Addition theorem	
<input type="checkbox"/> Multiplication theorem	<input type="checkbox"/> Normal distribution	
<input type="checkbox"/> Poisson distribution	<input type="checkbox"/> Exponential distribution	<input type="checkbox"/> Median
<input type="checkbox"/> Mean	<input type="checkbox"/> Standard deviation	<input type="checkbox"/> Variance
<input type="checkbox"/> Correlation coefficient	<input type="checkbox"/> Estimation	
<input type="checkbox"/> Regression analysis	<input type="checkbox"/> Newton's method	<input type="checkbox"/> Absolute error
<input type="checkbox"/> Relative error	<input type="checkbox"/> Rounding error	<input type="checkbox"/> Truncation error
<input type="checkbox"/> Directed graph	<input type="checkbox"/> Queue	<input type="checkbox"/> Dynamic programming

► Q1-13 through Q1-19

1.3 Theory of Information ★★

[Learning objectives]

- Understand the outline of information theory and code theory.
- Understand the outline of the theory of information including predicate logic, formal language, and automata.
- Understand the outline of artificial intelligence.
- Understand the outline of compiler theory, programming language theory and semantics.

□ Keywords

<input type="checkbox"/> Channel coding	<input type="checkbox"/> Huffman coding	<input type="checkbox"/> Data compression
<input type="checkbox"/> Reverse Polish notation	<input type="checkbox"/> Time complexity	<input type="checkbox"/> Expert system
<input type="checkbox"/> Knowledge base	<input type="checkbox"/> Inference engine	<input type="checkbox"/> Neural network
<input type="checkbox"/> Semantic analysis	<input type="checkbox"/> Code generation	
<input type="checkbox"/> Intermediate language	<input type="checkbox"/> Object program	<input type="checkbox"/> Formal language
<input type="checkbox"/> BNF	<input type="checkbox"/> Syntax chart	<input type="checkbox"/> Automaton
<input type="checkbox"/> Procedural language	<input type="checkbox"/> Functional language	<input type="checkbox"/> Logical language
<input type="checkbox"/> Object-oriented language		

► Q1-20 through Q1-23

1.4 Theory of Communications

[Learning objectives]

- Understand and apply fundamental techniques as well as the types and characteristics of typical methods for transmitting information.

□ Keywords

<input type="checkbox"/> PCM (Pulse Code Modulation)	<input type="checkbox"/> CRC
<input type="checkbox"/> Hamming code	<input type="checkbox"/> Parity check
<input type="checkbox"/> Checksum	<input type="checkbox"/> ECC

► Q1-24 and Q1-25

1.5 Theory of Measurement and Control

[Learning objectives]

- Understand the fundamental mechanisms of signal processing.
- Understand the necessity and fundamental mechanisms of control.

□ Keywords

<input type="checkbox"/> Filtering	<input type="checkbox"/> D/A conversion	<input type="checkbox"/> A/D conversion
<input type="checkbox"/> Real-time OS	<input type="checkbox"/> Open loop	
<input type="checkbox"/> Response characteristics	<input type="checkbox"/> Control stability	<input type="checkbox"/> Feedback control

► Q1-26

Chapter 2 Algorithm and Programming

2.1 Data structure ★★★

[Learning objectives]

- Learn and apply approaches to and fundamental mechanisms of data structures.
- Learn and apply types and characteristics of data structures.

□ Keywords

<input type="checkbox"/> Multidimensional array	<input type="checkbox"/> Static array	<input type="checkbox"/> Dynamic array
<input type="checkbox"/> Linear list	<input type="checkbox"/> Unidirectional list	<input type="checkbox"/> Bidirectional list
<input type="checkbox"/> Circular list	<input type="checkbox"/> FIFO	<input type="checkbox"/> LIFO
<input type="checkbox"/> Push	<input type="checkbox"/> Pop	<input type="checkbox"/> Root
<input type="checkbox"/> Leaf	<input type="checkbox"/> Branch	<input type="checkbox"/> Binary tree
<input type="checkbox"/> Complete binary tree	<input type="checkbox"/> Balanced tree	<input type="checkbox"/> Ordered tree
<input type="checkbox"/> N-ary tree	<input type="checkbox"/> Search tree	<input type="checkbox"/> Binary search tree
<input type="checkbox"/> Depth-first search	<input type="checkbox"/> Breadth-first search	<input type="checkbox"/> Pre-order
<input type="checkbox"/> Post-order	<input type="checkbox"/> In-order	

► Q1-27 and Q1-28

2.2 Algorithms ★★

[Learning objectives]

- Learn and apply fundamental approaches to and methods of representation for algorithms and flowcharts.
- Learn and apply the fundamentals of typical algorithms.
- Learn and apply fundamental methods of design for algorithms.

□ Keywords

<input type="checkbox"/> Flowchart (Terminal, Process, Decision, Loop limit)	<input type="checkbox"/> Selection sort
<input type="checkbox"/> Bubble sort	<input type="checkbox"/> Merge sort
<input type="checkbox"/> Shell sort	<input type="checkbox"/> Quick sort
<input type="checkbox"/> Linear search	<input type="checkbox"/> Binary search
<input type="checkbox"/> Depth-first search	<input type="checkbox"/> Breadth-first search
<input type="checkbox"/> String pattern matching	<input type="checkbox"/> Recursion
<input type="checkbox"/> Divide-and-conquer approach	<input type="checkbox"/> Shortest path search

► Q1-29 through Q1-38

2.3 Programming

[Learning objectives]

- Learn and apply programming methods and the fundamentals of coding.
- Learn and apply fundamental grammar notation for programming languages.

□ Keywords

- | | | |
|--|---|---|
| <input type="checkbox"/> Indentation | <input type="checkbox"/> Nesting depth | |
| <input type="checkbox"/> Naming conventions | <input type="checkbox"/> Prohibited use of instructions | |
| <input type="checkbox"/> Increased functionality efficiency, usability, maintainability of a program | | |
| <input type="checkbox"/> Main routine | <input type="checkbox"/> Subroutine | <input type="checkbox"/> Integer type |
| <input type="checkbox"/> Real type | <input type="checkbox"/> Boolean type | <input type="checkbox"/> Character type |
| <input type="checkbox"/> Abstract data type | <input type="checkbox"/> Structure type | |

► Q1-39 and Q1-40

2.4 Programming Languages ★★

[Learning objectives]

- Learn and apply types, characteristics, and fundamental description methods of programming languages.
- Learn and apply methods for program creation for C, COBOL, Java, and assembler.
- Learn and apply the usage methods for spreadsheet software.

□ Keywords

- | | | |
|--|---|--|
| <input type="checkbox"/> Procedural language | <input type="checkbox"/> Object-oriented language | <input type="checkbox"/> Script language |
| <input type="checkbox"/> Fortran | <input type="checkbox"/> COBOL | <input type="checkbox"/> PL/I |
| <input type="checkbox"/> Pascal | <input type="checkbox"/> BASIC | <input type="checkbox"/> C |
| <input type="checkbox"/> Java | <input type="checkbox"/> C++ | <input type="checkbox"/> Perl |
| <input type="checkbox"/> PHP | <input type="checkbox"/> Python | <input type="checkbox"/> Ruby |

► Q1-41 and Q1-42

2.5 Other languages ★★

[Learning objectives]

- Understand and apply types, characteristics, and fundamental description methods for typical markup languages.
- Understand the characteristics of other languages used in computers.

□ Keywords

- ☐ Start tag ☐ End tag
- ☐ DTD (Document Type Definition)
- ☐ SGML (Standard Generalized Markup Language)
- ☐ SOAP (Simple Object Access Protocol)
- ☐ XML Schema ☐ XHTML Basic
- ☐ Modulation of XHTML
- ☐ XSL (eXtensible Stylesheet Language)
- ☐ UML (Class diagram, Sequence diagram, Object diagram, Communication diagram (Collaboration diagram), State machine diagram (Statechart diagram), Operation, Attribute, Role name)

► Q1-43

1.1**Basic Theory****Q1-1** □□□

Which of the following represents the hexadecimal fraction 0.C as a decimal fraction?

- a) 0.12 b) 0.55 c) 0.75 d) 0.84

Q1-2 □□□

Which of the following is an appropriate description concerning radix conversion?

- a) A finite fraction of a binary value is always a finite fraction after conversion to a decimal value.
- b) A finite fraction of an octal value is not always a finite fraction after conversion to a binary value.
- c) A finite fraction of an octal value is not always a finite fraction after conversion to a decimal value.
- d) A finite fraction of a decimal value is always a finite fraction after conversion to an octal value.

Q1-3 □□□

Which of the following is an appropriate method for checking if an 8-bit unsigned value x is a multiple of 16?

- a) The logical product of x and each bit of the binary value 00001111 results in all zeros.
- b) The logical sum of x and each bit of the binary value 00001111 results in all zeros.
- c) The logical product of x and each bit of the binary value 11110000 results in all zeros.
- d) The logical sum of x and each bit of the binary value 11110000 results in all zeros.

Q1-4 □□□ **Mandatory question**

A register stores a numeric value in binary. In this register, after the positive integer x is stored, if the operation “shift the register value two bits to the left and then add x ” is performed, how many times larger than x is the resulting register value? Here, overflow does not occur.

- a) 3 b) 4 c) 5 d) 6

Q1-5 □□□ **Mandatory question**

Which of the following is the absolute value of the negative value 10101110 represented in 2's complement?

- a) 01010000 b) 01010001 c) 01010010 d) 01010011

Q1-6 □□□

In a fixed point format that represents negative numbers in 2's complement, which of the following is the range of integers that can be represented with n bits? Here, the position of the decimal point is on the right of the lowest bit.

- a) -2^n through 2^{n-1} b) $-2^{n-1} - 1$ to 2^{n-1}
 c) -2^{n-1} to $2^{n-1} - 1$ d) -2^{n-1} to 2^{n-1}

Q1-7 □□□

Among the 1-byte data with equal numbers of 0s and 1s, which of the following represents the largest unsigned binary integer as a decimal integer?

- a) 120 b) 127 c) 170 d) 240

Radix Conversion

Binary to
decimal
conversion

Binary value $\dots X_3 X_2 X_1 X_0 . X_{-1} X_{-2} \dots$ (X_3 through X_{-2} are the zero (0) or one (1) of each digit of the binary value)
 Decimal value $\dots X_3 \times 2^3 + X_2 \times 2^2 + X_1 \times 2^1 + X_0 \times 2^0 + X_{-1} \times 2^{-1} + X_{-2} \times 2^{-2} \dots$

Check!

Q1-8 □□□

Which of the following is an appropriate description of the floating point format that represents a real number a as $a = \pm x \times y^z$.

- a) x is the fraction, z is the exponent, and y is the radix.
- b) x is the radix, z is the fraction, and y is the exponent.
- c) x is the radix, z is the exponent, and y is the fraction.
- d) x is the exponent, z is the radix, and y is the fraction.

Q1-9 □□□

Mandatory question

In floating point arithmetic operations, when addition or subtraction is performed on a number with a large absolute value and a number with a small absolute value, which of the following refers to a phenomenon where some or all of the valid digits of the number with the small absolute value do not appear in the result?

- a) Truncation error
- b) Cancellation of significant digits
- c) Loss of trailing digits
- d) Absolute error

Q1-10 □□□

For the sets A and B , which of the following is a relationship that is always valid? Here, \cap is a product set and \cup is a union set, \bar{A} is a complement set of A , and $A \subseteq B$ means “ A is a subset of B .”

- a) $A \subseteq (A \cap \bar{B})$
- b) $(A \cup B) \subseteq (\bar{A} \cup \bar{B})$
- c) $(A \cap B) \subseteq (A \cup \bar{B})$
- d) $(A \cap B) \subseteq (\bar{A} \cap \bar{B})$

Q1-11 □□□

Mandatory question

Which of the following is equal to the logical expression $\overline{(\bar{A} + B) \cdot (A + \bar{C})}$? Here, \cdot represents a logical product, $+$ represents a logical sum, and \bar{X} represents the negation of X .

- a) $A \cdot \bar{B} + \bar{A} \cdot C$
- b) $\bar{A} \cdot B + A \cdot \bar{C}$
- c) $(A + \bar{B}) \cdot (\bar{A} + C)$
- d) $(\bar{A} + B) \cdot (A + \bar{C})$

Q1-12 □□□

If x , y , and z are logical variables, T is true, and F is false, which of the following is the logical expression that represents the function $f(x, y, z)$ shown in the truth table below? Here, \wedge is a logical product, \vee is a logical sum, and \bar{A} is the negation of A .

x	y	z	$f(x, y, z)$
T	T	T	T
T	T	F	T
T	F	T	T
T	F	F	F
F	T	T	F
F	T	F	F
F	F	T	T
F	F	F	F

a) $(x \wedge y) \vee (y \wedge z)$

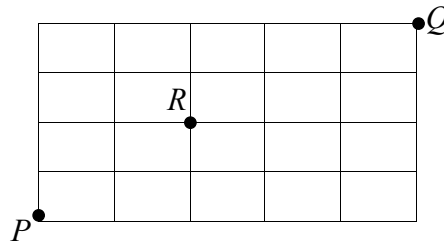
b) $(x \wedge y) \vee (\bar{y} \wedge \bar{z})$

c) $(x \wedge y) \vee (\bar{y} \wedge \bar{z})$

d) $(x \wedge \bar{y}) \vee (\bar{y} \wedge \bar{z})$

Q1-13 □□□

How many shortest paths are there from node P to node Q via node R along the grid lines in the figure below?



a) 16

b) 24

c) 32

d) 60

Logical Operations: Formula 1

Idempotent laws $A + A = A$ $A \cdot A = A$

Check!

Q1-14 □□□

Mandatory question

From a bag containing four white balls and five red balls, one ball is removed and then another ball is removed without putting the first ball back into the bag. What is the probability that both balls are red?

a) $\frac{1}{6}$

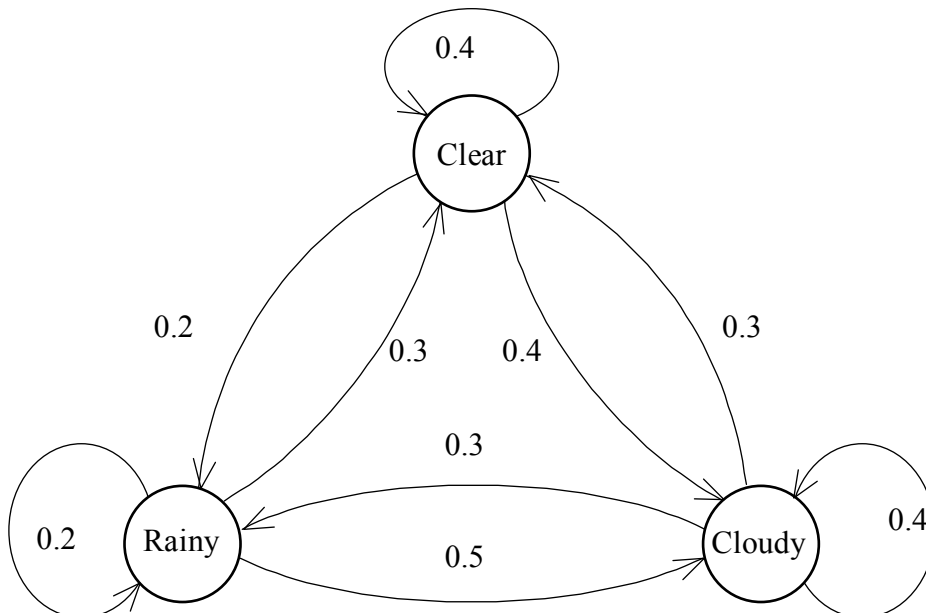
b) $\frac{16}{81}$

c) $\frac{25}{81}$

d) $\frac{5}{18}$

Q1-15 □□□

The diagram below shows daily changes in the weather for a given region. The numbers represent the probability of a change in the weather for the next day. When the weather is rainy on a given day, what is the probability that the weather is clear two days later?



a) 0.15

b) 0.27

c) 0.3

d) 0.33

Q1-16 □□□

How many character strings with one to seven characters in length can be generated using the two characters A and B ?

a) 128

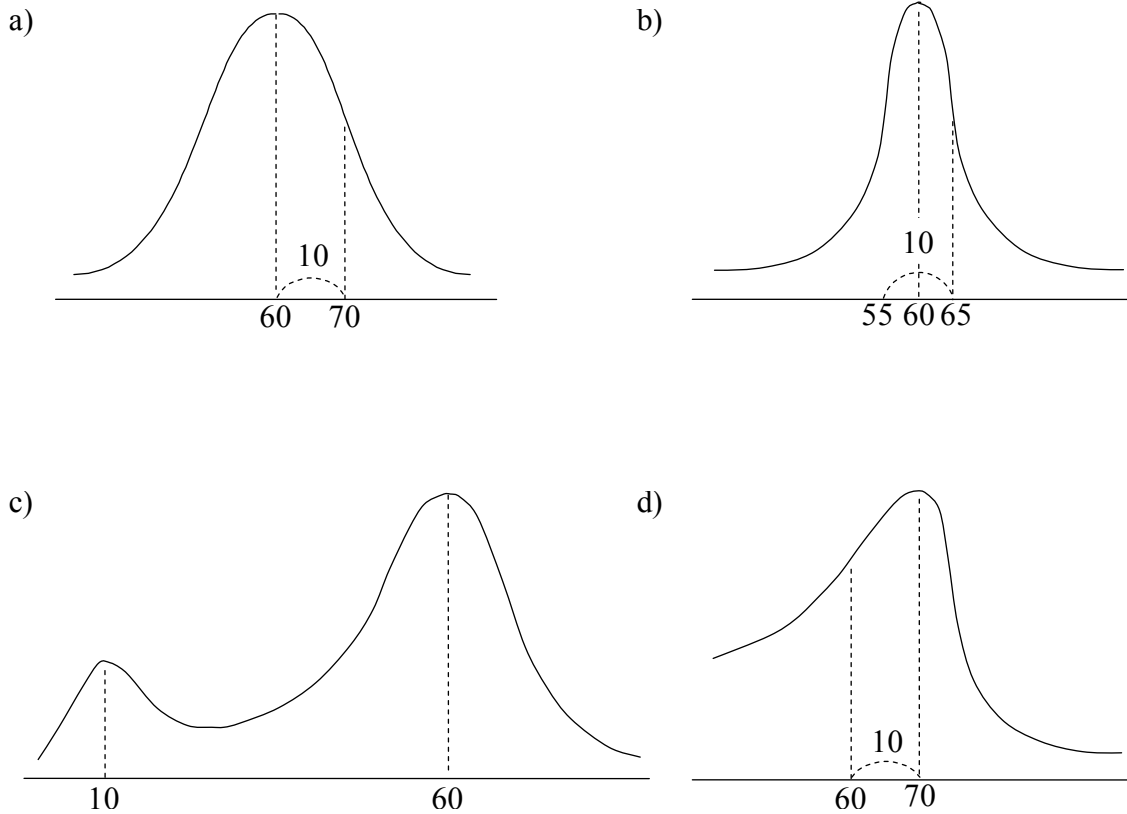
b) 254

c) 255

d) 256

Q1-17 □□□

Which of the following is a graph that represents normal distribution with an average of 60 and a standard deviation of 10?



Q1-18 □□□

When N is the number of observed values, which of the following is the expression to calculate the average of these values? Here, S ($S > 0$) is the sum of the observed values, $[X]$ is the maximum integer that is lower than or equal to X . The average value is rounded with one decimal place to the nearest integer.

- a) $\left[\frac{S}{N} - 0.5 \right]$ b) $\left[\frac{S}{N} - 0.4 \right]$
- c) $\left[\frac{S}{N} + 0.4 \right]$ d) $\left[\frac{S}{N} + 0.5 \right]$

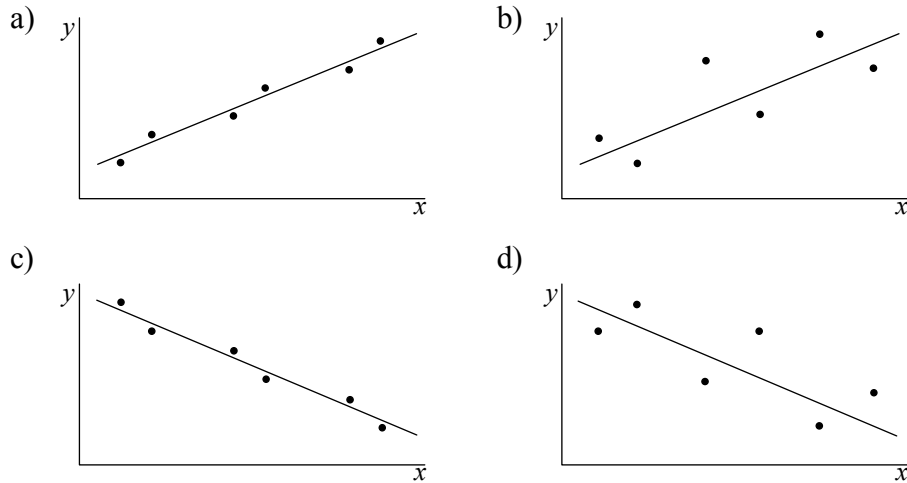
Logical Operations: Formula 2

Commutative laws $A + B = B + A$ $A \bullet B = B \bullet A$

Check!

Q1-19 □□□

The below are graphs showing the distribution of samples and respective regression lines where each sample correlation coefficient is -0.9 , -0.7 , 0.7 , or 0.9 . Which of the following is the graph that has a sample correlation coefficient of -0.9 ?



Q1-20 □□□

Which of the following uses a knowledge base to perform inference?

- | | |
|--------------------|-------------------|
| a) Expert system | b) Neural network |
| c) Virtual reality | d) Fuzzy computer |

Q1-21 □□□

Mandatory question

With reverse Polish notation (postfix notation), which of the following is an expression that is represented as “ $EF - G \div CD - AB + \div +$ ”?

- a) $((A+B)+(C-D)) \div G - (E \div F)$
- b) $((A+B) \div (C-D)) + G \div (E-F)$
- c) $((E-F) \div G) + ((C-D) \div (A+B))$
- d) $((E-F) \div G) \div ((C-D) + (A+B))$

Q1-22 □□□

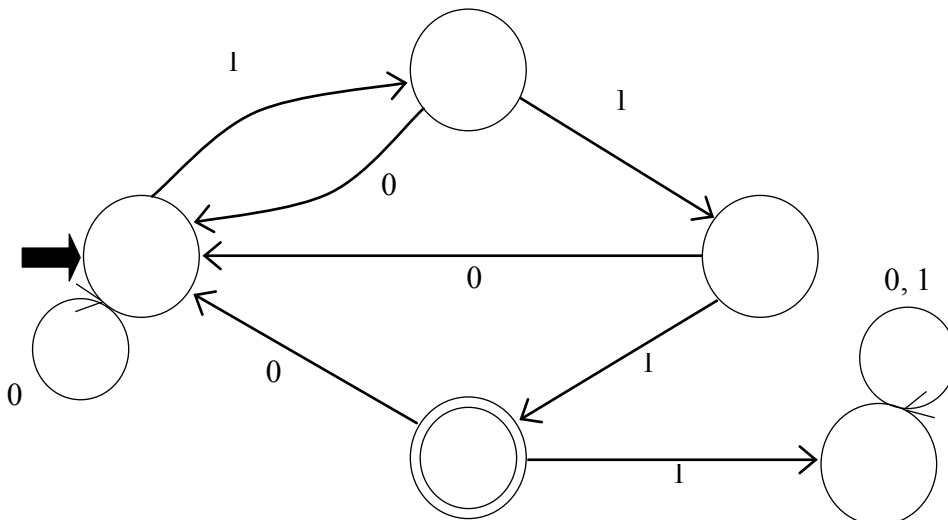
Which of the following is the bit string S that is defined in the BNF below?

$$\langle S \rangle ::= 01 \mid 0 \langle S \rangle 1$$

- a) 000111 b) 010010 c) 010101 d) 011111

Q1-23 □□□

Which of the following is the character string accepted by the finite automaton shown in the diagram below? Here, \bullet represents the initial state, and \circ represents the accepting state.



- a) 01011 b) 01111 c) 10111 d) 11110

Logical Operations: Formula 3

Distributive laws $A \bullet (B + C) = (A \bullet B) + (A \bullet C)$ $A + (B \bullet C) = (A + B) \bullet (A + C)$

Check!

Q1-24 □□□

Mandatory question

When a string contains a consecutive sequence of the same character, the repeating characters are replaced with a combination of the number of occurrences and the character in order to shorten the length of the string. Which of the following is this technique?

- a) EBCDIC encoding
- b) Cyclic encoding
- c) Huffman encoding
- d) Run length encoding

Q1-25 □□□

The values of the bits in an 8-bit register are d_0, d_1, \dots, d_7 , and the value of the parity bit is p . Which of the following equations always holds for odd parity? Here, \oplus represents the operation for the exclusive logical sum.

- a) $0 \oplus d_0 \oplus d_1 \oplus \dots \oplus d_7 = p$
- b) $d_0 \oplus d_1 \oplus \dots \oplus d_7 = p$
- c) $d_0 \oplus d_1 \oplus \dots \oplus d_7 \oplus p = 0$
- d) $d_0 \oplus d_1 \oplus \dots \oplus d_7 \oplus p = 1$

Q1-26 □□□

Which of the following is an appropriate explanation of the sequence control that is used to control industrial devices?

- a) It is a method of control that progresses through each level of control one by one in accordance with a predefined order or predefined conditions.
- b) It is a method of control that, when external interference can be predicted, assumes external interference and performs the necessary changes in advance.
- c) It is a method of control that is resistant to unpredictable external interference because it constantly monitors the controlled variable and takes this into account in control.
- d) It is a method of control that is based on vagueness such as “slightly more” or “slightly less.”

1.2

Algorithms and Programming

Q1-27 ☐☐☐

Mandatory question

When the operations below are performed on an empty stack, which of the following is the data that remains in the stack? Here, “push x ” stores the data x in the stack, and “pop” retrieves data from the stack.

push 1 → push 2 → pop → push 3 → push 4 → pop → push 5 → pop

- a) 1 and 3 b) 2 and 4 c) 2 and 5 d) 4 and 5

Q1-28 ☐☐☐

Mandatory question

The table below is an internal representation of a list that is composed of linked cells using an array. The list represents [Tokyo, Shinagawa, Nagoya, Shin-Osaka]. Which of the following is the operation to change the list to [Tokyo, Shin-Yokohama, Nagoya, Shin-Osaka]? Here, $A(i, j)$ represents the cell at row i column j . For example, $A(3, 1)$ = “Nagoya,” and $A(3, 2) = 4$. Furthermore, “→” represents an assignment.

		Column	
		1	2
Row	A	1	2
	1	“Tokyo”	2
	2	“Shinagawa”	3
	3	“Nagoya”	4
	4	“Shin-Osaka”	0
	5	“Shin-Yokohama”	

	First operation	Second operation
a)	$5 \rightarrow A(1,2)$	$A(A(1,2),2) \rightarrow A(5,2)$
b)	$5 \rightarrow A(1,2)$	$A(A(2,2),2) \rightarrow A(5,2)$
c)	$A(A(1,2),2) \rightarrow A(5,2)$	$5 \rightarrow A(1,2)$
d)	$A(A(2,2),2) \rightarrow A(5,2)$	$5 \rightarrow (1,2)$

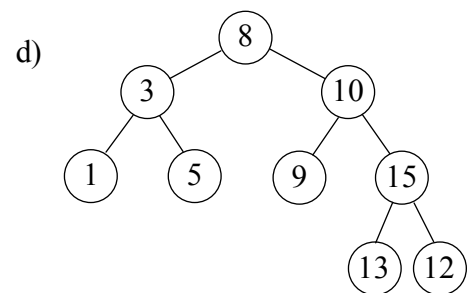
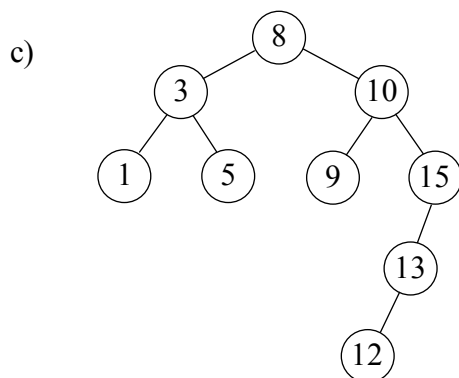
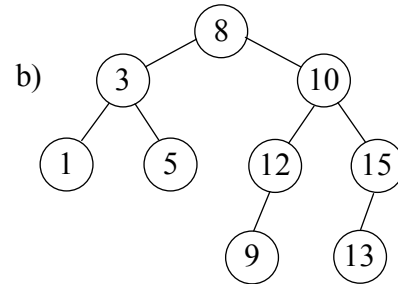
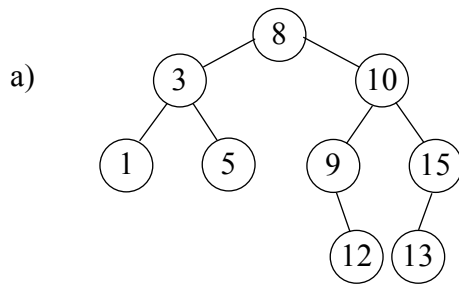
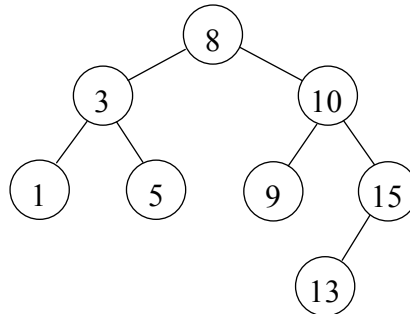
Logical Operations: Formula 4

Associative laws $A + (B + C) = (A + B) + C$ $A \bullet (B \bullet C) = (A \bullet B) \bullet C$

Check!

Q1-29 □□□

When 12 is inserted into the binary search tree below, which of the following is the tree that correctly represents the position of the inserted node 12?



Q1-30 ☐☐☐ **Mandatory question**

When $h(x) = \text{mod}(x, 97)$ is applied as a hash function for key x , how many keys in the range of 1 through 1000 have the same hash value as that of key 1094? Here, $\text{mod}(x, 97)$ represents the remainder of x divided by 97.

- a) 9 b) 10 c) 11 d) 12

Q1-31 ☐☐☐

Which of the following is an appropriate explanation of the hash method?

- a) It is a method for accessing a record by using a function to calculate the storage address for the record from the key value of the record.
 b) It is a method for accessing a record by using the storage address for the next record that is stored inside each record.
 c) It is a method for accessing a record by using the key value of a record and a correspondence table of storage addresses of records.
 d) It is a method for accessing a record directly by using the key value of a record as the storage address of the record.

Q1-32 ☐☐☐

There is an array with n data elements sorted into ascending order. When a binary search is used to search for two certain values, which of the following is an expression that calculates the approximate number of comparisons?

- a) $\log_2 n$ b) $(\log_2 n + 1) / 2$
 c) n d) n^2

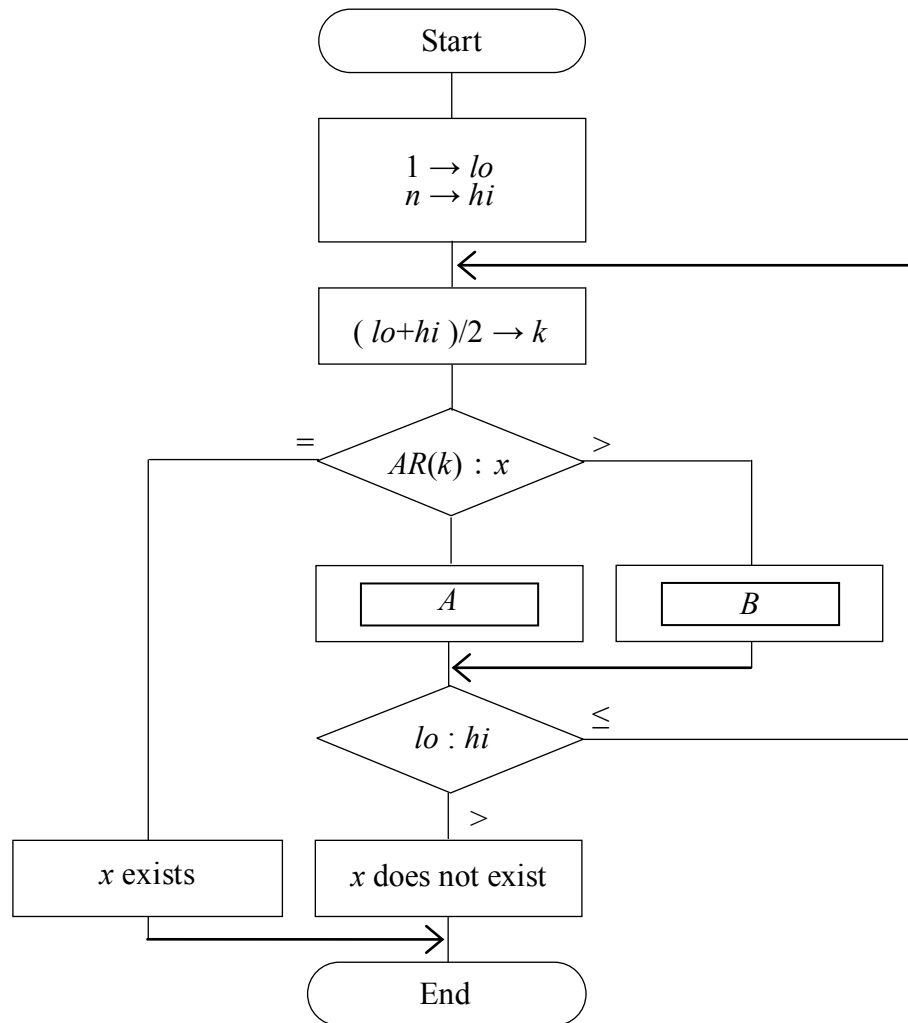
Logical Operations: Formula 5

Absorption laws	$A + (A \bullet B) = A$	$A \bullet (A + B) = A$
	$A + (\bar{A} \bullet B) = A + B$	$(A \bullet \bar{B}) + B = A + B$

Check!

Q1-33 □□□

There is an array AR that stores n elements of data sorted in ascending order. The flowchart below shows the process of using a binary search on array AR to retrieve the data element x . Which of the following is the correct combination of operations to be inserted into blanks A and B ? Here, the results of division operations are rounded down to the nearest integer.



	A	B
a)	$k + 1 \rightarrow hi$	$k - 1 \rightarrow lo$
b)	$k - 1 \rightarrow hi$	$k + 1 \rightarrow lo$
c)	$k + 1 \rightarrow lo$	$k - 1 \rightarrow hi$
d)	$k - 1 \rightarrow lo$	$k + 1 \rightarrow hi$

Q1-34 □□□

Which of the following is the appropriate description concerning a sorting method for data?

- a) In a quick sort, a subset of data elements that are retrieved at a set interval are sorted, the interval is then further reduced, and the same operation is performed. This is repeated until the interval becomes one.
- b) In a shell sort, adjacent data elements are compared and switched if the order of size is the wrong way around. This operation is then repeated.
- c) In a bubble sort, an intermediate base value is decided and elements are divided into a group containing elements with a greater value and a group containing elements with a lower value. The same process is then repeated inside each group.
- d) In a heap sort, an unsorted section is configured into an ordered tree, and then the greatest value or the lowest value is retrieved and moved to a sorted section. This operation is repeated, and the unsorted section becomes progressively smaller.

Q1-35 □□□

When a function or a procedure is called, which of the following is an appropriate data structure for the temporary storage of a return address or data during a process?

- a) Binary search tree
- b) Queue
- c) Stack
- d) Doubly-linked list

Q1-36 □□□

For the natural number n , function $f(n)$ is recursively defined as shown below. Which of the following is the value of $f(5)$?

$f(n)$: if $n \leq 1$ then return 1 else return $n + f(n-1)$

- a) 6
- b) 9
- c) 15
- d) 25

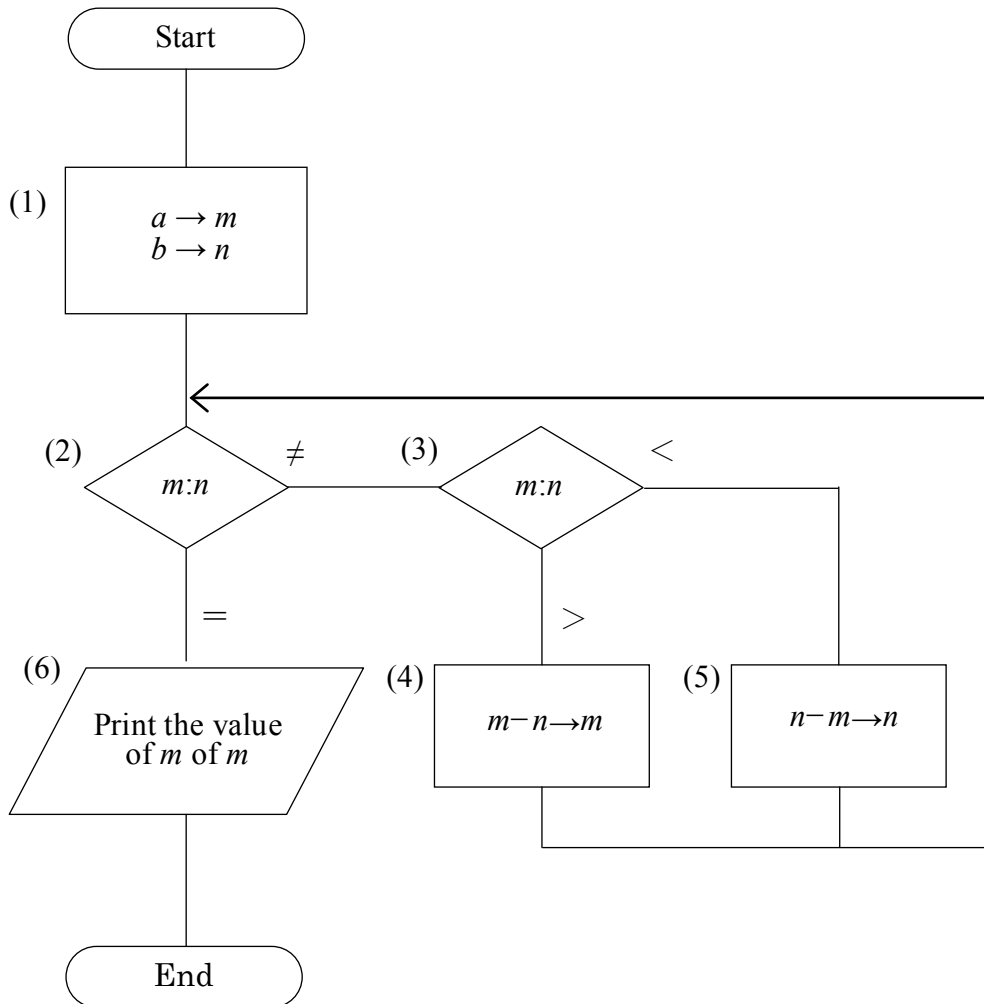
Logical Operations: Formula 6

Decompression Law $\overline{\overline{A}} = A$

Check !

Q1-37 □□□

In the flowchart below, in order to perform operations in order of “(1) → (2) → (3) → (5) → (2) → (3) → (4) → (2) → (6)”, which of the following is the relationship between a and b which are initial values that should be assigned to m and n in (1)? Here, a and b are both positive integers.



a) $a = 2b$

b) $2a = b$

c) $2a = 3b$

d) $3a = 2b$

Q1-38 □□□

The decision table below is used to determine an award for a proposal to improve business operations. What is the total amount of the awards for improvement proposals *A* and *B*?

Reduced amount: less than 100,000 yen	Y	Y	N	N
Reduced period: less than one week	Y	N	Y	N
Award: 500 yen	X	–	–	–
Award: 1,000 yen	–	X	X	–
Award: 3,000 yen	–	–	–	X

[Improvement proposals]

Improvement proposal *A*: Reduced amount: 200,000 yen, Reduced period: 3 days

Improvement proposal *B*: Reduced amount: 200,000 yen, Reduced period: 2 weeks

- a) 1,000 b) 1,500 c) 2,000 d) 3,500

Q1-39 □□□

Which of the following is an appropriate description concerning the standardization of programming?

- The original aim is not to deny the programmer individuality, but to easily acquire the effect of optimization through a compiler.
- The establishment of programming conventions has the effect of preventing errors that are easily made by a programmer.
- The aim is to define rules for common points that do not depend on a programming language.
- Standardization clearly defines the standard execution time of a program and has the effect of promoting the efficient creation of a program.

Logical Operations: Formula 7

Operations with Constants	$A + 1 = 1$	$A + 0 = A$	$A + A = \bar{1}$
	$A \bullet 1 = 1$	$A \bullet 0 = 0$	$A \bullet A = \bar{0}$

Check!

Q1-40 □□□

Which of the following is the appropriate description concerning the various characteristics of a program?

- a) In order to implement recursive processing, the status of a running program must be recorded and controlled in an FIFO manner.
- b) In order to implement a reentrant program, the program must be divided into a procedure section and a data section, and a data section must exist for each process section.
- c) Serially-reusable programs can also be reentrant.
- d) A program that can be executed by multiple processes simultaneously is recursive.

Q1-41 □□□

Which of the following is a characteristic of object-orientated programs?

- a) The order of calculation is not specified by the control flow rather than by the flow of data. A series of instructions becomes executable when all input data is available.
- b) Control of calculation is passed from instruction to instruction in sequence. The passing of data between instructions is performed indirectly by a reference to memory through a “variable.” The definition of instructions and data is separated.
- c) Data is hidden from the outside, and can be manipulated indirectly with a procedure called a method. A program is a collection of bundles of data and methods.
- d) A program is composed of nested arithmetic and logical expressions, instructions (symbols of operations) that represent functions, and data. “Execution of instructions” corresponds to the “calculation (evaluation) of the values of arithmetic and logical expressions or functions.”

Q1-42 □□□

Mandatory question

Which of the following is an appropriate explanation of a Java servlet?

- a) It is a program that is developed with Java and executed on a Web application server at the request of a client.
- b) It is a program that is developed with Java and executed after being downloaded from a server.
- c) It is a set of rules for handling a program developed with Java as an application component.
- d) It is an interpreter that executes a program developed with Java, and has a function to execute a sort of intermediate code called bytecode.

Q1-43 □□□

Which one of the following is the most appropriate as a characteristic of XML?

- a) XML adds functions to HTML for the main purpose of improving the display performance of webpages.
- b) In XML, optional tags can be defined to simplify the exchange of data between information systems over a network.
- c) The style languages that can be used for XML are the same as those for HTML.
- d) Unlike SGML-based HTML, XML was developed based on original specifications.

Logical Operations: Formula 8

De Morgan's laws $\overline{A+B} = \overline{A} \cdot \overline{B}$ $\overline{A \cdot B} = \overline{A} + \overline{B}$

Check!

Section 1 Basic Theory List of Answers

Q1-1	c)	Q1-31	a)
Q1-2	a)	Q1-32	a)
Q1-3	a)	Q1-33	c)
Q1-4	c)	Q1-34	d)
Q1-5	c)	Q1-35	c)
Q1-6	c)	Q1-36	c)
Q1-7	d)	Q1-37	d)
Q1-8	a)	Q1-38	c)
Q1-9	c)	Q1-39	b)
Q1-10	c)	Q1-40	b)
Q1-11	a)	Q1-41	c)
Q1-12	b)	Q1-42	a)
Q1-13	d)	Q1-43	b)
Q1-14	d)		
Q1-15	d)		
Q1-16	b)		
Q1-17	a)		
Q1-18	d)		
Q1-19	c)		
Q1-20	a)		
Q1-21	c)		
Q1-22	a)		
Q1-23	c)		
Q1-24	d)		
Q1-25	d)		
Q1-26	a)		
Q1-27	a)		
Q1-28	c)		
Q1-29	c)		
Q1-30	c)		

Technology

Morning Exam

Section 2

Computer System

Learning Objectives

1. Be able to explain the functions and role of each device in a computer system.
2. Be able to explain an I/O interface.
3. Be able to understand each function and characteristic of an operating system.
4. Be able to understand system configurations, and thus be able to calculate its performance and reliability.

Chapter 1 Computer Components

1.1 Processors ★★★

[Learning objectives]

- Understand the types and configurations of computers, and apply them to associated matters.
- Understand the architecture, structure, features, and operating principle of processors, and apply them to associated matters.
- Understand the indexes or indicators that represent processor performance, and apply them to associated matters.
- Understand the high-speed, high-reliability technology of processors, and apply it to associated matters.

□ Keywords

- | | |
|--|--|
| <input type="checkbox"/> General-purpose computer | <input type="checkbox"/> Server |
| <input type="checkbox"/> Process computer | <input type="checkbox"/> Microcomputer |
| <input type="checkbox"/> PDA (Personal Digital Assistant) | <input type="checkbox"/> Operation <input type="checkbox"/> Control |
| <input type="checkbox"/> Storage | <input type="checkbox"/> Input <input type="checkbox"/> Output |
| <input type="checkbox"/> Wired logic control | <input type="checkbox"/> Microprogram control |
| <input type="checkbox"/> Accumulator | <input type="checkbox"/> Complementer |
| <input type="checkbox"/> Instruction address register (instruction counter, program counter, and sequential control counter) | |
| <input type="checkbox"/> Instruction register | <input type="checkbox"/> General register <input type="checkbox"/> Index register |
| <input type="checkbox"/> Base register | <input type="checkbox"/> SVC (SuperVisor Call) interrupt |
| <input type="checkbox"/> I/O interrupt | <input type="checkbox"/> Cycle time <input type="checkbox"/> FLOPS |
| <input type="checkbox"/> Instruction mix | <input type="checkbox"/> Pipeline <input type="checkbox"/> Super-pipeline <input type="checkbox"/> Superscalar |
| <input type="checkbox"/> VLIW <input type="checkbox"/> SISD | <input type="checkbox"/> SIMD <input type="checkbox"/> MISD <input type="checkbox"/> MIMD |
| <input type="checkbox"/> Loosely coupled multiprocessor system | <input type="checkbox"/> Tightly coupled multiprocessor system |

- Q2-1 through Q2-8

1.2 Memory ★★★

[Learning objectives]

- Understand the types and characteristics of memory, and apply them to associated matters.
- Understand the mechanisms of storage devices, including the configuration of the main memory, configuration of the memory system, and storage hierarchy, and apply them to associated matters.
- Understand the types and characteristics of storage media, and apply them to associated matters.

□ Keywords

- ☐ RAM ☐ ROM ☐ DRAM ☐ SRAM
- ☐ Flash memory ☐ Auxiliary memory
- ☐ Disk cache ☐ Write through ☐ Write back
- ☐ Memory interleave ☐ Bank ☐ Read-only
- ☐ Write-once ☐ Rewritable ☐ Hard disk
- ☐ CD (CD-ROM, CD-R)
- ☐ DVD (DVD-ROM, DVD-RAM, DVD-R)
- ☐ Flash memory (USB memory, SD card)
- ☐ Floppy disk ☐ Streamer ☐ RAM file

► Q2-9 through Q2-15

1.3 Buses

[Learning objectives]

- Understand an outline of the types, characteristics, and configurations of buses.

□ Keywords

- ☐ Address bus ☐ Data bus ☐ Control bus
- ☐ System bus ☐ Memory bus ☐ I/O bus ☐ PCI
- ☐ Serial bus ☐ Parallel bus ☐ Bus access mode

► Q2-16

1.4 I/O interfaces and drivers ★★

[Learning objectives]

- Understand the types and characteristics of a typical I/O interface, and apply them to associated matters.
- Understand the basic role and functions of a device driver.

□ Keywords

- | | | | |
|---|--|--|--|
| <input type="checkbox"/> USB | <input type="checkbox"/> RS-232C | <input type="checkbox"/> IEEE 1394 | <input type="checkbox"/> SCSI |
| <input type="checkbox"/> Serial ATA | <input type="checkbox"/> Bluetooth | <input type="checkbox"/> IrDA | <input type="checkbox"/> Star connection |
| <input type="checkbox"/> Cascade connection | <input type="checkbox"/> Hub | <input type="checkbox"/> Daisy chain | |
| <input type="checkbox"/> Terminator | <input type="checkbox"/> Tree connection | <input type="checkbox"/> Program control | |
| <input type="checkbox"/> Device driver | | | |

► Q2-17 through Q2-19

1.5 I/O devices ★★

[Learning objectives]

- Understand the types and characteristics of typical I/O devices, and apply them to associated matters.
- Understand the types and characteristics of a typical auxiliary storage device, and apply them to associated matters.

□ Keywords

- | | | |
|--|---|--|
| <input type="checkbox"/> Keyboard | <input type="checkbox"/> Pointing device | <input type="checkbox"/> Touch screen |
| <input type="checkbox"/> Mouse | <input type="checkbox"/> Joystick | <input type="checkbox"/> Trackball |
| <input type="checkbox"/> Scanner | <input type="checkbox"/> Sound input device | <input type="checkbox"/> Biometric authentication device |
| <input type="checkbox"/> Barcode reader | <input type="checkbox"/> Digitizer | <input type="checkbox"/> Tablet |
| <input type="checkbox"/> Digital camera | <input type="checkbox"/> Magnetic card | |
| <input type="checkbox"/> Reader | <input type="checkbox"/> IC card reader | <input type="checkbox"/> Liquid crystal display |
| <input type="checkbox"/> TFT liquid crystal | <input type="checkbox"/> STN liquid crystal | |
| <input type="checkbox"/> OLED (Organic Light Emitting Diode) display | | |
| <input type="checkbox"/> Plasma display | <input type="checkbox"/> Interlaced mode | |
| <input type="checkbox"/> Non-interlaced mode | <input type="checkbox"/> Impact printer | |
| <input type="checkbox"/> Non-impact printer | <input type="checkbox"/> Serial printer | |
| <input type="checkbox"/> Line printer | <input type="checkbox"/> Page printer | <input type="checkbox"/> Laser printer |
| <input type="checkbox"/> Inkjet printer | <input type="checkbox"/> Voice synthesizer | |
| <input type="checkbox"/> Hard disk drive | <input type="checkbox"/> Floppy disk drive | <input type="checkbox"/> CD-R/RW drive |
| <input type="checkbox"/> Blu-ray drive | <input type="checkbox"/> DVD-R/RW drive | <input type="checkbox"/> Magnetic tape unit |
| <input type="checkbox"/> Track | <input type="checkbox"/> Cylinder | <input type="checkbox"/> Blocking factor |
| <input type="checkbox"/> IBG (Interblock Gap) | <input type="checkbox"/> Sector | <input type="checkbox"/> Defragmentation |

► Q2-20 through Q2-24

Chapter 2 System Components

2.1 System configuration ★★★

[Learning objectives]

- Understand the processing modes, usage, and application areas of systems, and apply them to associated matters.
- Understand the types and characteristics of typical system configurations, and apply them to associated matters.
- Understand the characteristics and configurations of client/server systems.
- Understand the concept of reliability design of systems.

□ Keywords

- | | | |
|---|---|---|
| <input type="checkbox"/> Parallel processing | <input type="checkbox"/> Client/server processing | |
| <input type="checkbox"/> Transaction processing | <input type="checkbox"/> Interactive processing | <input type="checkbox"/> Dual system |
| <input type="checkbox"/> Duplex system | <input type="checkbox"/> Cluster | |
| <input type="checkbox"/> Multiprocessor system | <input type="checkbox"/> Load sharing system | |
| <input type="checkbox"/> Backup site | <input type="checkbox"/> Hot site / Hot standby | |
| <input type="checkbox"/> Warm site / Warm standby | <input type="checkbox"/> Cold site / Cold standby | |
| <input type="checkbox"/> Primary system (currently used system) | | |
| <input type="checkbox"/> Secondary system (backup system) | <input type="checkbox"/> Tight coupling | |
| <input type="checkbox"/> Loose coupling | <input type="checkbox"/> Peer to peer | <input type="checkbox"/> Grid computing |
| <input type="checkbox"/> Massively parallel | | |
| <input type="checkbox"/> Three-layer client/server system (presentation layer, function layer, and database access layer) | | |
| <input type="checkbox"/> Client | <input type="checkbox"/> Server | <input type="checkbox"/> Thin client system |
| <input type="checkbox"/> RPC (Remote Procedure Call) | | <input type="checkbox"/> Web browser |
| <input type="checkbox"/> Web server | <input type="checkbox"/> RAID0 | <input type="checkbox"/> RAID1 |
| | | <input type="checkbox"/> RAID2 |
| <input type="checkbox"/> RAID3 | <input type="checkbox"/> RAID4 | <input type="checkbox"/> RAID5 |
| | | <input type="checkbox"/> RAID6 |
| <input type="checkbox"/> Striping | <input type="checkbox"/> Mirroring | <input type="checkbox"/> Parity |
| | | <input type="checkbox"/> Fault |
| <input type="checkbox"/> Fault tolerant system | | <input type="checkbox"/> Fault avoidance system |
| <input type="checkbox"/> Fail safe | <input type="checkbox"/> Fail soft | <input type="checkbox"/> Foolproof |
| | | <input type="checkbox"/> NAS |

► Q2-25 through Q2-33

2.2 System evaluation indexes or indicators ★★★

[Learning objectives]

- Understand the concept for measurement of system performance, reliability, and economical efficiency, as well as the concept of performance indicators and capacity planning, and apply them to associated matters.

□ Keywords

- | | | |
|--|---|-------------------------------------|
| <input type="checkbox"/> Response time | <input type="checkbox"/> RASIS | <input type="checkbox"/> Throughput |
| <input type="checkbox"/> Benchmark | <input type="checkbox"/> TPC | <input type="checkbox"/> SPECint |
| <input type="checkbox"/> Monitoring | <input type="checkbox"/> Sizing | <input type="checkbox"/> SPECfp |
| | <input type="checkbox"/> Bath tub curve | |

- ▶ Q2-34 through Q2-41

Chapter 3 Software

3.1 Operating systems ★★★

[Learning objectives]

- Understand the types, characteristics, functions, and configurations of operating systems, and apply them to associated matters.
- Understand the management mechanisms for typical functions of operating systems, such as job management, task management, and memory management, and apply them to associated matters.

□ Keywords

- | | | |
|--|--|--|
| <input type="checkbox"/> System software | <input type="checkbox"/> UNIX | <input type="checkbox"/> OS for PCs |
| <input type="checkbox"/> Open OS | <input type="checkbox"/> Microkernel | |
| <input type="checkbox"/> Monolithic kernel | <input type="checkbox"/> Middleware | |
| <input type="checkbox"/> Kernel mode (Supervisor mode) | <input type="checkbox"/> User mode | |
| <input type="checkbox"/> Service program | <input type="checkbox"/> Process management | |
| <input type="checkbox"/> Spooling | <input type="checkbox"/> Operations management | <input type="checkbox"/> Interrupt |
| <input type="checkbox"/> Multiprogramming | <input type="checkbox"/> Reader | <input type="checkbox"/> Job scheduler |
| <input type="checkbox"/> Initiator | <input type="checkbox"/> Terminator | <input type="checkbox"/> Master scheduler |
| <input type="checkbox"/> Writer | <input type="checkbox"/> Batch processing | <input type="checkbox"/> Ready state |
| <input type="checkbox"/> Running state | <input type="checkbox"/> Waiting state | |
| <input type="checkbox"/> Process | <input type="checkbox"/> Preemptive | <input type="checkbox"/> Non-preemptive |
| <input type="checkbox"/> Time slice | <input type="checkbox"/> Priority scheduling | <input type="checkbox"/> Round robin |
| <input type="checkbox"/> Time quantum | <input type="checkbox"/> Dispatch | <input type="checkbox"/> Channel |
| <input type="checkbox"/> I/O interrupt | <input type="checkbox"/> Roll-in | <input type="checkbox"/> Roll-out |
| <input type="checkbox"/> Swap-in | <input type="checkbox"/> Swap-out | <input type="checkbox"/> Overlay (Segment) |
| <input type="checkbox"/> Garbage collection | | |
| <input type="checkbox"/> Compaction | <input type="checkbox"/> Base address | <input type="checkbox"/> Segment |

- | | | |
|--|---|--|
| <input type="checkbox"/> Paged segment | <input type="checkbox"/> Thrashing | <input type="checkbox"/> Dynamic address translation |
| <input type="checkbox"/> Page fault | <input type="checkbox"/> Page replacement | |
| <input type="checkbox"/> LRU | <input type="checkbox"/> FIFO | |

► Q2-42 through Q2-52

3.2 Middleware

[Learning objectives]

- Understand the role and basic functions of typical middleware, and apply them to associated matters.

☐ Keywords

- | |
|---|
| <input type="checkbox"/> Linking software between application programs |
| <input type="checkbox"/> DBMS <input type="checkbox"/> Communication management system |
| <input type="checkbox"/> Software development support tool <input type="checkbox"/> Operations management tool |
| <input type="checkbox"/> TP (Transaction Processing) monitor |
| <input type="checkbox"/> Shell <input type="checkbox"/> API <input type="checkbox"/> Component <input type="checkbox"/> JavaBeans |
| <input type="checkbox"/> ActiveX <input type="checkbox"/> CORBA |

► Q2-53 and Q2-54

3.3 File systems

[Learning objectives]

- Understand the mechanism of file management by arrangement in hierarchies, and apply them to associated matters.
- Understand the types and characteristics of file systems, and apply them to associated matters.
- Understand the types and typical characteristics of file organization, access methods, and backup methods, and apply them to associated matters.

☐ Keywords

- | | | |
|---|--|---|
| <input type="checkbox"/> Root directory | <input type="checkbox"/> Current directory | |
| <input type="checkbox"/> Search techniques | <input type="checkbox"/> FAT file system | <input type="checkbox"/> NTFS |
| <input type="checkbox"/> HFS (Hierarchical File System) | <input type="checkbox"/> Volume | <input type="checkbox"/> Multiple backups |
| <input type="checkbox"/> Full backup | <input type="checkbox"/> Differential backup | |

► Q2-55 and Q2-56

3.4 Development tools ★★

[Learning objectives]

- Understand the types, characteristics, and basic functions of basic development tools used in software development, and apply them to associated matters.

□ Keywords

- ☐ CASE tool ☐ Testing tool ☐ Emulator ☐ Simulator
- ☐ ICE (In-Circuit Emulator)
- ☐ Tracer ☐ Inspector ☐ Snapshot
- ☐ Assertion checker ☐ Assembler ☐ Interpreter
- ☐ Linker ☐ Loader ☐ Compiler ☐ Cross compiler
- ☐ Generator ☐ Preprocessor ☐ Source program
- ☐ Object program ☐ Load module

▶ Q2-57 through Q2-60

3.5 Open source software ★★

[Learning objectives]

- Understand the types, typical characteristics, considerations for use, and trends of open source software, and apply them to associated matters.

□ Keywords

- ☐ Linux kernel ☐ Python ☐ Copyleft
- ☐ Dual license ☐ GPL (General Public License)
- ☐ BSD (Berkeley Software Distribution License)
- ☐ MPL (Mozilla Public License) ☐ UnixWare
- ☐ FreeBSD (Free Berkley Software Distribution)
- ☐ OpenBSD, The Open Group

▶ Q2-61

Chapter 4 Hardware

4.1 Hardware ★★★

[Learning objectives]

- Understand the concept of electric and electronic circuits as computer components.
- Understand the characteristics of typical methods for electronically controlling a machine.
- Understand the characteristics of components and the basic considerations of the logical design.
- Understand the importance of power consumption in the development of embedded devices.

Keywords

- | | | | |
|--|---|-------------------------------------|-----------------------------|
| <input type="checkbox"/> NAND circuit | <input type="checkbox"/> Flip-flop | | |
| <input type="checkbox"/> Open loop control | <input type="checkbox"/> Closed loop control | | |
| <input type="checkbox"/> Sequence control | <input type="checkbox"/> PWM (Pulse Width Modulation) control | | |
| <input type="checkbox"/> Diode | <input type="checkbox"/> LED | <input type="checkbox"/> Transistor | <input type="checkbox"/> IC |
| <input type="checkbox"/> LSI | <input type="checkbox"/> VLSI (Very Large Scale Integration) | | |
| <input type="checkbox"/> Flash memory | <input type="checkbox"/> Circuit design | | |

- Q2-62 through Q2-65

2.1**Computer Components****Q2-1** □□□

When an instruction that involves access to the main memory is executed, which of the following is an operation that is performed between “instruction decode” and “operand fetch”?

- a) Calculation of an effective address
- b) Start of an I/O device
- c) Calculation of a branch address
- d) Occurrence of an interrupt

Q2-2 □□□

Which of the following causes an external interrupt?

- a) A page fault that occurs when a non-existent page is accessed under virtual memory management
- b) A privileged instruction violation that occurs when a system management instruction is executed under the general user mode
- c) Machine check due to a hardware failure
- d) Operation exception, such as an overflow caused by a floating-point operation instruction

Q2-3 □□□

Which of the following is an appropriate description concerning the clock frequency of the CPU in a PC?

- a) The timing of instruction execution in the CPU changes depending on the clock frequency. The speed of instruction execution increases with the clock frequency.
- b) The communication speed of the LAN changes depending on the clock frequency. The communication speed of the LAN increases with the clock frequency.
- c) The rotation speed of the hard disk changes depending on the clock frequency. The rotation speed increases with the clock frequency, and the transfer rate of the hard disk increases.
- d) The interrupt interval of the real-time processing changes depending on the clock frequency. The interrupt frequency increases with the clock frequency, and the processing speed of the real-time processing increases.

Q2-4 □□□ **Mandatory question**

A CPU runs at 1 GHz and is capable of executing one machine-language instruction in an average time of 0.8 clocks. Approximately how many million instructions can this CPU execute in one second?

- a) 1.25 b) 2.5 c) 800 d) 1,250

Q2-5 □□□

A CPU has a clock frequency of 1 GHz. When the instruction type of the CPU consists of two types as shown in the table below, what is the approximate performance in MIPS of the CPU?

Instruction type	Execution time (clock)	Frequency of appearance (%)
Instruction 1	10	60
Instruction 2	5	40

- a) 34 b) 100 c) 125 d) 133

Q2-6 □□□ **Mandatory question**

Which of the following is an explanation of pipeline processing in a processor?

- a) It is a method in which multiple processors are synchronized with each other to process multiple data in parallel, based on a single instruction.
- b) It is a method in which the execution time required for a single instruction in a single processor is made as short as possible.
- c) It is a method in which a single processor executes multiple instructions simultaneously by slightly shifting them in stages.
- d) It is a method in which multiple processors process multiple data, based on their own instructions.

Logical operations formula 9

Formula for exclusive logical sum

$$A \oplus B = (\bar{A} \bullet B) + (A \bullet \bar{B}) = (\bar{A} \bullet \bar{B}) \bullet (A + B)$$

Check!

Q2-7 □□□

Which of the following is an explanation of superscalar?

- a) It is a method for splitting a vector to be processed into a set of vectors with the same length as the vector register when the length of the vector is longer than that of the vector register, and then repeating the process.
- b) It is a method for increasing speed with more deeply staged pipelines.
- c) It is a method for increasing speed by enabling the simultaneous execution of multiple instructions with multiple pipelines.
- d) It is a method for increasing speed by using a long instruction word and simultaneously controlling multiple functional units with a single instruction.

Q2-8 □□□

Which of the following is the architecture that allows one instruction to perform multiple instances of the same operation simultaneously for different data, and is implemented on CPUs that are designed for multimedia data processing?

- a) MIMD b) MISD c) SIMD d) SISD

Q2-9 □□□

Mandatory question

Which of the following is an appropriate explanation of DRAM?

- a) It represents one bit depending on whether or not the capacitor is electrically charged. It is often used as the main memory.
- b) Data is written during the manufacturing process. It is used as a memory for storing microprograms.
- c) Data can be written by a dedicated device, and can be erased by ultraviolet irradiation.
- d) It is composed of flip-flops. Although the access speed is fast, the manufacturing cost is high. It is used for cache memory.

How to calculate the probability

Probability =	$\frac{\text{No. of times a particular event occurs}}{\text{No. of all events that can occur}}$	Example)	Probability of drawing a heart from 52 playing cards	=	$\frac{\text{No. of hearts}}{\text{No. of cards}} = \frac{13}{52} = \frac{1}{4}$
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Check!

Q2-10 □□□

Which of the following is the storage device that has the shortest access time?

- a) CPU L2 cache memory
- b) CPU register
- c) Hard disk
- d) Main memory

Q2-11 □□□

Which of the following is an appropriate description concerning cache memory?

- a) It is implemented in two methods. In one method, when a write instruction is executed, data is written to both cache memory and main memory. In the other method, data is written only to cache memory, and is written back into main memory only when it is flushed.
- b) If a cache miss occurs, an interrupt is generated and data is transferred from main memory to cache memory by the program.
- c) Cache memory is used to bridge the difference in capacity between real memory and virtual memory.
- d) Due to a remarkable improvement in the access speed of semiconductor memory, the necessity of cache memory is decreasing.

Q2-12 □□□**Mandatory question**

Which of the following is a combination of the access time and hit ratio for cache memory, and the access time for main memory that has the shortest effective access time for the main memory?

	Cache memory		Main memory
	Access time (nanoseconds)	Hit ratio (%)	Access time (nanoseconds)
a)	10	60	70
b)	10	70	70
c)	20	70	50
d)	20	80	50

Q2-13 □□□

The access time of the cache memory and main memory of systems A and B are as shown in the table below. The hit ratio and effective access time of the cache memory when a particular program is executed in system A are the same as when the program is executed in system B . Which of the following is the hit ratio of the cache memory in such a case?

Unit: nanosecond		
	System A	System B
Cache memory	15	10
Main memory	50	70

- a) 0.2 b) 0.3 c) 0.5 d) 0.8

Q2-14 □□□**Mandatory question**

Which of the following is an appropriate explanation of memory interleaving?

- a) In order to improve the speed of access to main memory from the CPU, data is written simultaneously in both the cache memory and main memory.
- b) In order to improve the speed of access to main memory from the CPU, the main memory is internally divided into multiple banks and each bank is accessed concurrently.
- c) In order to eliminate the bottleneck that is caused by the difference in the access speed of the CPU and main memory, a high-speed and low-capacity memory is allocated.
- d) In order to remove factors that disrupt pipeline processing, the cache memory is divided into two segments: one for instructions and the other for data.

Q2-15 □□□

Which of the following is an optical disc that uses organic dye for the recording layer of the storage media, and records data with a laser beam by burning tiny holes called pits?

- a) CD-R b) CD-RW c) DVD-RAM d) DVD-ROM

How to calculate the expected value

$$\text{Expected value} = x_1p_1 + x_2p_2 + \dots + x_np_n$$

x_1, x_2, \dots, x_n : The value of variable x of a particular attempt
 p_n : Probability of x_n

Check!

Q2-16 □□□

Which of the following is an appropriate explanation of a system bus?

- a) It is a standard that is used in many PCs for serial data transfer between PCs and modems or between PCs and peripheral devices.
- b) It is a mechanism for transferring data between the I/O device and main memory independently of the CPU.
- c) It is a digital signal transmission path that is used for backplanes and expansion slots, and is shared among multiple devices.
- d) It enables connection of devices in a tree topology through a hub, and makes use of two data transfer modes: high speed and low speed.

Q2-17 □□□ **Mandatory question**

Which of the following is an explanation of USB?

- a) It is a parallel interface that is used for connection of a CD-ROM drive or a DVD drive installed in a PC.
- b) It is a parallel interface used for connection of a hard disk or a printer in a daisy chain.
- c) It is a serial interface that enables devices to be connected in a tree topology via a hub.
- d) It is a serial interface that transfers data to a printer by using infrared rays.

Q2-18 □□□

Which of the following is an appropriate characteristic of serial ATA?

- a) It has bidirectional compatibility with SAS (Serial Attached SCSI).
- b) It uses a daisy chain connection.
- c) It has compatibility with parallel ATA in terms of cable and connector.
- d) It is hot swappable.

Q2-19 □□□

Which of the following is the software that is provided for each peripheral device to serve as an interface between the OS and each peripheral device that is connected to a PC so that the application software can use such a peripheral device?

- a) Installer
- b) Device driver
- c) Device manager
- d) Formatter

Q2-20 □□□

Which of the following is a display that requires no backlight because it is self-luminous upon the application of electric voltage, and is characterized by low voltage operation and low power consumption?

- a) CRT
- b) PDP
- c) TFT liquid crystal
- d) Organic Light Emitting Diode (OLED)

Q2-21 □□□

Which of the following is an appropriate explanation of a plasma display?

- a) It displays images by using the light emitted from a gas discharge.
- b) It does not emit light by itself, so it uses a backlight to display images.
- c) It has a structure in which an organic compound is sandwiched between electrodes, and displays images through the use of the light emitted when electricity is passed through this structure.
- d) An electron beam is discharged from an electron gun, and light is emitted when the beam hits the fluorescent material on the surface of the tube to display characters and images.

Q2-22 □□□

Mandatory question

A hard disk has a rotation speed of 5,000 rpm, and an average seek time of 20 milliseconds. The memory capacity per track of the hard disk is 15,000 bytes. What is the average access time, in milliseconds, that is necessary for transferring one block when one block has 4,000 bytes of data?

- a) 27.6 b) 29.2 c) 33.6 d) 35.2

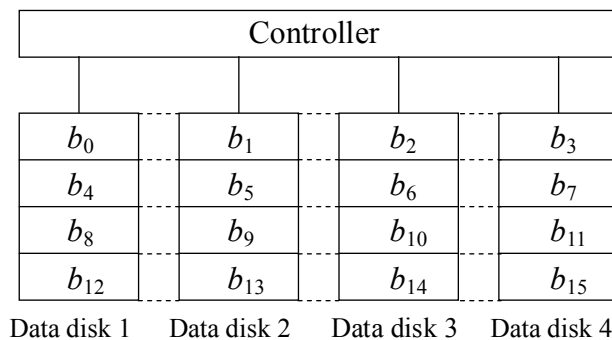
Q2-23 □□□

In a system, one block is composed of 8 sectors and a sector comprises 500 bytes. The system manages files by allocating file area in units of blocks. When files with a size of 2,000 bytes and 9,000 bytes are saved, what is the total number of sectors that is allocated to these two files? Here, sectors occupied by management information such as directories are ignored in the calculation.

- a) 22 b) 26 c) 28 d) 32

Q2-24 □□□

Which of the following is the mechanism of segmenting and storing data on multiple hard disks, as shown in the figure below? Here, b_0 to b_{15} indicate the order in which each bit of data is stored in the data disk.



- a) Striping b) Disk cache
c) Blocking d) Mirroring

Calculating the factorial

$$n! = 1 \times 2 \times 3 \times \dots \times (n-1) \times n$$

Check!

2.2 System Components

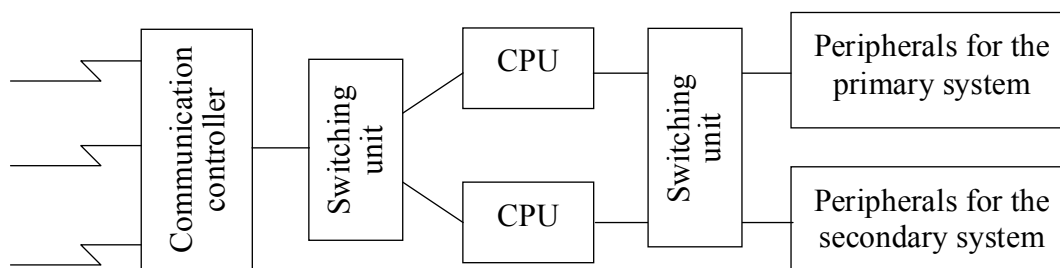
Q2-25 □□□

On what basis are the configurations of RAID 1 to 5 classified?

- a) Access performance to hard disk drives used in each configuration
- b) Differences in the interface connected to the computer
- c) Combinations of where and how both data and redundant bits are stored
- d) Guaranteed reliability that is measured in MTBF

Q2-26 □□□

A system configuration includes two systems as shown in the figure below in which one system performs on-line processing as the primary system, and the other system is on standby as the secondary system in case of a failure of the primary system. Normally, the secondary system performs batch processing. Which of the following indicates such a system configuration?



- a) Simplex system
- b) Dual system
- c) Duplex system
- d) Parallel processor system

Combinations calculation 1

A permutation combination in which m number of different items are selected from n number of items and arranged

$${}_nP_m = \frac{n!}{(n-m)!}$$

Check!

Q2-27 □□□

Which of the following is an appropriate description concerning a hot standby system?

- a) A standby system monitors whether or not the primary system is running, and when it detects a breakdown in the primary system, it immediately takes over the processing of the primary system.
- b) A standby system monitors the jobs that are entered into the primary system, and when a job with a large amount of data processing is entered, the standby system executes the job in place of the primary system.
- c) The standby system monitors the load status of the primary system, and when an overload (overload status) in the primary system is detected, it takes over and performs the processing that resulted in the overload.
- d) The standby system simultaneously executes the same processing as the primary system, and completes the processing if the primary system breaks down.

Q2-28 □□□

Which of the following is an appropriate characteristic of a client/server system?

- a) It is a form of distributed processing in which the client and server work together to perform intended processing, and functions are divided based on the concept of services that are provided by the server.
- b) A tightly coupled system configuration is adopted so that the client and server can have access to common data resources in coordination.
- c) In response to the requests from many servers, the client simultaneously provides the services while it works in coordination with the servers, and controls access to the client resources from the servers.
- d) The database installed on the client that provides the services can also be expanded flexibly according to the size of the system.

Q2-29 □□□

A client/server system is to be constructed. Which of the following is the activity that is reduced most effectively when client processing is performed by a browser instead of a dedicated application?

- a) Maintenance of the client environment
- b) Recovery from a server failure
- c) Construction of databases
- d) Creation and deletion of login accounts

Q2-30 □□□

Which of the following is the technique that is used to improve file access speed by dividing the data of each file into fixed-size blocks, and distributing these blocks across multiple disks that can be accessed in parallel?

- a) Disk at once
- b) Disk cache
- c) Disk striping
- d) Disk mirroring

Q2-31 □□□ **Mandatory question**

Which of the following is an appropriate explanation of a fault tolerant system?

- a) It is a system that retains the necessary functions of the overall system even when the system partially fails.
- b) It is a system that is installed as a backup in a remote site in preparation for local disasters.
- c) It is a system in which multiple processors are connected via a network so as to share the resources.
- d) It is a system in which a single transaction is processed in parallel in multiple processors, and the results are compared.

Combinations calculation 2

A combination in which r number of different items are extracted from n number of items

$${}_nC_r = \frac{n!}{r!(n-r)!}$$

Check!

Q2-32 □□□

Which of the following is appropriate as the concept of fail safe?

- a) A system is always controlled in a safe state even when a failure occurs in the system.
- b) When a problem occurs in the functions of a system, the system operation is continued by degrading its functionality rather than stopping immediately.
- c) The reliability of the system is increased by preparing multiple components of the system that have a significant impact on reliability.
- d) A system is designed so that a malfunction does not occur easily even if an unspecified number of users operate the system.

Q2-33 □□□

Which of the following is a method of connecting auxiliary storage devices, such as a hard disk drive or a magnetic tape unit, in a high-speed dedicated network that is separated from the normal LAN?

- a) DAFS b) DAS c) NAS d) SAN

Q2-34 □□□

Which of the following is an appropriate explanation of throughput?

- a) It is the time that elapses after the loading of a job into a system until the complete acquisition of the result, and it is affected by the I/O speed and the overhead time.
- b) It is the operating ratio of a job, and is calculated from “running time of the job ÷ operation time”.
- c) It is the maximum number of jobs that can be executed concurrently, and depends on the resources of the system that is used.
- d) It is the number of jobs processed per unit time, and spooling is useful for the improvement of system throughput.

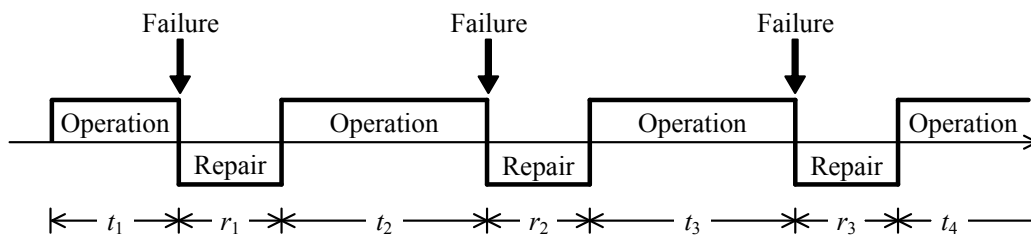
Q2-35 □□□

Which of the following is an appropriate explanation concerning the benchmark used for performance evaluation of a computer?

- TPC, which is a typical benchmark for on-line transaction processing, uses TPS as an objective performance scale but does not have a cost scale.
- Performance benchmarks for an entire computer system include Dhrystone, Whetstone, Livermore Fortran Kernel, Linpack, and SPEC.
- The execution of various types of benchmark tests for performance evaluation is useful in selecting the model to be installed because it enables the understanding of the characteristics of system performance.
- The benchmark test is a general-purpose evaluation model, and its results can be widely applied to the evaluation of computer performance.

Q2-36 □□□ **Mandatory question**

When the system operations model is shown in the figure below, which of the following is the combination of expressions that represent the MTBF and MTTR of the system? Here, t_i represents the system operating time, and r_i represents the system repair time ($i = 1, 2, \dots, n$).



	MTBF	MTTR
a)	$\frac{1}{n} \sum_{i=1}^n r_i$	$\frac{1}{n} \sum_{i=1}^n t_i$
b)	$\frac{1}{n} \sum_{i=1}^n t_i$	$\frac{1}{n} \sum_{i=1}^n r_i$
c)	$\frac{1}{n} \sum_{i=1}^n t_i$	$\frac{1}{n} \sum_{i=1}^n (t_i + r_i)$
d)	$\frac{1}{n} \sum_{i=1}^n (t_i + r_i)$	$\frac{1}{n} \sum_{i=1}^n r_i$

Q2-37 □□□

Among indicators or indexes of RAS used for evaluating the level of system reliability, which of the following is a measure of availability?

- | | |
|--|--------------------------------|
| a) $\frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$ | b) $\text{MTBF} + \text{MTTR}$ |
| c) MTBF | d) MTTR |

Q2-38 □□□

Which of the following causes an increase in availability?

- a) Both MTBF and MTTR are doubled.
- b) Both MTBF and MTTR are halved.
- c) MTBF is doubled and MTTR is halved.
- d) MTBF is halved and MTTR is doubled.

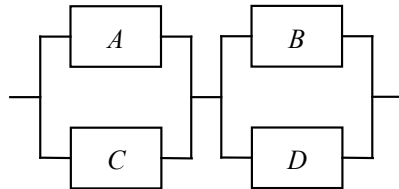
Combinations calculation 3

A combination in which r number of items are extracted from n number of items by allowing duplications ${}_n H_r = {}_{n+r-1} C_r = \frac{(n+r-1)!}{r!(n-1)!}$

Check!

Q2-39 ☐☐☐ **Mandatory question**

Which of the following is the closest to the availability of an entire system that is composed of the four devices *A* to *D*? Here, the availability of devices *A* and *C* is 0.9 and the availability of devices *B* and *D* is 0.8. Furthermore, a section in which devices are connected in parallel is available when either of the devices is operating (available).



- a) 0.72 b) 0.92 c) 0.93 d) 0.95

Q2-40 ☐☐☐

Two printers have an availability of 0.7 and 0.6 respectively. Which of the following is the probability that one of these printers is available and the other is broken down? Here, the operational state of the two printers is independent, and factors other than the printers are ignored.

- a) 0.18 b) 0.28 c) 0.42 d) 0.46

Q2-41 ☐☐☐

In an online system, when an average of 600,000 instructions and two file accesses per transaction need executing, what is the average processing time (in milliseconds) for one transaction on a computer that has a CPU performance of 30 MIPS? Here, the average file access time is 30 milliseconds, and no other processing than this transaction occurs.

- a) 8 b) 40 c) 62 d) 80

How to calculate the average

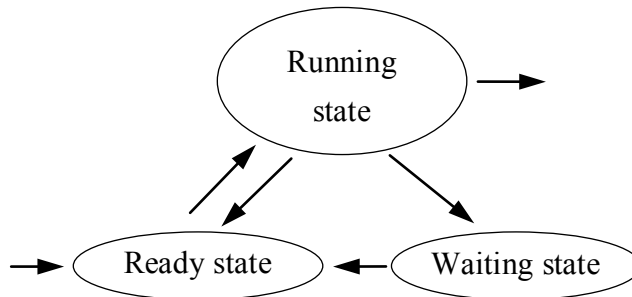
$$\text{Average} = \frac{x_1 + x_2 + \dots + x_n}{n} = \frac{1}{n} \sum_{i=1}^n x_i \quad \begin{array}{l} x_1, x_2, \dots, x_n : \text{Each data} \\ n : \text{No. of data} \end{array}$$

Check!

2.3 Software

Q2-42 □□□

The diagram below shows the state transition of a task in a multitasking computer. Which of the following is an event that causes the state to change from “running” to “ready”?



- a) A task with a higher priority is set to the ready state.
- b) A task is generated.
- c) The processing based on an I/O request is completed.
- d) An I/O request is issued.

Q2-43 □□□

The table below shows the priority of five tasks *A* through *E*, and the operation sequence and processing time of the CPU and I/O device when each task is separately executed. Among tasks *B* through *E*, which of the following is the task that must be combined with task *A* that has a “high” priority so that the idle time of the CPU from the simultaneous start of the execution of the combined tasks until the end of the execution of both tasks can be reduced to zero? Here, there is no I/O conflict, and the OS overheads can be ignored. Furthermore, the numbers within parentheses in the table indicate the processing time.

	Task	Priority	Operation sequence and processing time (in milliseconds) during separate execution
	<i>A</i>	High	CPU(3) → I/O(3) → CPU(3) → I/O(3) → CPU(2)
a)	<i>B</i>	Low	CPU(2) → I/O(5) → CPU(2) → I/O(2) → CPU(3)
b)	<i>C</i>	Low	CPU(3) → I/O(2) → CPU(2) → I/O(3) → CPU(2)
c)	<i>D</i>	Low	CPU(3) → I/O(2) → CPU(3) → I/O(1) → CPU(4)
d)	<i>E</i>	Low	CPU(3) → I/O(4) → CPU(2) → I/O(5) → CPU(2)

Q2-44 □□□

Which of the following is a task scheduling algorithm where a specific task has a high possibility of waiting indefinitely for the allocation of CPU resources?

- a) The priority of each task is determined and the tasks are executed from the highest priority to the lowest. However, the priority is increased gradually according to the length of time waiting for CPU allocation.
- b) Each task is executed according to the order in the CPU queue, and once a fixed period of time has elapsed, the execution of a task is suspended and it is appended to the end of the CPU queue.
- c) Processing is performed from the task with the shortest expected processing time. When the processing that is currently being executed is completed or suspended for some reason, the next task is started.
- d) Tasks are appended to the end of the ready queue in order of arrival at the system, and the CPU is always allocated to the first task in the ready queue.

Q2-45 □□□

There are three CPU-bound jobs *A*, *B*, and *C*. When these jobs are executed separately, the processing time is 5 minutes for job *A*, 10 minutes for job *B*, and 15 minutes for job *C*. When these three jobs are executed concurrently based on the scheduling algorithm described below, approximately how long (in minutes) does it take to complete job *B*?

[Scheduling algorithm]

- (1) If a job does not finish within a fixed period of time (called a time quantum), it is suspended and moved to the end of the queue.
- (2) Jobs are executed in queueing order.
- (3) The time quantum has a sufficiently smaller value in comparison with the processing time of a job.
- (4) The switching time between jobs is ignored.

- a) 15 b) 20 c) 25 d) 30

Q2-46 ☐☐☐ **Mandatory question**

When a virtual memory system does not have enough main memory, which of the following is the state in which the overheads of the system increase and the processor utilization by applications decreases if the number of programs running concurrently is increased?

- a) Thrashing
- b) Fragmentation
- c) Paging
- d) Bottleneck

Q2-47 ☐☐☐

In a computer using the variable partitioning method by which the main memory is allocated in units of program modules, five modules *A* to *E* are loaded and unloaded in the order shown below. When the last module *E* is loaded, how many free main memory areas exist? Here, the size of the main memory is 500 KB, and nothing is loaded in the initial state. In addition, modules are loaded from the beginning of a free area, and no other conditions are considered.

[Order of loading and unloading]

Load *A* → Load *B* → Load *C* → Unload *B* → Load *D* → Unload *A* → Load *E*

[Size of modules]

Module	Size (KB)
<i>A</i>	200
<i>B</i>	100
<i>C</i>	150
<i>D</i>	80
<i>E</i>	90

- a) 3
- b) 4
- c) 5
- d) 6

How to calculate the median

Median (middle value) Example) 1, 1, 2, 2, 2, 4, 5, 5, 8, 8, 10 Median = 4

Note: If there is an even number of data points, the median is the mean of the two middle values.

Check!

Q2-48 □□□

Which of the following is an effect that is achieved by a virtual memory system?

- a) The effective access speed of the main memory increases.
- b) The apparent capacity of the main memory increases.
- c) The power consumption decreases.
- d) The information in main memory is not erased even if the power is turned off.

Q2-49 □□□

In a paging-based virtual memory system, the LRU algorithm is used for page replacement. When pages 1, 2, 3, 4, 5, 2, 1, 3, 2, and 6 are accessed in this order by using four page frames that are allocated to the main memory, which of the following is the page that is replaced when page 6 is accessed? Here, no page exists in the main memory in the initial state.

- a) 1
- b) 2
- c) 4
- d) 5

Q2-50 □□□**Mandatory question**

Which of the following is an appropriate explanation of the spooling function?

- a) When a task is being executed, the CPU is allocated to another task if the CPU switches to the idle state as a result of the execution of an I/O instruction.
- b) The program being executed is temporarily suspended, and control is transferred to the control program.
- c) By performing data transfer between main memory and a low-speed I/O device via an auxiliary storage device, the throughput of the entire system is improved.
- d) By providing a buffer pool that consists of multiple buffers and increasing the probability of accessing the buffer in main memory, the access time for the auxiliary storage is reduced.

How to calculate the mode

Mode (the number that occurs most frequently in the data set)

Example) 1, 1, 2, 2, 2, 4, 5, 5, 8, 8, 10 Mode = 2

Check!

Q2-51 □□□

A computer takes 200 nanoseconds for a single access to main memory, and has an overhead of 100 milliseconds for each page fault. When a page fault occurs once every 500,000 accesses to the main memory, which of the following is the maximum number of page faults per second? Here, factors other than the page fault overhead are ignored in the calculation.

- a) 3 b) 4 c) 5 d) 6

Q2-52 □□□

When printing is performed under the conditions below, what is the minimum capacity (in MB) required for all spool files?

[Conditions]

- (1) The same job is executed continuously four times with a multiplicity of 1.
- (2) When the job is executed in a stand-alone mode, it takes 20 minutes.
- (3) A spool file for printing with a size of 400 megabytes is secured for the execution of a single job, and the printing data is written to this file.
- (4) After the execution of the job, the contents of the spool file are processed by the printing function of the OS.
- (5) Once printing is completed, the spool file is deleted by the OS. Here, the deletion time is ignored.
- (6) One printer is available, and the printing speed is 10 minutes for every 100 MB.
- (7) The jobs can be executed and printed in parallel, and these processes do not affect each other.

- a) 400 b) 800 c) 1,200 d) 1,600

Q2-53 □□□

Which of the following is an appropriate explanation of API (Application Program Interface) in an OS?

- a) It is a mechanism by which an application directly operates hardware to achieve various functions.
- b) It is a mechanism by which various functions provided by the OS are used from an application.
- c) It is a mechanism by which communication is performed between multiple applications across a network.
- d) It is a mechanism by which the menu items of each application are standardized for the convenience of the users.

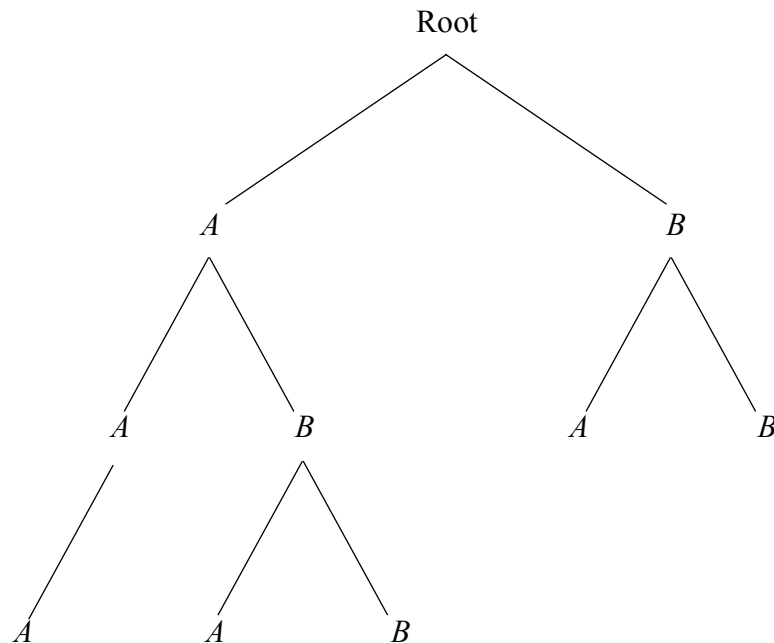
Q2-54 □□□

Which of the following is an appropriate explanation of middleware?

- a) Software that provides basic functions for using the CPU, memory, and I/O devices from the application software
- b) Software that uses the functions of an OS to provide higher-level basic functions common to various application fields
- c) Software that manages business resources in an integrated way and helps achieve efficient business, from the perspective of using business resources effectively
- d) Software that has functions, such as communication via e-mail and electronic bulletin boards, data sharing, and centralized schedule management, to support collaborative work

Q2-55 □□□ **Mandatory question**

Multiple directories with the directory names A and B are managed in a structure shown in the figure below.



When the current directory is moved in order of $\backslash A \backslash B \rightarrow \dots \rightarrow \dots \backslash B \rightarrow \dots \backslash A$, what is the resulting current directory? Here, directories are specified as follows:

[Method of specifying directories]

- (1) A directory is referenced as “directory name\ ... \directory name”, where the directory names on the path are listed and separated by “\” in sequence, followed by the directory name.
- (2) The current directory is represented by “.” (a period).
- (3) The directory one level above is represented by “..” (two periods).
- (4) When a reference begins with a “\”, it is assumed that the root directory is omitted from the beginning of the reference.
- (5) When a reference does not start with “\”, “.” (a period), or “..” (two periods), it is assumed that “.” for the current directory is omitted from the beginning of the reference.

a) $\backslash A$ b) $\backslash A \backslash A$ c) $\backslash A \backslash B \backslash A$ d) $\backslash B \backslash A$
How to calculate the variance

$$\text{Variance} = \frac{1}{n} = \{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \dots + (x_n - \bar{x})^2\} = \overline{x^2} - (\bar{x})^2$$

x_1, x_2, \dots, x_n : Each data
 \bar{x} : Mean value
 n : No. of data

Check!

Q2-56 □□□

Among the descriptions concerning the storage of a file, which of the following is an appropriate explanation of an archive?

- a) The specific data of main memory or the value of a register is temporarily stored in another storage device.
- b) Two hard disks store identical files in order to secure the reliability of data storage.
- c) The update history of a file is stored on a hard disk.
- d) Multiple files are bundled and stored as a single file in a storage device.

Q2-57 □□□

Which of the following is an appropriate explanation of various types of language processors?

- a) An assembler converts a source program that is written for a particular processor into a source program for another processor.
- b) An interpreter is a microprogram that decodes and executes a program written for another computer.
- c) A generator creates a program as appropriate for the purpose of processing by specifying the necessary conditions, such as input, process, and output, as parameters.
- d) A translator executes a program written in a high-level language while interpreting it on a per line basis.

Q2-58 □□□

Which of the following is an appropriate explanation of optimization in a compiler?

- a) Generating an intermediate code for an interpreter, instead of creating an object code
- b) Generating an object code which runs on a computer whose architecture is different from the computer which performs compilation
- c) Generating an object code with improved run-time processing efficiency by analyzing the program code
- d) Generating an object code is generated which displays the invoked routine name and the content of a variable at a particular point in time during the execution of a program

How to calculate the standard deviation

Standard deviation = $\sqrt{S^2}$ S: Variance

Check!

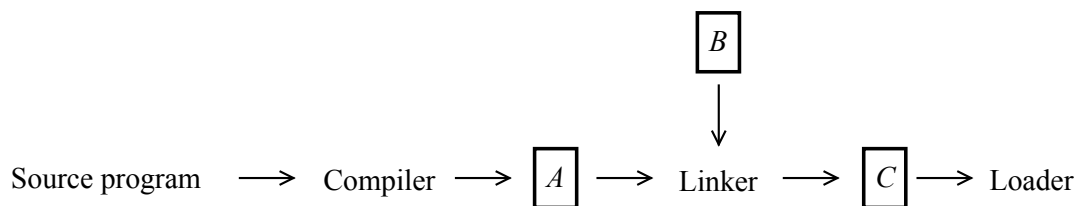
Q2-59 □□□

Which of the following is an appropriate explanation of the functions of a programming tool?

- a) An inspector displays the content of data during the execution of a program.
- b) A simulator displays the execution path within a program or between programs.
- c) A tracer makes it easier to search for functional explanations and data definitions in each program.
- d) A browser edits the source code of a program by using functions such as character insertion, deletion, and substitution.

Q2-60 □□□

The figure below shows the flow from the translation of a program until its execution. Which of the following is an appropriate combination of inputs/outputs to and from compiler, linker, and loader?



	<i>A</i>	<i>B</i>	<i>C</i>
a)	Object program	Library module	Load module
b)	Library module	Load module	Object program
c)	Load module	Object program	Library module
d)	Load module	Library module	Object program

Q2-61 □□□

Mandatory question

Which of the following is an appropriate explanation in accordance with the definition of open source software provided by OSI?

- a) When open source software is created for a particular industry, the source code can be released only within that industry.
- b) When open source software is modified and redistributed, the same license must be applied so that the distribution conditions are the same as the original software.
- c) When open source software is redistributed as a product by a third party, the developer of the open source software can ask the third party for a licensing fee.
- d) When open source software is modified, such as for in-house use but not for redistribution, the modified source code need not be released to the public.

Calculating a sequence of numbers

$$\text{Sum of integers from 1 to } n = \sum_{k=1}^n k = 1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}$$

Check!

2.4 Hardware

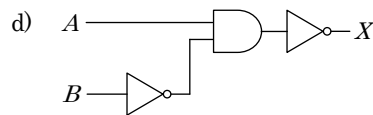
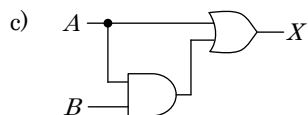
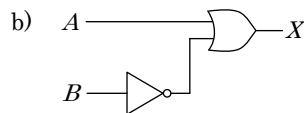
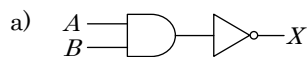
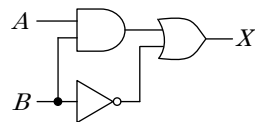
Q2-62 ■■■ Mandatory question

Which of the following is an appropriate description concerning flash memory?

- a) It operates at high speed and is used for cache memory.
- b) All the data in memory can be erased with ultraviolet rays.
- c) Data in memory must be re-written periodically.
- d) Data can be electrically erased on a block-by-block basis.

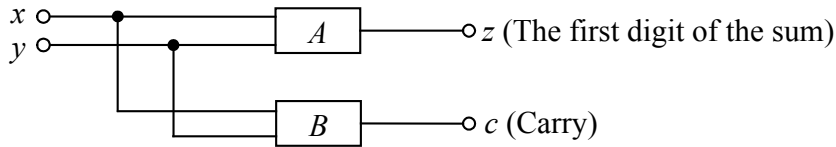
Q2-63 ■■■ Mandatory question

Which of the following is a logic circuit from which the same output is obtained as the logic circuit shown in the figure below? Here, \square represents the logical product (AND), \sqcup represents the logical sum (OR), and \neg represents negation (NOT).



Q2-64 □□□

The half adder in the diagram below adds two single-digit binary numbers x and y , and produces z (the first digit of the sum) and c (carry) as output. Which of the following is an appropriate combination of the gate devices A and B ?



	A	B
a)	Exclusive logical sum (XOR)	Logical product (AND)
b)	Negative logical product (NAND)	Negative logical sum (NOR)
c)	Negative logical sum (NOR)	Exclusive logical sum (XOR)
d)	Logical product (AND)	Logical sum (OR)

Q2-65 □□□

Which of the following is an appropriate explanation of SoC (System on a Chip)?

- It is an electronic circuit board of a computer including the CPU, chipset, video chip, and memory.
- It is a semiconductor chip equipped with a series of circuits that manages the transfer of data between devices such as the CPU, memory, and peripherals.
- It is a semiconductor chip in which all the necessary functions (systems) are integrated using the same process.
- It is a semiconductor chip in which functions with different processes are manufactured by individually optimized processes, and each chip is wired appropriately on the package.

How to calculate the value in performance

$$\text{Computer performance (MIPS)} = \frac{1}{\text{Mean instruction execution time (seconds)} \times 10^6}$$

Check!

Section 2 Computer System List of Answers

Q2-1	a)	Q2-31	a)	Q2-61	d)
Q2-2	c)	Q2-32	a)	Q2-62	d)
Q2-3	a)	Q2-33	d)	Q2-63	b)
Q2-4	d)	Q2-34	d)	Q2-64	a)
Q2-5	c)	Q2-35	c)	Q2-65	c)
Q2-6	c)	Q2-36	b)		
Q2-7	c)	Q2-37	a)		
Q2-8	c)	Q2-38	c)		
Q2-9	a)	Q2-39	d)		
Q2-10	b)	Q2-40	d)		
Q2-11	a)	Q2-41	d)		
Q2-12	d)	Q2-42	a)		
Q2-13	d)	Q2-43	c)		
Q2-14	b)	Q2-44	c)		
Q2-15	a)	Q2-45	c)		
Q2-16	c)	Q2-46	a)		
Q2-17	c)	Q2-47	a)		
Q2-18	d)	Q2-48	b)		
Q2-19	b)	Q2-49	d)		
Q2-20	d)	Q2-50	c)		
Q2-21	a)	Q2-51	c)		
Q2-22	b)	Q2-52	c)		
Q2-23	d)	Q2-53	b)		
Q2-24	a)	Q2-54	b)		
Q2-25	c)	Q2-55	d)		
Q2-26	c)	Q2-56	d)		
Q2-27	a)	Q2-57	c)		
Q2-28	a)	Q2-58	c)		
Q2-29	a)	Q2-59	a)		
Q2-30	c)	Q2-60	a)		

Technology

Morning Exam

Section 3

Technology Elements

Learning Objectives

1. Be able to understand the details of screen, form, and code design in the field of human interfaces.
2. Be able to understand various data formats and application systems such as virtual reality in the field of multimedia.
3. Be able to understand the fundamentals of data model, as well as E-R diagram and normalization in the field of data analysis.
4. Be able to understand SQL based database manipulation methods on the fundamentals of set operation and relational operation in the field of data manipulation.
5. Be able to explain the functions of a DBMS (DataBase Management System) and failure recovery of a database.
6. Be able to explain the functions of each layer of OSI, protocols of TCP/IP, transmission technologies such as error control and synchronization control, and communication lines.
7. Be able to explain various technologies and details of services in the field of the Internet.
8. Be able to calculate transfer speed and line utilization rate for assessing the performance of a network.
9. Be able to explain characteristics and functions of transmission media and various communication devices.
10. Be able to explain encryption, authentication, access control, and antivirus measures in the topic of security.
11. Be able to explain firewalls and security protocols in the topic of network security.
12. Be able to explain the fundamentals of risk analysis, categories, and measures in the topic of risk management.

Chapter 1 Human Interface

1.1 Human interface technology ★★

[Learning objectives]

- Understand the concept and purpose of information architecture, and apply them to associated matters.
- Understand the types and features of typical human interface technologies, and apply them to associated matters.
- Understand the features and components of GUI and points to be considered in GUI screen design, and apply them to associated matters.

□ Keywords

<input type="checkbox"/> Navigation	<input type="checkbox"/> Usability	<input type="checkbox"/> Accessibility	<input type="checkbox"/> Interactive system
<input type="checkbox"/> Voice recognition	<input type="checkbox"/> Image recognition	<input type="checkbox"/> Moving image recognition	
<input type="checkbox"/> Feature extraction	<input type="checkbox"/> Selective perception		
<input type="checkbox"/> Non-verbal interface	<input type="checkbox"/> Natural language interface		
<input type="checkbox"/> Window	<input type="checkbox"/> Icon	<input type="checkbox"/> Radio button (Radio box)	
<input type="checkbox"/> Checkbox	<input type="checkbox"/> List box	<input type="checkbox"/> Pull-down menu	
<input type="checkbox"/> Pop-up menu	<input type="checkbox"/> Text box		

► Q3-1 through Q3-3

1.2 Interface design

[Learning objectives]

- Understand the concept and basic procedures of screen design, form design, and code design, and apply them to associated matters.
- Understand the desirable interface that is created by applying the concept of universal design and its basic techniques, and apply them to associated matters.

□ Keywords

<input type="checkbox"/> Numeric check	<input type="checkbox"/> Format check	<input type="checkbox"/> Limit check	<input type="checkbox"/> Combination check
<input type="checkbox"/> Matching check	<input type="checkbox"/> Balance check	<input type="checkbox"/> Check character	<input type="checkbox"/> Form overlay
<input type="checkbox"/> Sequence code	<input type="checkbox"/> Block code (Classification code)		
<input type="checkbox"/> Group classification code	<input type="checkbox"/> Mnemonic code	<input type="checkbox"/> Synthetic code	
<input type="checkbox"/> Frame	<input type="checkbox"/> Navigation	<input type="checkbox"/> In-site search function	<input type="checkbox"/> ISO 13407
<input type="checkbox"/> WAI (Web Accessibility Initiative)			
<input type="checkbox"/> WCAG 1.0 (Web Content Accessibility Guidelines 1.0)			

► Q3-4 through Q3-7

Chapter 2 Multimedia

2.1 Multimedia technology ★★

[Learning objectives]

- Understand the mechanism of characters, audio, and images in computers, and methods of integrating and handling them, and apply them to associated matters.
- Understand the purpose of information compression and decompression, as well as the typical characteristics, and apply them to associated matters.

☐ Keywords

<input type="checkbox"/> Web content	<input type="checkbox"/> Hypermedia	<input type="checkbox"/> Streaming	<input type="checkbox"/> Authoring environment
<input type="checkbox"/> PDF	<input type="checkbox"/> PCM	<input type="checkbox"/> MIDI	
<input type="checkbox"/> WAV (Waveform Audio Format)	<input type="checkbox"/> MP3	<input type="checkbox"/> JPEG	
<input type="checkbox"/> GIF	<input type="checkbox"/> PNG	<input type="checkbox"/> BMP	<input type="checkbox"/> TIFF
<input type="checkbox"/> Exif (Exchangeable Image File Format)	<input type="checkbox"/> MPEG	<input type="checkbox"/> QuickTime	
<input type="checkbox"/> AVI	<input type="checkbox"/> ZIP	<input type="checkbox"/> LZH	<input type="checkbox"/> Compression ratio
<input type="checkbox"/> Lossless compression	<input type="checkbox"/> Lossy compression		

► Q3-8 through Q3-10

2.2 Multimedia application ★★

[Learning objectives]

- Understand the characteristics of multimedia systems, and examples of multimedia applications.

☐ Keywords

<input type="checkbox"/> CG	<input type="checkbox"/> Simulator	<input type="checkbox"/> Video game
<input type="checkbox"/> AR (Augmented Reality)		
<input type="checkbox"/> VR (Virtual Reality)	<input type="checkbox"/> Video on demand	

► Q3-11 and Q3-12

Chapter 3 Databases

3.1 Database architecture

[Learning objectives]

- Understand the types of database, their characteristics, database models, and basic concept of a three-layer schema, and apply them to associated matters.
- Understand the purpose and typical functions of a database management system, and apply them to associated matters.

☐ Keywords

- | | |
|---|---|
| <input type="checkbox"/> Relational database | <input type="checkbox"/> Structured database |
| <input type="checkbox"/> HDB (Hierarchical DataBase) | <input type="checkbox"/> NDB (Network DataBase) |
| <input type="checkbox"/> OODB (Object Oriented DataBase) | |
| <input type="checkbox"/> Hypertext database | <input type="checkbox"/> Multimedia database |
| <input type="checkbox"/> XML database | <input type="checkbox"/> Conceptual data model |
| <input type="checkbox"/> Logical data model (External model) | <input type="checkbox"/> Relational model |
| <input type="checkbox"/> Hierarchical model | <input type="checkbox"/> Network model |
| <input type="checkbox"/> Physical data model (Internal model) | |
| <input type="checkbox"/> Conceptual schema | <input type="checkbox"/> External schema (Subschema) |
| <input type="checkbox"/> Internal schema (Storage schema) | <input type="checkbox"/> Relation |
| <input type="checkbox"/> Tuple (Row) | <input type="checkbox"/> Attribute (Column, Field) |
| <input type="checkbox"/> Occurrence | <input type="checkbox"/> Domain |
| <input type="checkbox"/> Database definition function | <input type="checkbox"/> Database manipulation function |
| <input type="checkbox"/> Database control function | <input type="checkbox"/> Maintenance function <input type="checkbox"/> Data security protection |
| <input type="checkbox"/> Exclusive control | <input type="checkbox"/> Failure recovery <input type="checkbox"/> Security |

- Q3-13 and Q3-14

3.2 Database design ★★★

[Learning objectives]

- Understand the concept of data analysis and database design, and apply them to associated matters.
- Understand the purpose and procedure of data normalization, and apply them to associated matters.
- Understand the points to be considered in the physical design of databases, and apply them to associated matters.

□ Keywords

- | | |
|--|---|
| <input type="checkbox"/> Elimination of data duplication | <input type="checkbox"/> Metadata |
| <input type="checkbox"/> Data dictionary | <input type="checkbox"/> Entity <input type="checkbox"/> Attribute |
| <input type="checkbox"/> Relationship | <input type="checkbox"/> Primary key <input type="checkbox"/> Foreign key |
| <input type="checkbox"/> Field (Item) | <input type="checkbox"/> Record <input type="checkbox"/> File |
| <input type="checkbox"/> NULL <input type="checkbox"/> Unique constraint | <input type="checkbox"/> Normalization |
| <input type="checkbox"/> Full functional dependency | <input type="checkbox"/> Partial functional dependency |
| <input type="checkbox"/> Transitive functional dependency | |

► Q3-15 through Q3-18

3.3 Data manipulation ★★★

[Learning objectives]

- Understand the typical data manipulations for a relational database, and apply them to associated matters.
- Understand the basics of key database languages and SQL statements, and apply them to associated matters.

□ Keywords

- | | |
|--|--|
| <input type="checkbox"/> Relational algebra | <input type="checkbox"/> Interactive SQL <input type="checkbox"/> Embedded SQL |
| <input type="checkbox"/> View <input type="checkbox"/> Query | <input type="checkbox"/> Referential constraint |
| <input type="checkbox"/> Check constraint | <input type="checkbox"/> Non-NULL constraint |
| <input type="checkbox"/> Access right | <input type="checkbox"/> Set function <input type="checkbox"/> Cursor |

► Q3-19 through Q3-24

3.4 Transaction processing ★★★

[Learning objectives]

- Understand the basic mechanisms of failure recovery and exclusive control of a database, and apply them to associated matters.
- Understand the concept for transaction management and improving access efficiency, and apply them to associated matters.
- Understand the necessity of access control for data, and key types of access rights.

□ Keywords

- | | | |
|--|---|---|
| <input type="checkbox"/> Exclusive lock | <input type="checkbox"/> Shared lock | <input type="checkbox"/> Lock granularity |
| <input type="checkbox"/> Deadlock | <input type="checkbox"/> One-phase commitment | <input type="checkbox"/> Two-phase commitment |
| <input type="checkbox"/> Journal file (Log file) | | <input type="checkbox"/> Checkpoint |
| <input type="checkbox"/> Roll forward | <input type="checkbox"/> Roll back | <input type="checkbox"/> Warm start |
| <input type="checkbox"/> Cold start | <input type="checkbox"/> “Read” right | <input type="checkbox"/> “Insert” right |
| <input type="checkbox"/> “Delete” right | | |

► Q3-25 through Q3-28

3.5 Database application

[Learning objectives]

- Understand how databases are applied to data analysis, business systems, software development and maintenance, etc.
- Understand the characteristics and advantages of distributed databases, their points to be kept in mind, and mechanism of data synchronization.
- Understand the outline of data resource management.

□ Keywords

- | | |
|---|---|
| <input type="checkbox"/> OLTP (Online Transaction Processing) | <input type="checkbox"/> Document management system |
| <input type="checkbox"/> SFA (Sales Force Automation) | <input type="checkbox"/> Transparency |
| <input type="checkbox"/> Commitment control | <input type="checkbox"/> Replication |
| <input type="checkbox"/> IRDS (Information Resource Directory System) | |
| <input type="checkbox"/> Repository | |

► Q3-29 through Q3-31

Chapter 4 Network

4.1 Network architecture ★★

[Learning objectives]

- Understand the definitions of LAN and WAN, their typical characteristics, and the typical services offered by telecommunications companies, and apply them to associated matters.
- Understand wired LAN and wireless LAN, mechanism of switching systems, and their typical characteristics, and apply them to associated matters.
- Understand the relation between line speed, data volume, and transfer time, and apply them to associated matters.

□ Keywords

- | | | |
|--|--|--|
| <input type="checkbox"/> Internet service provider | <input type="checkbox"/> Metered rate | <input type="checkbox"/> Flat monthly fee |
| <input type="checkbox"/> IDF (Intermediate Distribution Frame) | | <input type="checkbox"/> Packet switched network |
| <input type="checkbox"/> Circuit switching network | <input type="checkbox"/> Frame relay service | |
| <input type="checkbox"/> ATM (Asynchronous Transfer Mode) service | | |
| <input type="checkbox"/> Coaxial cable | <input type="checkbox"/> Twisted pair cable | <input type="checkbox"/> Optical fiber cable |
| <input type="checkbox"/> Electromagnetic wave | <input type="checkbox"/> Infrared ray | <input type="checkbox"/> Wireless LAN access point |
| <input type="checkbox"/> Packet | <input type="checkbox"/> VoIP (Voice over Internet Protocol) | |
| <input type="checkbox"/> Transfer rate | <input type="checkbox"/> bps (bit per second: bit/second) | <input type="checkbox"/> Circuit capacity |
| <input type="checkbox"/> Bit error rate | <input type="checkbox"/> Traffic intensity | <input type="checkbox"/> Erlang |
| <input type="checkbox"/> IPv4 | <input type="checkbox"/> IPv6 | <input type="checkbox"/> Address class |
| | | <input type="checkbox"/> Global IP address |
| <input type="checkbox"/> Private IP address <input type="checkbox"/> NAT (Network Address Translation) | | |
| <input type="checkbox"/> Overlay network | <input type="checkbox"/> DNS | <input type="checkbox"/> Proxy server |
| | | <input type="checkbox"/> Firewall |

- Q3-32 through Q3-35

4.2 Data communication and control ★★★

[Learning objectives]

- Understand the basic concept and configuration of network architecture, and apply them to associated matters.
- Understand the types and typical characteristics of transmission methods and lines, and apply them to associated matters.
- Understand the types and typical characteristics of devices for LAN to LAN connection, and apply them to associated matters.
- Understand the basic mechanism and characteristics of typical control functions in a network, and apply them to associated matters.

□ Keywords

<input type="checkbox"/> Point to point (Point-to-point connection)	<input type="checkbox"/> Tree topology	<input type="checkbox"/> Bus topology
<input type="checkbox"/> Star topology	<input type="checkbox"/> Ring topology	<input type="checkbox"/> Physical layer
<input type="checkbox"/> Network layer	<input type="checkbox"/> Transport layer	<input type="checkbox"/> Session layer
<input type="checkbox"/> Application layer	<input type="checkbox"/> Simplex	<input type="checkbox"/> Half duplex
<input type="checkbox"/> Two-wire	<input type="checkbox"/> Four-wire	<input type="checkbox"/> Series
<input type="checkbox"/> WDM (Wavelength Division Multiplexing)	<input type="checkbox"/> Circuit switching	<input type="checkbox"/> Packet switching
<input type="checkbox"/> ATM switching	<input type="checkbox"/> Frame relay	<input type="checkbox"/> Cell relay
<input type="checkbox"/> Leased line	<input type="checkbox"/> Repeater	<input type="checkbox"/> Hub
<input type="checkbox"/> Cascade connection	<input type="checkbox"/> Switching hub	<input type="checkbox"/> Router
<input type="checkbox"/> Digital service unit	<input type="checkbox"/> Layer-2 (L2) switch	
<input type="checkbox"/> Layer-3 (L3) switch	<input type="checkbox"/> Bridge	<input type="checkbox"/> Gateway
<input type="checkbox"/> Spanning tree	<input type="checkbox"/> Data Link control	<input type="checkbox"/> Routing control
<input type="checkbox"/> Basic mode data transmission control procedure		<input type="checkbox"/> Flow control
<input type="checkbox"/> Polling / Selecting	<input type="checkbox"/> HDLC	<input type="checkbox"/> Multilink procedure
<input type="checkbox"/> Connection method		<input type="checkbox"/> Switching method
<input type="checkbox"/> SYN synchronization		<input type="checkbox"/> Connection-less method
<input type="checkbox"/> Frame synchronization		<input type="checkbox"/> Flag synchronization
<input type="checkbox"/> CSMA/CD	<input type="checkbox"/> Token passing	<input type="checkbox"/> TDMA (Time Division Multiple Access)
		<input type="checkbox"/> Collision

► Q3-36 through Q3-38

4.3 Communication protocols ★★

[Learning objectives]

- Understand which layer of the OSI model is implemented by TCP/IP, which is one of the typical protocols, and apply it to associated matters.

□ Keywords

<input type="checkbox"/> Packet	<input type="checkbox"/> Header	<input type="checkbox"/> PPP	
<input type="checkbox"/> PPPoE (Point to Point Protocol over Ethernet)		<input type="checkbox"/> IP address	
<input type="checkbox"/> Subnet address	<input type="checkbox"/> Subnet mask		
<input type="checkbox"/> Physical address	<input type="checkbox"/> Routing	<input type="checkbox"/> Unicast	<input type="checkbox"/> Broadcast
<input type="checkbox"/> Multicast	<input type="checkbox"/> ICMP (Internet Control Message Protocol)		
<input type="checkbox"/> CIDR (Classless Inter Domain Routing)	<input type="checkbox"/> Port number		
<input type="checkbox"/> TELNET	<input type="checkbox"/> DHCP	<input type="checkbox"/> IMAP	<input type="checkbox"/> NTP
<input type="checkbox"/> 10BASE-T	<input type="checkbox"/> 100BASE-TX	<input type="checkbox"/> 1000BASE-T	<input type="checkbox"/> HDLC
<input type="checkbox"/> IEEE 802.11a/b/g/n	<input type="checkbox"/> CORBA		
<input type="checkbox"/> Distributed object technology			

- ▶ Q3-39 through Q3-44

4.4 Network management

[Learning objectives]

- Understand the outline of control items in network operations management.
- Understand the outline of tools and protocols for network management.

□ Keywords

<input type="checkbox"/> Network configuration	<input type="checkbox"/> Version	<input type="checkbox"/> Information collection	
<input type="checkbox"/> Fault isolation	<input type="checkbox"/> Fault cause identification	<input type="checkbox"/> Recovery action	
<input type="checkbox"/> Record	<input type="checkbox"/> Traffic monitoring	<input type="checkbox"/> ping	
<input type="checkbox"/> ifconfig (ipconfig)	<input type="checkbox"/> arp	<input type="checkbox"/> netstat	<input type="checkbox"/> SNMP agent
<input type="checkbox"/> SNMP management station			
<input type="checkbox"/> MIB (Management Information Base)			

- ▶ Q3-45

4.5 Network application ★★

[Learning objectives]

- Understand the mechanisms of the Web and e-mail used on the Internet, and apply them to associated matters.
- Understand the characteristics of an intranet and an extranet, and apply them to associated matters.
- Understand the characteristics of network OS, and apply them to associated matters.
- Understand the outline of typical communication services.

☐ Keywords

- | | | | |
|--|--|--|-------------------------------|
| <input type="checkbox"/> SMTP | <input type="checkbox"/> POP3 | <input type="checkbox"/> IMAP4 | <input type="checkbox"/> MIME |
| <input type="checkbox"/> HTTP | <input type="checkbox"/> CGI | <input type="checkbox"/> cookie | <input type="checkbox"/> URL |
| <input type="checkbox"/> Upload | <input type="checkbox"/> Download | | |
| Search engine (<input type="checkbox"/> Full text search, <input type="checkbox"/> Directory type, <input type="checkbox"/> Robot type) | | | |
| <input type="checkbox"/> VPN | <input type="checkbox"/> PVC (Permanent Virtual Connection (or Circuit)) | | |
| <input type="checkbox"/> EC (Electronic Commerce) | <input type="checkbox"/> EDI | | |
| <input type="checkbox"/> NetWare | <input type="checkbox"/> Leased line service | <input type="checkbox"/> Circuit switching service | |
| <input type="checkbox"/> Packet switching service | <input type="checkbox"/> IP telephone | <input type="checkbox"/> ADSL | |
| <input type="checkbox"/> FTTH | <input type="checkbox"/> Mobile communication | <input type="checkbox"/> Satellite communication service | |
| <input type="checkbox"/> International communication services | <input type="checkbox"/> Wide-area Ethernet | <input type="checkbox"/> IP-VPN | |

- ▶ Q3-46 through Q3-49

Chapter 5 Security

5.1 Information security ★★★

[Learning objectives]

- Understand the concept of information security, and apply them to associated matters.
- Understand the technologies of information security required for information systems development, and apply them to associated matters.

□ Keywords

- | | |
|---|---|
| <input type="checkbox"/> Accountability | <input type="checkbox"/> Authenticity |
| <input type="checkbox"/> OECD “Guideline for the Security of Information Systems and Networks: Towards a Culture of Security” adopted by OECD | |
| <input type="checkbox"/> Public key cryptography | <input type="checkbox"/> Common key cryptography |
| <input type="checkbox"/> Public key | <input type="checkbox"/> Private key <input type="checkbox"/> DES (Data Encryption Standard) |
| <input type="checkbox"/> RSA (Rivest Shamir Adleman) | <input type="checkbox"/> Digital signature |
| <input type="checkbox"/> Message authentication | <input type="checkbox"/> Time authentication |
| <input type="checkbox"/> Challenge-response authentication | <input type="checkbox"/> Login (User ID and Password) |
| <input type="checkbox"/> Callback | <input type="checkbox"/> IC card <input type="checkbox"/> PIN code <input type="checkbox"/> One time password |
| <input type="checkbox"/> Fingerprint authentication | <input type="checkbox"/> Vein authentication <input type="checkbox"/> Iris authentication |
| <input type="checkbox"/> Voice authentication | <input type="checkbox"/> Face authentication <input type="checkbox"/> False rejection rate, false acceptance rate |
| <input type="checkbox"/> Public key certificate | <input type="checkbox"/> CA (Certification Authority) <input type="checkbox"/> SSL |

- ▶ Q3-50 through Q3-57

5.2 Information security management ★★

[Learning objectives]

- Understand the basic concept of information security management.
- Understand the basic concept of threats and vulnerabilities to information assets, as well as methods and procedures for risk analysis and assessment.
- Understand the basic concept of information security policy.
- Understand the purpose of development of security regulations on corporate activities.
- Understand the mechanism of Information Security Management Systems (ISMS) and activities of security institutions.

□ Keywords

- | | | | |
|---|---|-----------------------------------|---|
| <input type="checkbox"/> Physical asset | <input type="checkbox"/> Software asset | <input type="checkbox"/> Accident | <input type="checkbox"/> Disaster |
| <input type="checkbox"/> Fault | <input type="checkbox"/> Theft | <input type="checkbox"/> Error | <input type="checkbox"/> Computer crime |
| <input type="checkbox"/> Information leakage | <input type="checkbox"/> Unauthorized access | | |
| <input type="checkbox"/> Unauthorized intrusion | <input type="checkbox"/> Wiretapping | <input type="checkbox"/> Spoofing | |
| <input type="checkbox"/> Falsification | <input type="checkbox"/> DoS (Denial of Service) attack | <input type="checkbox"/> Virus | |
| <input type="checkbox"/> Worm | <input type="checkbox"/> Social engineering | <input type="checkbox"/> Bug | <input type="checkbox"/> Security hole |
| <input type="checkbox"/> Man-made vulnerability | | | |
- Risk type (☐ Loss of property, ☐ Loss of responsibility, ☐ Loss of net earnings, ☐ Human cost, ☐ Peril, ☐ Hazard, ☐ Moral hazard)
- | | | | |
|---|---|---|--|
| <input type="checkbox"/> Risk control | <input type="checkbox"/> Risk finance | <input type="checkbox"/> Risk avoidance | <input type="checkbox"/> Risk transfer |
| <input type="checkbox"/> Risk retention | <input type="checkbox"/> Risk optimization | <input type="checkbox"/> Risk diversification | |
| <input type="checkbox"/> Risk concentration | <input type="checkbox"/> Security policy | <input type="checkbox"/> Information security measures criteria | |
| <input type="checkbox"/> Security control regulations | <input type="checkbox"/> Document control regulations | | |
| <input type="checkbox"/> Information management regulations | <input type="checkbox"/> Privacy policy | | |
| <input type="checkbox"/> Security education regulations | <input type="checkbox"/> ISO/IEC 27001 | | |
| <input type="checkbox"/> ISMS conformity assessment system | <input type="checkbox"/> ISMS certification | | |
| <input type="checkbox"/> ISO/IEC 17799 (JIS Q 27002) | <input type="checkbox"/> IPA security center | | |

- Q3-58 through Q3-65

5.3 Security technology evaluation

[Learning objectives]

- Understand the basic concept of information security evaluation.

□ Keywords

- | | |
|--|---|
| <input type="checkbox"/> Evaluation procedure | <input type="checkbox"/> Security functional requirements |
| <input type="checkbox"/> Security assurance requirements | <input type="checkbox"/> Assurance level |

5.4 Information security measures

[Learning objectives]

- Study the information security measures from human, technological, and physical security aspects, and apply them to associated matters.

□ Keywords

- | | | |
|---|--|--|
| <input type="checkbox"/> Company regulations | <input type="checkbox"/> Information security education | |
| <input type="checkbox"/> Password management | <input type="checkbox"/> Measures against cracking | |
| <input type="checkbox"/> Cryptographic processing | <input type="checkbox"/> Measures against computer viruses | <input type="checkbox"/> OS updating |
| <input type="checkbox"/> Network monitoring | <input type="checkbox"/> Access control | <input type="checkbox"/> Intrusion detection |
| <input type="checkbox"/> RAS technology | <input type="checkbox"/> Quakeproof and fireproof facilities | |
| <input type="checkbox"/> Monitoring camera | <input type="checkbox"/> Locking management | <input type="checkbox"/> Entrance access control |

- ▶ Q3-66 and Q3-67

5.5 Security implementation technology

[Learning objectives]

- Understand the outline of security measures implemented in network and database.
- Understand the outline of attacks on applications and security measures.

□ Keywords

- | | | |
|--|--|---|
| <input type="checkbox"/> Firewall | <input type="checkbox"/> Packet filtering | <input type="checkbox"/> IDS (Intrusion Detection System) |
| <input type="checkbox"/> IPS (Intrusion Protection System) | | <input type="checkbox"/> Authentication server |
| <input type="checkbox"/> WEP (Wired Equivalent Privacy) | | <input type="checkbox"/> WPA (Wi-Fi Protected Access) |
| <input type="checkbox"/> Encryption | <input type="checkbox"/> User authentication | <input type="checkbox"/> Database access control |
| <input type="checkbox"/> Logging | <input type="checkbox"/> Account management | <input type="checkbox"/> Password management |
| <input type="checkbox"/> Utilization control of external media | | <input type="checkbox"/> Unauthorized access detection |
| <input type="checkbox"/> Security measures for Web systems | | <input type="checkbox"/> Secure programming |
| <input type="checkbox"/> Buffer overflow attack | <input type="checkbox"/> Cross-site scripting attack | |
| <input type="checkbox"/> Web beacon | | |

- ▶ Q3-68 and Q3-69

3.1***Human interface*****Q3-1** □□□

Which of the following is the explanation of accessibility?

- a) It is an approach to improving public services and streamlining administrative duties by managing the information of a basic resident register on a computer network.
- b) It is an approach to interoperability where computers of different specifications mutually access the database managed by the respective computer over a network.
- c) It is an ability to trace the history of all processes from the production stage to the final consumption or disposal stage for products and food items.
- d) It is the degree to which software products, information services, or Web sites are available to anyone including elderly people and people with disabilities.

Q3-2 □□□

Which of the following is the user interface that enables frequently-used operations to be performed efficiently?

- a) Undo function (Return to original)
- b) Online help
- c) Shortcut key
- d) Progress bar

Q3-3 □□□

Which of the following is an appropriate case where the method of choosing from a list of options is adopted as the input method for the GUI screen?

- a) Each item needs to be checked and modified individually.
- b) There are only a few types of input data and the content of data is fixed.
- c) The input data can take many values.
- d) A large amount of data, such as sentences, is entered.

Q3-4 □□□

Which of the following is appropriate as a data checking method?

- a) A check digit test appends one digit to a numeric item, performs a certain calculation by using the other digits, and checks that the calculation result does not exceed the value of the appended digit.
- b) A balance check takes two or more totals that are supposed to be equal, such as the debit and credit amounts on a journal book, and checks that the two numbers are actually equal when they are calculated separately.
- c) A format check determines whether all mandatory information is entered.
- d) A limit check determines the maximum or minimum value of data elements in a file.

Q3-5 □□□

Which of the following is the most appropriate design principle of data entry screens?

- a) For incorrect input, the reason for the error is displayed together with a message stating that the subsequent processes cannot be performed, and then the program is terminated.
- b) Too much explanation on the screen makes the user feel cumbersome, so a help function for the input items that need explanation is provided to keep the screen simple.
- c) Irrespective of the layout of input form, the input items are sorted in their processing sequence in the program, and are arranged from top to bottom, and left to right.
- d) Users are familiar with operations such as registration, updating, or canceling of input data, so the checking of input data is omitted to improve operability.

Cash memory and access time

Effective access time of
main memory $= T_c \times \alpha + T_m \times (1 - \alpha)$

T_c : Access time of cache memory

α : Hit ratio T_m : Access time of main memory

Check!

Q3-6 □□□

Which of the following is a suitable combination of code types to be inserted into items *A* through *C* in the table below that describes the characteristics of each code type?

	<i>A</i>	<i>B</i>	<i>C</i>
Advantages	<ul style="list-style-type: none"> - The number of digits is less. - When codes in the order of occurrence are assigned, addition can be made easily. 	<ul style="list-style-type: none"> - Several groupings can be made with fewer digits. 	<ul style="list-style-type: none"> - Classification criteria of structure of data items is very clear. - As each digit has a specific meaning of classifications, it is easy to understand.
Disadvantages	<ul style="list-style-type: none"> - Classification is incomprehensible. 	<ul style="list-style-type: none"> - Inconvenient when data is added and when the number of records is large. 	<ul style="list-style-type: none"> - The number of digits can easily become large.
Application area	<ul style="list-style-type: none"> - It is used when the classification criteria cannot be established easily. 	<ul style="list-style-type: none"> - It is used for grouping under limitations of the number of code digits. 	<ul style="list-style-type: none"> - It can be used when the classification criteria is clear.

	<i>A</i>	<i>B</i>	<i>C</i>
a)	Block code	Group classification code	Sequence code
b)	Group classification code	Sequence code	Block code
c)	Sequence code	Block code	Group classification code
d)	Sequence code	Group classification code	Block code

Q3-7 □□□ **Mandatory question**

Which of the following is the appropriate description of usability of Web contents?

- It refers to the design that allows use by anyone irrespective of disability, age, gender, or nationality.
- It refers to the function that lets people with disabilities and elderly people use and operate a service without any trouble.
- It refers to the design that does not place any burden on people with disabilities and elderly people.
- It refers to the extent to which users can achieve their target requirements without feeling stressed.

3.2 Multimedia

Q3-8 □□□

Audio sampling is performed 11,000 times per second and each of the sampled values is recorded as 8-bit data. In this case, how many minutes of audio can be recorded in a flash memory with a capacity of 512×10^6 bytes?

- a) 77 b) 96 c) 775 d) 969

Q3-9 □□□ **Mandatory question**

Which of the following is an international standard for the compression encoding of still image data?

- a) BMP b) GIF c) JPEG d) MPEG

Q3-10 □□□

Which of the following is the appropriate characteristic of the compression technique for still image data?

- a) The size of a file that is compressed with a lossless encoding method is smaller than that of a lossy encoding method.
 b) In a lossless encoding method, the compression ratio does not affect the quality of the image after decompression.
 c) In a lossy encoding method, the size of a decompressed image is smaller than that of the original image.
 d) In image compression based on a lossy encoding method, the compression ratio cannot be changed.

Calculation of Disk Access Time 1

Access time of hard disk =	Seek time (Average time for positioning)	+	Search time (Average rotational latency time)	+	Data transfer time
----------------------------	---	---	--	---	--------------------

Check!

Q3-11 □□□

Which of the following is the most appropriate explanation of VR (Virtual Reality)?

- a) VR improves the GUI by first displaying a coarse mosaic-like image and then gradually making it clear, instead of by displaying the image in sequence from the top.
- b) VR enables computer-simulated objects and space to be perceived like the real world by using computer graphics or such other technology.
- c) VR conducts computer based simulation in place of wind tunnel experiments used for the design of automobiles and aircrafts.
- d) VR synthesizes the separately taken video footages of scenery and persons in order to create a video that is different from reality.

Q3-12 □□□

When a shape is drawn in computer graphics, which of the following is a technique that is used to obscure the step-like jagged edges of the shape by placing different intermediate colors in the pixels near the edges?

- | | |
|------------------|-------------|
| a) Anti-aliasing | b) Clipping |
| c) Shading | d) Morphing |

3.3**Database****Q3-13** □□□

Which of the following is an appropriate description of relational databases?

- a) Relation of data is shown with hierarchical structure.
- b) Related data is linked with pointer.
- c) Data structures that contain the combination of data and its operation procedure are handled.
- d) A collection of data is shown with several two-dimensional tables.

Q3-14 □□□

Which of the following is an appropriate description concerning the three-schema architecture of a database?

- a) The three-schema architecture is composed of the three layers: a database server layer, an application sever layer, and a client layer.
- b) Logical data independence is achieved by preparing a schema that shows the logical relationship of data, and a schema that shows the view of data as desired by users.
- c) An internal schema describes data itself separately from the viewpoint of individual applications and the viewpoint of computers.
- d) An external schema describes how to memorize data on the storage device so that the user need not be concerned about the physical database structure.

Q3-15 □□□

A company with offices spread across multiple buildings decides to create a database for managing the locations where PCs are installed. The three tables of “Asset”, “Room”, and “Building” are created, and the relations for each table are defined. When new data is entered, the data must already exist in the referenced table. Which of the following is the appropriate sequence of entering data in each table? Here, the underlined items in the respective tables indicate a primary key or a foreign key.

Asset

<u>PC_number</u>	<u>Building_number</u>	<u>Room_number</u>	Model_name
------------------	------------------------	--------------------	------------

Room

<u>Building_number</u>	<u>Room_number</u>	Room_name
------------------------	--------------------	-----------

Building

<u>Building_number</u>	Building_name
------------------------	---------------

- a) Asset → Building → Room b) Building → Room → Asset
c) Room → Asset → Building d) Room → Building → Asset

Q3-16 □□□

Which of the following is an appropriate characteristic of the primary key of a relational database?

- a) Unless search conditions are specified on the column identified as a primary key, rows cannot be searched.
b) If a numerical type column is specified as a primary key, that column cannot be used in arithmetic operations.
c) In one table, there cannot be multiple rows that have the same primary key value.
d) The primary key cannot be composed of multiple columns.

Calculation of Disk Access Time 2

$$\text{Search time of hard disk (average rotational latency time)} = \frac{1}{2 \times \text{Rotation speed}}$$

Check!

Q3-17 □□□

Which of the following is the third normal form of the “Employee” table? Here, the underlined items indicate a primary key.

Employee (Employee_number, Employee_name,
 {Skill_code, Skill_name, Skill_years_of_experience})
 ({ } indicates repetition)

- a)

<u>Employee_number</u>	<u>Employee_name</u>
------------------------	----------------------

<u>Skill_code</u>	Skill_name	Skill_years_of_experience
-------------------	------------	---------------------------
- b)

<u>Employee_number</u>	Employee_name	<u>Skill_code</u>	Skill_years_of_experience
------------------------	---------------	-------------------	---------------------------

<u>Skill_code</u>	Skill_name
-------------------	------------
- c)

<u>Employee_number</u>	<u>Skill_code</u>	Skill_years_of_experience
------------------------	-------------------	---------------------------

<u>Employee_number</u>	Employee_name
------------------------	---------------

<u>Skill_code</u>	Skill_name
-------------------	------------
- d)

<u>Employee_number</u>	<u>Skill_code</u>
------------------------	-------------------

<u>Employee_number</u>	Employee_name	Skill_years_of_experience
------------------------	---------------	---------------------------

<u>Skill_code</u>	Skill_name
-------------------	------------

Q3-18 □□□

When the attributes of the relation “Order” shown below has the functional dependencies from (1) through (7), which of the following is the correct primary key? Here, (A, B) indicates the tuple of attributes A and B , and $A \rightarrow C$ indicates that C is functionally dependent on A .

Relation “Order”:

(Order_number, Order_date, Customer_number, Customer_name, Product_number, Product_name, Quantity, Sales_amount)

Functional dependencies

- (1) Order_number \rightarrow Order_date
- (2) Order_number \rightarrow Customer_number
- (3) Order_number \rightarrow Customer_name
- (4) Customer_number \rightarrow Customer_name
- (5) (Order_number, Product_number) \rightarrow Quantity
- (6) (Order_number, Product_number) \rightarrow Sales_amount
- (7) Product_number \rightarrow Product_name

- a) (Order_number)
- b) (Order_number, Customer_number)
- c) (Order_number, Customer_number, Product_number)
- d) (Order_number, Product_number)

Q3-19 □□□**Mandatory question**

Which of the following is an appropriate description concerning the operation of a relational database?

- a) “Join” combines two or more tables in order to create a single table.
- b) “Project” retrieves rows that satisfy certain conditions from a table.
- c) “Select” retrieves specific columns from a table.
- d) “Insert” puts specific columns in a table.

Calculation of Disk Access Time 3

$$\text{Data transfer time of hard disk} = \frac{\text{Data volume}}{\text{Data transfer rate}} = \frac{\text{Data volume}}{\text{Transfer rate} \times \text{Capacity of one track}}$$

Check!

Q3-20 ☐☐☐ **Mandatory question**

Among data manipulations concerning the three tables “Product,” “Orders” and “Customers,” shown below, which of the following can be executed without being subject to referential constraints? Here, a solid underline represents a primary key, and a dotted underline represents a foreign key.

Product (Product_code, Product_name, Unit, Amount)

Order (Order_code, Product_code, Order_quantity, Customer_code)

Customer (Customer_code, Customer_name, Customer_address)

- a) Adding a new record to the “Customer” table
- b) Deleting a record from the “Product” table
- c) Changing the Product_code in the “Product” table
- d) Adding a new record to the “Order” table

Q3-21 ☐☐☐

Company *A* produces cosmetics and sells its products through sales agents. For the purpose of developing the future sales strategy, the company plans to create a database consisting of three tables shown below. Which of the following information **cannot be obtained** simply by using this data?

Customer data

Customer	Name	Gender	Date_of_birth
----------	------	--------	---------------

Daily sales data of sales agents

Sales_agent	Date	Product	Sales_quantity
-------------	------	---------	----------------

Product data bought by customers

Customer	Sales_agent	Product	Sales_quantity
----------	-------------	---------	----------------

- a) Daily variation in sales quantity for each product
- b) Hot-selling products by gender
- c) Daily variation in the number of buyers for each sales agent
- d) Age distribution of the buyers for each sales agent

Q3-22 □□□

Which of the following is the SQL statement in the “Shipping_record” table that returns the maximum value?

Shipping_record

Product_number	Date	Quantity
NP200	2006-10-10	3
FP233	2006-10-10	2
NP200	2006-10-11	1
FP233	2006-10-11	2

- a) `SELECT AVG(Quantity)`
`FROM Shipping_record WHERE Product_number = 'NP200'`
- b) `SELECT COUNT(*)`
`FROM Shipping_record`
- c) `SELECT MAX(Quantity)`
`FROM Shipping_record`
- d) `SELECT SUM(Quantity)`
`FROM Shipping_record WHERE Date = '2006-10-11'`

Q3-23 ☐☐☐ **Mandatory question**

Which of the following is the correct syntax of SQL statement?

- a) `SELECT Order_date, AVG(Quantity)`
`FROM Order_details`
- b) `SELECT Order_date, AVG(Quantity)`
`FROM Order_details`
`GROUP BY Order_date`
- c) `SELECT Order_date, AVG(SUM(Quantity))`
`FROM Order_details`
`GROUP BY Order_date`
- d) `SELECT Order_date`
`FROM Order_details`
`WHERE SUM(Quantity) > 1000`
`GROUP BY Order_date`

Calculation of MTBF

MTBF (Mean Time Between Failure) = $T_1 + T_2 + \dots + T_n$ T_1, \dots, T_n : Each continuous operating time of a system

Check!

Q3-24 □□□

Which of the following is an appropriate SQL statement that can be used to search for Department_code of departments that have less than five employees with the job duty of Programmer in the “Employee” table? Here, the structure of the “Employee” table is given below, and none of the columns has a null value.

Employee (Employee_number, Employee_name, Department_code, Job_duty)

- a)

```
SELECT DISTINCT Department_code FROM Employee S1
WHERE 5 > (SELECT COUNT(S2.Employee_number) FROM Employee S2
WHERE S1.Department_code = S2.Department_code
AND S2.Job_duty = 'Programmer')
```
- b)

```
SELECT DISTINCT Department_code FROM Employee S1
WHERE 5 < (SELECT COUNT(S2.Employee_number) FROM Employee S2
WHERE S1.Department_code = S2.Department_code
AND S2.Job_duty <> 'Programmer')
```
- c)

```
SELECT DISTINCT Department_code FROM Employee S1
WHERE EXISTS (SELECT * FROM Employee S2
WHERE S1.Department_code = S2.Department_code
AND S2.Job_duty = 'Programmer')
GROUP BY S1.Department_code HAVING COUNT(*) < 5
```
- d)

```
SELECT DISTINCT Department_code FROM Employee S1
WHERE S1.Department_code IN (SELECT S2.Department_code FROM Employee S2
WHERE S1.Department_code = S2.Department_code
AND S2.Job_duty = 'Programmer')
GROUP BY S2.Department_code HAVING COUNT(*) < 5)
```

Q3-25 □□□

As shown in the table below, when tables T_1 and T_2 that are shared resources are updated by transactions A and B , which of the following is the point where deadlock occurs? Here, steps (1) through (8) in the table show the execution sequence of processes. Moreover, each table is locked just before the table is updated, and unlocked once the transaction is completed.

	Transaction A	Transaction B
<div>Time</div> <div>↓</div>	(1) Start transaction	(2) Start transaction
	(3) Update Table T_1	(4) Update Table T_2
	(5) Update Table T_2	(6) Update Table T_1
	(7) Finish transaction	(8) Finish transaction

- a) (3) b) (4) c) (5) d) (6)

Calculation of MTTR

$$\text{MTTR (Mean Time To Repair)} = \frac{t_1 + t_2 + \dots + t_n}{n} \quad \begin{array}{l} t_1, \dots, t_n: \text{Each repair time of a system} \\ n: \text{Number of repairs} \end{array}$$

Check!

Q3-26 □□□

Which of the following is an appropriate description concerning exclusive control of the database?

- a) For a resource on which a shared lock is placed by one transaction, a shared lock can be placed by another transaction.
- b) For a resource on which a shared lock is placed by one transaction, an exclusive lock can be placed by another transaction.
- c) For a resource on which an exclusive lock is placed by one transaction, a shared lock can be placed by another transaction.
- d) For a resource on which an exclusive lock is placed by one transaction, an exclusive lock can be placed by another transaction.

Q3-27 □□□

There are two main files that are used for recovering a database at the occurrence of a media failure. One of these files is a backup file. Which of the following is the other file?

- | | |
|---------------------|----------------|
| a) Transaction file | b) Master file |
| c) Rollback file | d) Log file |

Q3-28 □□□**Mandatory question**

Transaction T is completed after the checkpoint is processed, and then system failure occurs. Which of the following is the recovery technique that is used for restoring the database to the state just after the completion of Transaction T ? Here, in addition to the checkpoint, the transaction log is also available.

- | | |
|----------------------|---------------------------|
| a) Two-phase locking | b) Transaction scheduling |
| c) Roll back | d) Roll forward |

Q3-29 □□□

Which of the following is an appropriate description of data mining?

- a) A parallel access method for searching through a large amount of data at high speed
- b) A technique for analyzing a large amount of data statistically and mathematically to discover rules and cause-effect relationships
- c) A method for storing a database for the accumulation of a large amount of time-series data such as sales performance and actual production results
- d) A technique for creating individual databases for each department according to the purpose of usage by users

Q3-30 □□□

Which of the following is an appropriate explanation of transparency of a distributed database?

- a) A client application program accesses databases on multiple servers. The application program can access the databases as if they are operating on one server.
- b) A client application program accesses the databases on multiple servers. The application program needs to know which server's database should be accessed.
- c) Application programs of multiple clients share and access a database on one server.
- d) Application programs of multiple clients access a database on one server through the application program operating on the server.

Q3-31 □□□

In a client/server system that uses a database server, the generation of a large number of SQL statements becomes a problem that is caused by communication load between the client and the server. Which of the following is the appropriate solution to this problem?

- a) Redefinition the index
- b) Use of the stored procedure function
- c) Reorganization of the database
- d) Use of dynamic SQL

Calculation of Availability 1

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

Check!

3.4

Network**Q3-32** ☐☐☐**Mandatory question**

In order to enable uninterrupted playback of 1.2-Mbyte audio data that is encoded at a speed of 64 Kbps while the data is downloaded through a network at a communication speed of 48 Kbps, at least how many seconds of data should be buffered before the playback is started?

- a) 50 b) 150 c) 200 d) 350

Q3-33 ☐☐☐

When data is sent at the transmission rate of 2,400 bps on a transmission line with a bit error ratio of 1/600,000, every how many seconds on average does a single bit error occurs?

- a) 250 b) 2,400 c) 20,000 d) 600,000

Q3-34 ☐☐☐

Which of the following is the role to be played by a DNS server in a TCP/IP network?

- a) Making it possible to call a program running on a server by simply specifying the program name without being aware of the physical location of the server
- b) Making it possible to convert an internal private IP address into a global IP address and to access the Internet
- c) Making it possible to map a domain name or a host name to an IP address
- d) Making it possible to assign an IP address from a pool of registered IP addresses on server that are not currently in use, in response to a PC's request for the assignment of an IP address

Q3-35 □□□

Mandatory question

Which of the following is the appropriate explanation of the NAT function of a router that is used in an Internet connection?

- a) NAT is a function that caches access to the Internet so that when a Web site with the same IP address is accessed again, the Web site can be quickly displayed.
- b) NAT is a function for detecting a specific bit pattern from IP packets that are being transmitted.
- c) NAT is a function that allows only IP packets addressed to a specific terminal to pass through.
- d) NAT is a function that converts a private IP address to a global IP address and vice versa.

Q3-36 □□□

Which of the following is the appropriate characteristic of a 10-Mbps LAN that uses CSMA/CD?

- a) When collision between transmission frames occurs, the sending terminals suspend the transmission and resend them after a random period of waiting.
- b) When multiple terminals simultaneously send data, time-division multiplexing of the transmission path takes place, and therefore a transmission rate of 10 Mbps cannot be guaranteed.
- c) In order for a terminal to obtain data transmission rights, it is necessary to acquire a token.
- d) As a time slot is defined for each terminal, it is necessary to send data at that timing.

Q3-37 □□□

Which of the following is a device that interconnects LANs at the physical layer of the OSI basic reference model?

- a) Gateway
- b) Bridge
- c) Repeater
- d) Router

Calculation of Availability 2

Availability of system connected serially = $A_1 \times A_2 \times \dots \times A_n$

$A_1 - A_n$: Availability of each device
n: Number of devices

Check!

Q3-38 □□□

Which of the following is an appropriate description concerning inter-LAN connection devices?

- a) A gateway converts protocols in only Layers 1 to 3 of the OSI basic reference model.
- b) A bridge relays frames based on an IP address.
- c) A repeater extends the transmission distance by amplifying signals between the same types of segments.
- d) A router relays frames based on a MAC address.

Q3-39 □□□ **Mandatory question**

Which of the following is the specification that is not present in IPv4, but is added or changed in IPv6?

- a) 128 bits are allocated as address space.
- b) A subnet mask is implemented for the effective use of address space.
- c) An IP address is represented with the pair of network address and subnet mask.
- d) A private address is implemented for the effective use of limited IP addressed.

Q3-40 □□□

When the IP address of a communicating party is known but the MAC address is not known, which of the following is a method that is used for obtaining the MAC address?

- a) ARP
- b) DHCP
- c) ICMP
- d) NAT

Q3-41 □□□ **Mandatory question**

When the IP address and subnet mask of a PC are as shown below, which of the following is the appropriate network address of this PC?

IP address: 200.170.70.19
Subnet mask: 255.255.255.240

- a) 200.170.70.0
- b) 200.170.70.16
- c) 200.170.70.31
- d) 200.170.70.255

Q3-42 □□□

Which of the following is the address class of the IP address 192.168.10.10?

- a) Class A
- b) Class B
- c) Class C
- d) Class D

Q3-43 □□□

When a network is constructed in a TCP/IP environment, an increase in the number of clients makes the management of IP addresses cumbersome. Which of the following is a protocol that dynamically assigns IP addresses in response to requests from clients in order to efficiently manage the IP addresses?

- a) DHCP
- b) HTTP
- c) LDAP
- d) SNMP

Q3-44 □□□

Which of the following is the upper-layer protocol of IP that achieves connectionless datagram communication without having the functions of acknowledgment and sequence control for reliability?

- a) ICMP
- b) PPP
- c) TCP
- d) UDP

Calculation of Availability 3

Availability of systems connected in parallel = $1 - (1 - A_1) \times (1 - A_2) \times \dots \times (1 - A_n)$ A_1, \dots, A_n : Availability of each device
n: Number of devices

Check!

Q3-45 □□□

Among the protocols used in a TCP/IP environment, which of the following is a network management protocol that is used for collecting information about constituent devices and for obtaining information at the time of a failure?

- a) NNTP b) NTP c) SMTP d) SNMP

Q3-46 □□□**Mandatory question**

Which of the following is the technology that is used for establishing a network connection between remote communication sites through a public network (e.g. the Internet) as if a leased line were virtually used?

- a) IP-VPN b) IPv6 c) PBX d) VoIP

Q3-47 □□□

Which of the following is a mechanism that stores user information and other data in a browser according to instructions from a Web server so that the Web server can identify the PC from which the server is accessed?

- a) CGI b) Cookie c) SSL d) URL

Q3-48 □□□

Which of the following is an appropriate description of SMTP?

- a) SMTP is a protocol for accessing information stored on a Web server.
b) SMTP is a system for creating and editing electronic documents that contain a combination of characters, diagrams, and images.
c) SMTP is a protocol for forwarding e-mails.
d) SMTP is one of the document description languages for structural representation of documents.

Q3-49 □□□

Which of the following is the appropriate explanation of a splitter in ADSL?

- a) It refers to the interface between the premises wiring and the router.
- b) It is a device that separates and combines high-frequency data signals and low-frequency audio signals.
- c) It is ADSL transmission equipment installed in a telephone exchange.
- d) It is a function that corrects errors produced by noise.

3.5 Security

Q3-50 □□□

Mandatory question

A certain store receives orders from customers through a network using public key cryptography so that a third party cannot know the order details. Which of the following is the appropriate combination of keys used by the store and customers respectively?

	Store	Customers
a)	Public key	Private key
b)	Public key	Public key and private key
c)	Private key	Public key
d)	Private key	Public key and private key

Q3-51 □□□

There are two main purposes of using digital signatures for communication. The first purpose is for the recipient to verify the sender of a message. Which of the following is the other purpose?

- a) The recipient checks whether any changes are made to the message after it is signed.
- b) The recipient checks whether the message is wrongfully decoded during transmission.
- c) The recipient checks the sender's ID.
- d) The recipient checks whether to return the private key or not.

Calculation of Data Transfer Time

$$\text{Data transfer time} = \frac{\text{Amount of data transferred}}{\text{Communication speed} \times \text{Link utilization factor}}$$

Check!

Q3-52 □□□

When a document is sent or received using public key cryptography, which of the following is an appropriate description of how to handle keys so that the content of the document can be kept secret?

- a) The encryption and decryption keys may be public, but the encryption algorithm must be kept private.
- b) The encryption key may be public, but the encryption algorithm must be kept private.
- c) The encryption key must be kept private, but the decryption key may be public.
- d) The decryption key must be kept private, but the encryption key may be public.

Q3-53 □□□

Which of the following is a protocol that is used for enhancing the confidentiality of e-mail content?

- a) IMAP4
- b) POP3
- c) SMTP
- d) S/MIME

Q3-54 □□□**Mandatory question**

Which of the following is the purpose of using a message digest in a message authentication code?

- a) To check that the message has not been falsified
- b) To check the encryption method used in the message
- c) To check the summary of the message
- d) To ensure the confidentiality of the message

Q3-55 □□□

Which of the following is an authentication that exchanges information between two communication entities X and Y as per the procedure described below?

[Procedure]

- (1) Y sends a character string (challenge) including random information to X .
 - (2) Based on the predefined rules between X and Y , X generates a new character string (response) from the string received from Y , and returns it to Y .
 - (3) Y checks whether the returned character string (response) is correct or not.
- a) X authenticates Y .
 - b) X authenticates Y , and as a result Y authenticates X .
 - c) Y authenticates X .
 - d) Y authenticates X , and as a result X authenticates Y .

Q3-56 □□□

When a company's in-house system is remotely accessed from a hotel during a business trip, which of the following is the method for enhancing the authentication process?

- a) Initiating a connection by notifying the IP address
- b) Initiating a callback connection by using the IP address
- c) Initiating a connection by notifying the sender's user ID
- d) Initiating a connection by using a one-time password

Calculation of Profits 1

Gross profit = Net sales – Cost of sales

Check!

Q3-57 □□□

Mandatory question

Which of the following is a characteristic of the security protocol SSL?

- a) SSL is a protocol that is used only on a Web server for strengthening security and is located in the network layer.
- b) In a Web server using SSL, FQDN is embedded in the digital certificate.
- c) A unique digital certificate for personal authentication needs to be prepared for each PC.
- d) In Japan, only government agencies can apply for a digital certificate whose common key is 128 bits in length.

Q3-58 □□□

Which of the following is an act that refers to social engineering?

- a) Attacking an OS by exploiting security holes
- b) Creating a computer virus
- c) Cracking a password by a dictionary attack in order to intrude into a computer
- d) Making a call to ask for a password by feigning the identity of the actual person

Q3-59 □□□

Which of the following is an example of phishing?

- a) Damaging users and servers by embedding a malicious script in a webpage when there are sections on the webpage that display the input contents as is
- b) Operating a virus infected computer from outside over a network such as the Internet
- c) Secretly collecting personal information of computer users such as their IP addresses and Web behavior, and sending this information to an external location
- d) Sending e-mails to people in order to lure them into accessing bogus Web sites that appear to be those of real companies, and stealing their personal information

Q3-60 □□□

Which of the following is an explanation of the pattern matching method used by antivirus software?

- a) Viruses are detected by comparing files before and after infection to check whether any changes are made to the files.
- b) Viruses are detected by making a comparison with the signature codes of known viruses.
- c) Viruses are detected by monitoring the system for abnormal phenomena caused by viruses.
- d) Viruses are detected by performing a matching check with the checksum of a file.

Q3-61 □□□

Which of the following is a result obtained from the risk analysis in the course of understanding the security status, analyzing risks, planning security measures, and implementing the security measures?

- a) Identified vulnerabilities
- b) Incorporated security controls
- c) Security specifications
- d) Extent of loss

Q3-62 □□□

Which of the following is the appropriate sequence of items (1) through (3) that are required for establishing ISMS in JIS Q 27001:2006?

- (1) Prepare a Statement of Applicability.
- (2) Select control purpose and controls for the treatment of risks.
- (3) Analyze and evaluate the risks.

- a) (1) → (2) → (3)
- b) (1) → (3) → (2)
- c) (2) → (3) → (1)
- d) (3) → (2) → (1)

Calculation of Profits 2

Operating income = Gross profit – Selling, General and Administrative Expense

Check!

Q3-63 □□□

Mandatory question

Which of the following is the appropriate description of information security policy that is defined in the ISMS conformity assessment scheme?

- a) It is a confidential document that provides important basic policies, and should only be made accessible to relevant personnel within an organization.
- b) It is defined in terms of the characteristics of the business, the organization, its location, assets, and technology.
- c) It describes the basic security policies which must not be changed even when the business environment or technology changes.
- d) It describes the details of security measures and system operations based on a risk analysis of a particular system.

Q3-64 □□□

When the content on a Web server is altered because of unauthorized access to the Web server from an external location, which of the following is the appropriate sequence of measures to be taken after that?

(1)	Analyze each log of the server, IDS (Intrusion Detection System), and firewall to identify the method of unauthorized access, extent of the damage, and intrusion path.
(2)	Reconstruct the system and apply the latest patches and security setting information.
(3)	Disconnect the server from the network.
(4)	Monitor the server for some time after connecting it to the network.

- a) (1) → (2) → (3) → (4)
- b) (1) → (3) → (2) → (4)
- c) (2) → (3) → (1) → (4)
- d) (3) → (1) → (2) → (4)

Q3-65 □□□

Which of the following is the act of obtaining a password or other confidential information from a person within an organization by using unauthorized means such as feigning an emergency situation?

- a) Social engineering
- b) Trojan horse
- c) Password crack
- d) Stepping-stone attack

Q3-66 □□□

Mandatory question

In a user authentication method that compares the input password with the registered password, which of the following is a measure for preventing theft of a registered password through unauthorized access to the password file?

- a) The hash value of the user ID corresponding to the password is registered. At the time of authentication, the input user ID is converted using the hash function, and the registered password and the input password are compared.
- b) The file in which the password is registered without modification is compressed. At the time of authentication, the compressed file is decompressed and compared with the input password.
- c) A password is registered as is. At the time of authentication, the input password and the registered password are both converted with hash function and then compared.
- d) A password is converted into a hash value and registered. At the time of authentication, the input password is converted with the hash function and then compared with the registered password.

Q3-67 □□□

Which of the following is the management approach for preventing falsification or destruction of data by unauthorized execution of a program that can be commonly available to users?

- a) Collection of a system access log
- b) Comparison of the source program and the executed program
- c) Storage of source programs in multiple locations
- d) Setting of access rights for files

Calculation of Profits 3

Ordinary profit = Operating profit + Non-operating profit – Non-operating expense

Check!

Q3-68 □□□

Which of the following is an explanation of a Web beacon?

- a) It is a virus that is downloaded from a Web site and deletes image files from a PC.
- b) It is a latent error in an application program used on a website.
- c) It is an unfair trick that damages both the PC and Web server itself through a malicious script.
- d) It is an image embedded in a Web page to collect information about access patterns of users.

Q3-69 □□□

In a wireless LAN, which of the following is used for restricting a connection with terminals other than those pre-registered at the access point?

- | | |
|--------------------------|-----------------|
| a) AES | b) IEEE 802.11b |
| c) MAC address filtering | d) TKIP |

Section 3 Technology Element List of Answers

Q3-1	d)	Q3-31	b)	Q3-61	d)
Q3-2	c)	Q3-32	a)	Q3-62	d)
Q3-3	b)	Q3-33	a)	Q3-63	b)
Q3-4	b)	Q3-34	c)	Q3-64	d)
Q3-5	b)	Q3-35	d)	Q3-65	a)
Q3-6	c)	Q3-36	a)	Q3-66	d)
Q3-7	d)	Q3-37	c)	Q3-67	d)
Q3-8	c)	Q3-38	c)	Q3-68	d)
Q3-9	c)	Q3-39	a)	Q3-69	c)
Q3-10	b)	Q3-40	a)		
Q3-11	b)	Q3-41	b)		
Q3-12	a)	Q3-42	c)		
Q3-13	d)	Q3-43	a)		
Q3-14	b)	Q3-44	d)		
Q3-15	b)	Q3-45	d)		
Q3-16	c)	Q3-46	a)		
Q3-17	c)	Q3-47	b)		
Q3-18	d)	Q3-48	c)		
Q3-19	a)	Q3-49	b)		
Q3-20	a)	Q3-50	c)		
Q3-21	c)	Q3-51	a)		
Q3-22	b)	Q3-52	d)		
Q3-23	b)	Q3-53	d)		
Q3-24	a)	Q3-54	a)		
Q3-25	d)	Q3-55	c)		
Q3-26	a)	Q3-56	d)		
Q3-27	d)	Q3-57	b)		
Q3-28	d)	Q3-58	d)		
Q3-29	b)	Q3-59	d)		
Q3-30	a)	Q3-60	b)		

Technology

Morning Exam

Section 4

Development Technology

Learning Objectives

1. Be able to explain the types of programming languages and their characteristics.
2. Understand the outline of all phases of system development, and be able to explain the goals, details, and documents that are created for each phase.
3. Be able to explain the types and characteristics of system development support tools, and approaches to the creation and reuse of standard components.
4. Be able to explain the characteristics of various models used in software development methodologies.
5. Be able to explain DFDs, E-R diagrams, object-oriented design, and modules design techniques concerning requirements analysis and design techniques.
6. Be able to explain the types and uses of test techniques, review methods, and quality management methods.
7. Be able to explain the basic points concerning process management methods and estimation techniques.
8. Be able to explain the outline of work concerning the operations and maintenance of a system.

Chapter 1 System Development Technology

1.1 System requirements definition

[Learning objectives]

- Understand the outline of system requirements definition.

□ Keywords

- | | |
|--|---|
| <input type="checkbox"/> System performance requirements (response time, throughput) | |
| <input type="checkbox"/> System functional specifications | <input type="checkbox"/> Database requirements |
| <input type="checkbox"/> Security requirements | <input type="checkbox"/> Migration requirements |
| <input type="checkbox"/> Test requirements | <input type="checkbox"/> Operational requirements |
| <input type="checkbox"/> Maintenance requirements | <input type="checkbox"/> Failure handling |
| <input type="checkbox"/> Education | <input type="checkbox"/> Training |
| <input type="checkbox"/> Cost | <input type="checkbox"/> Execution environment requirements |
| <input type="checkbox"/> Peripheral interface requirements | <input type="checkbox"/> Quality requirements |

1.2 Systems architecture design

[Learning objectives]

- Understand the outline of systems architecture design.

□ Keywords

- | | |
|---|---|
| <input type="checkbox"/> Hardware configuration | <input type="checkbox"/> Software configuration |
| <input type="checkbox"/> Manual operation | <input type="checkbox"/> Configuration item |
| <input type="checkbox"/> User work scope | <input type="checkbox"/> Hardware architecture |
| <input type="checkbox"/> Software architecture | <input type="checkbox"/> Application architecture |
| <input type="checkbox"/> Database architecture | <input type="checkbox"/> System integration test requirements |
| <input type="checkbox"/> Evaluation of systems architecture | |

1.3 Software requirements definition ★★

[Learning objectives]

- Understand the techniques required for software requirements definition, and apply them to associated matters.

□ Keywords

- | | |
|--|---|
| <input type="checkbox"/> Software configuration item | <input type="checkbox"/> Interface design |
| <input type="checkbox"/> Screen design | <input type="checkbox"/> Security implementation method |
| <input type="checkbox"/> Business operations modeling | <input type="checkbox"/> Form design |
| <input type="checkbox"/> Code design | <input type="checkbox"/> Slip design |
| <input type="checkbox"/> Data modeling | <input type="checkbox"/> Maintainability |
| <input type="checkbox"/> Evaluation of software requirements | <input type="checkbox"/> Hearing |
| <input type="checkbox"/> Use case | <input type="checkbox"/> Prototype |
| <input type="checkbox"/> DFD (activity, data store, data flow, process) | <input type="checkbox"/> E-R diagram |
| <input type="checkbox"/> UML (use case diagram, class diagram, operation, attribute, role name, sequence diagram, communication diagram (collaboration diagram), state machine diagram (statechart diagram)) | |
| <input type="checkbox"/> Context diagram | <input type="checkbox"/> Decision table |
| <input type="checkbox"/> Mini spec | <input type="checkbox"/> State transition diagram |

- ▶ Q4-1 through Q4-5

1.4 Software architecture design and software detailed design ★★

[Learning objectives]

- Understand the techniques required for software architecture design, and apply them to the associated matters.
- Learn the techniques required for software detailed design, and apply them.

□ Keywords

Software architecture design tasks (□ Software structure □ Software component (program) partitioning □ Architecture design of components □ Component-to-component interface design □ Decision of component functional specification □ Structuring, partitioning, and reuse of components □ I/O design □ Integration test requirements □ Checklist)

Software detailed design tasks (□ Software component unit □ Functional hierarchy diagram □ Component detailed design □ Software unit (module) partitioning □ Unit-to-unit interface detailed design □ Program design □ Database detailed design □ Test requirements □ White box test)

Interface design (□ I/O detailed design □ Screen design □ Form/slip design)

Software design techniques (□ Process-oriented design □ Data-oriented design □ Structured design □ Object-oriented design)

Structured design (□ Stepwise refinement □ Sequence, selection, iteration □ NS chart □ Warnier method □ Jackson method □ HIPO)

Object-oriented design (□ Class □ Instance □ Attribute □ Method □ Encapsulation □ Generalization □ Specialization)

Module design (Module partitioning techniques (□ STS partitioning □ TR partitioning □ Common functional partitioning □ Subroutine), Module partitioning criteria (□ Scope of control □ Scope of effect □ Amounts of partitioning □ Repartitioning □ Dependent module), Module partitioning specifications (□ Flowchart □ Decision table))

□ Software design evaluation (□ Design review □ Inspection □ Moderator □ Review participants □ Walkthrough □ Code review)

□ Software quality (Functionality, Reliability, Usability, Maintainability, Portability)

► Q4-6 through Q4-9

1.5 Software coding and testing ★★

[Learning objectives]

- Learn the techniques required for software coding and testing, and apply them.

□ Keywords

- | | | | |
|---|--|---|--|
| <input type="checkbox"/> Coding | <input type="checkbox"/> Programming languages | <input type="checkbox"/> Algorithm | <input type="checkbox"/> Data processing |
| <input type="checkbox"/> Traceability | <input type="checkbox"/> External consistency | <input type="checkbox"/> Internal consistency | |
| <input type="checkbox"/> Coverage of unit test | | | |
| <input type="checkbox"/> Appropriateness of coding techniques and conventions | | | |
| <input type="checkbox"/> Feasibility of software integration and tests | | | |
| <input type="checkbox"/> Feasibility of operations and maintenance | <input type="checkbox"/> Code inspection | | |
| <input type="checkbox"/> Debugging environment | <input type="checkbox"/> Static analysis | | |
| <input type="checkbox"/> Dynamic testing | <input type="checkbox"/> Assertion | | |
| <input type="checkbox"/> Debugger | <input type="checkbox"/> Test data generator | <input type="checkbox"/> Test design and management technique | |
| <input type="checkbox"/> Bug curve | <input type="checkbox"/> Error removal | <input type="checkbox"/> Bug control chart | |
| <input type="checkbox"/> Coverage | <input type="checkbox"/> Experimental design | <input type="checkbox"/> Test case | |
| <input type="checkbox"/> White box test | | <input type="checkbox"/> Statement coverage | |
| <input type="checkbox"/> Condition coverage | | <input type="checkbox"/> Decision condition coverage | |
| <input type="checkbox"/> Multiple-condition coverage | | <input type="checkbox"/> Black box test | |
| <input type="checkbox"/> Boundary value analysis | | <input type="checkbox"/> Equivalence partitioning | |
| <input type="checkbox"/> Cause-effect graph method | | <input type="checkbox"/> Error embedding method | |

- ▶ Q4-10 through Q4-13

1.6 Software integration and software qualification tests

[Learning objectives]

- Learn and apply the basic concept, procedures, and techniques of software integration and software qualification tests.

□ Keywords

- | | | |
|---|---|---|
| <input type="checkbox"/> Test requirements | <input type="checkbox"/> Test procedure | <input type="checkbox"/> Test data |
| <input type="checkbox"/> Software requirements | <input type="checkbox"/> Audit | <input type="checkbox"/> Test plan |
| <input type="checkbox"/> Test preparation (test environment, test data, etc.) | | |
| <input type="checkbox"/> Software integration test report | | <input type="checkbox"/> Top-down testing |
| <input type="checkbox"/> Bottom-up testing | <input type="checkbox"/> Driver | <input type="checkbox"/> Stub |

- ▶ Q4-14 through Q4-16

1.7 System integration and system qualification tests

[Learning objectives]

- Understand the techniques required for software integration and system qualification tests, and apply them to the associated matters.

□ Keywords

- | | |
|---|---|
| <input type="checkbox"/> Hardware configuration item | <input type="checkbox"/> Software configuration item |
| <input type="checkbox"/> Manual operation | <input type="checkbox"/> System requirements <input type="checkbox"/> Test plan |
| <input type="checkbox"/> Test preparation (test environment, test data, etc.) | |

- ▶ Q4-17

1.8 Software installation

[Learning objectives]

- Understand the outline of software installation.

□ Keywords

- | | |
|--|---|
| <input type="checkbox"/> Software installation requirements | <input type="checkbox"/> System migration requirements |
| <input type="checkbox"/> Criteria for determining whether or not software can be installed | |
| <input type="checkbox"/> Creation of installation plan | <input type="checkbox"/> Installation operation |
| <input type="checkbox"/> Software installation procedure | <input type="checkbox"/> Software system installation framework |
| <input type="checkbox"/> User department | <input type="checkbox"/> System operations department |

1.9 Software acceptance

[Learning objectives]

- Understand the outline of software acceptance.

□ Keywords

- | | | |
|--|--|--|
| <input type="checkbox"/> Delivery | <input type="checkbox"/> Acceptance procedure | <input type="checkbox"/> Acceptance criteria |
| <input type="checkbox"/> Acceptance test execution | <input type="checkbox"/> Receiving inspection | |
| <input type="checkbox"/> Receiving inspection criteria | <input type="checkbox"/> Preparedness for acceptance | |
| <input type="checkbox"/> Operation manual | <input type="checkbox"/> Operations regulations | |

1.10 Software maintenance

[Learning objectives]

- Understand the basic concept, style, and procedure of software maintenance, and apply them to the associated matters.

□ Keywords

- | | | |
|---|--|---|
| <input type="checkbox"/> Maintenance procedure | <input type="checkbox"/> Maintenance framework | <input type="checkbox"/> Feasibility of maintenance |
| <input type="checkbox"/> Maintenance test | <input type="checkbox"/> Regression test | <input type="checkbox"/> Hardware maintenance |
| <input type="checkbox"/> Scheduled maintenance | <input type="checkbox"/> Preventive maintenance | <input type="checkbox"/> On-site maintenance |
| <input type="checkbox"/> Remote maintenance | <input type="checkbox"/> Life cycle evaluation | |
| <input type="checkbox"/> Change procedure establishment | | |
| <input type="checkbox"/> Preparation of maintenance documentation | | |
| <input type="checkbox"/> Analyses of problems and change requests | | |
| <input type="checkbox"/> Reproduction or verification of problems | <input type="checkbox"/> Function addition | |
| <input type="checkbox"/> Performance improvement | <input type="checkbox"/> Correction of problems | |
| <input type="checkbox"/> Planning and implementation of the migration | <input type="checkbox"/> Notification to the users | |
| <input type="checkbox"/> Parallel operations of the old and new environments | <input type="checkbox"/> Verification of the migration | |
| <input type="checkbox"/> Evaluation of the migration | <input type="checkbox"/> Disposal planning | |
| <input type="checkbox"/> Parallel operations of the old and new software products | <input type="checkbox"/> Disposal notification | |
| <input type="checkbox"/> Data integrity | | |

- ▶ Q4-18 and Q4-19

Chapter 2 Software Development Management Techniques

2.1 Development process and methods ★★

[Learning objectives]

- Understand the concept of typical techniques concerning software development process, and apply them to the associated matters.

□ Keywords

Software development models (□ Waterfall model □ Spiral model □ Prototyping model

□ RAD (Rapid Application Development) □ Agile □ Software product line

□ Iterative model □ Incremental Model □ Evolutionary Model)

Software life cycle (□ SLCP-JCF2007 □ JIS X 0160)

Process maturity model of CMMI with 5 stages (□ Initial □ Managed □ Defined

□ Quantitatively managed □ Optimizing)

Reuse of software (□ Module independence □ Standardization □ Customization)

Reverse engineering (□ Compatibility □ Call graph)

Structured methods (□ Hierarchical structuring □ Stepwise refinement □ Structured chart

□ State transition diagram □ HIPO (Hierarchy plus Input Process Output) □ DFD

□ Software structure)

Formal method (□ VDM Tools) Mashup (□ Web2.0)

- ▶ Q4-20 through Q4-24

2.2 Intellectual property application management

[Learning objectives]

- Understand the outline of types of intellectual property rights, their features, items to be protected, and management.

□ Keywords

□ Author of the program

□ Employee work

□ Patent right

□ Exclusive license

□ Non-exclusive license

□ Licensor

□ Licensee

2.3 Development environment management

[Learning objectives]

- Understand the outline of necessity of managing the development environment, items to be managed, and management.

□ Keywords

- | | | |
|---|--|---|
| <input type="checkbox"/> Configuration item | <input type="checkbox"/> Software license | <input type="checkbox"/> Security |
| <input type="checkbox"/> Resource management | <input type="checkbox"/> Operations management | <input type="checkbox"/> Change history control |
| <input type="checkbox"/> Access right control | <input type="checkbox"/> Unauthorized copying | <input type="checkbox"/> Inventory taking |

▶ Q4-25

2.4 Configuration management and change control ★★

[Learning objectives]

- Understand the outline of configuration management and change control.

□ Keywords

- Configuration management (☐ SCM (Software Configuration Management)
- ☐ SCI (Software Configuration Item) ☐ SLCP (Software Life Cycle Process)
- ☐ Configuration management plan)
- Change control (☐ Consistency ☐ Accuracy) ☐ Version control
- ☐ Retention period

4.1

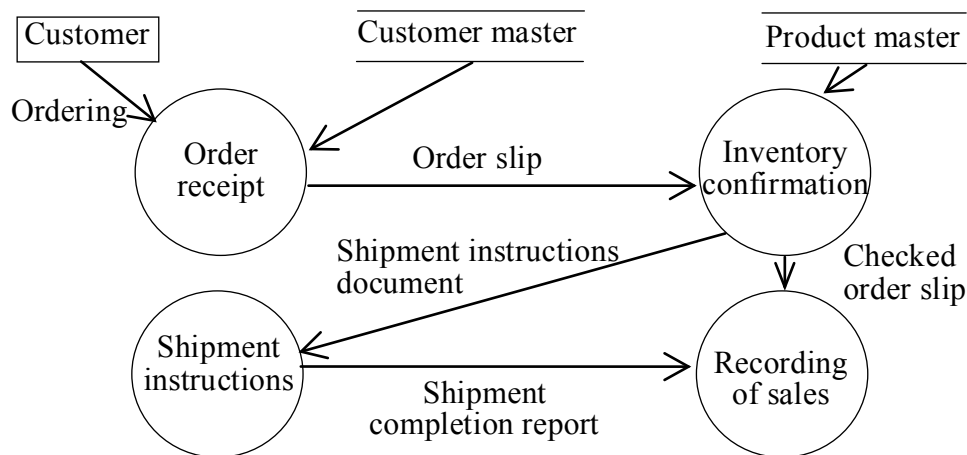
System Development Technology**Q4-1** □□□

Which of the following should be clearly specified as a software requirement?

- a) Disk capacity of the development environment
- b) Objectives of computerization
- c) Data definition
- d) Highest level design of databases

Q4-2 □□□

Which of the following is the notation used in the diagram below?



- a) DFD
- b) State transition diagram
- c) Flowchart
- d) Petri net

Q4-3 □□□

Mandatory question

Which of the following is the most appropriate description concerning code design for a business system?

- a) Actual assignment of code should be performed by a system designer who is proficient in methods for code processing.
- b) The attributes and number of digits in the code should be designed with importance placed on the internal processing efficiency of the computer.
- c) When mistakes in code input are judged to have a significant effect on business, check characters, such as check digits, should be implemented.
- d) Methods for code maintenance, such as additions, deletions, and changes, should be decided at the operational test phase.

Q4-4 □□□

Which of the following is UML that is standardized by the OMG?

- a) A modeling language that is used in software development and has an object-oriented approach
- b) An interface description language for the use of an object from another program
- c) A manipulation language of a relational database for operations such as table definition and data manipulation
- d) A markup language for describing the structure or meaning of a statement or data

Q4-5 □□□

A use case is a technique that clearly describes the functional requirements of a system and defines interactions between a user and the system. Which of the following is an appropriate scenario for modeling with use cases?

- a) The planning of a new IT service that uses the Internet
- b) Construction work on the air-conditioning equipment in a computer room
- c) Use of a parallel processor to reduce processing time
- d) The withdrawal of cash by a depositor from an ATM

Calculation of Profits 4

$\text{Net income} = \text{Ordinary income} + \text{Extraordinary income} - \text{Extraordinary loss} - \text{Income tax}$

Check!

Q4-6 □□□

Which of the following is an explanation of encapsulation in object-oriented design?

- a) The abstraction and organization of multiple objects with similar characteristics
- b) The inheritance of the characteristics of a base class by a subclass
- c) The abstraction of characteristics that are common between classes, and the creation of a base class
- d) The unification of data and the procedures that manipulate this data, and its concealment inside an object

Q4-7 □□□

In order to increase the independence of modules, it is necessary to weaken module coupling. Which of the following is the method for transferring information that has the weakest module coupling?

- a) Data defined in a common area is referenced by the relevant modules.
- b) Control parameters are passed as arguments, and the execution sequence of modules is controlled.
- c) Only data items are passed as arguments between modules.
- d) Required data is shared through external declaration.

Q4-8 □□□**Mandatory question**

Which one of the following has the highest module strength?

- a) A module that executes multiple functions in sequence for certain data
- b) A module that processes data from different input media
- c) A module that executes a single function
- d) A module that contains all tasks considered necessary at a specific point in time

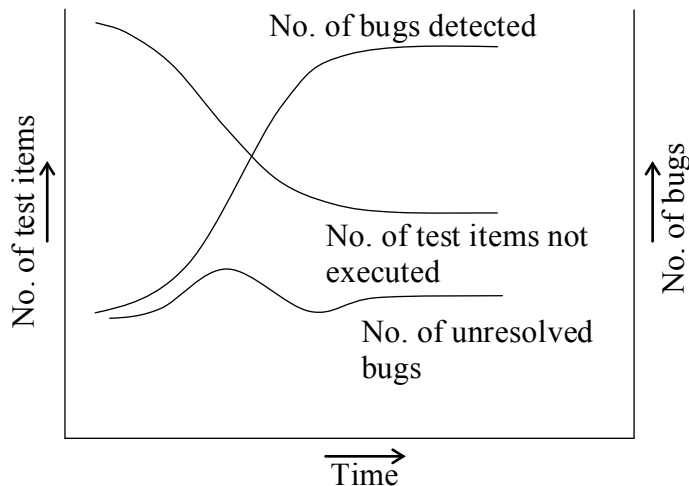
Q4-9 □□□

Which of the following is a method where the author and multiple involved persons review a design document at the completion of the design for the early detection of design errors?

- a) Walkthrough
- b) Desk checking
- c) Top-down testing
- d) Parallel simulation

Q4-10 □□□

In a bug control chart, if all the lines level out as shown in the figure below, which of the following is an appropriate assumption that can be made?



- a) Due to a bug that is difficult to resolve, subsequent testing is not progressing.
- b) Many bugs were detected, so the number of test items conducted is not increasing.
- c) The detection of bugs is halted, and the tests are close to being completed.
- d) The number of bugs detected is equal to that of test items conducted, and the number of unresolved bugs remains unchanged.

Q4-11 □□□

Which of the following is an appropriate description of the black box test?

- a) The coverage ratio of test cases is used as a standard for the preparation of test data.
- b) Even if there is redundant code in the test program, it cannot be detected.
- c) Whether the required portion is executed or not is verified with the focus on the internal structure of a program.
- d) An increase in the number of branch instructions or modules results in a sharp increase in test data.

Q4-12 □□□

Mandatory question

In the table below, input data of a certain program is divided into valid equivalence classes and invalid equivalence classes. When a test case is designed according to the equivalence partitioning method, which of the following is an appropriate combination of minimum test data?

Equivalence class	Data
Invalid equivalence class	-2, -1, 0
Valid equivalence class	1, 2, 3, 4, 5
Invalid equivalence class	6, 7, 8

- a) -2, 0, 1, 5, 6, 8
- b) 0, 1, 5, 6
- c) -1, 3, 6
- d) 1, 5

Q4-13 □□□

When modifications are made to a part of a system, which of the following is a test that verifies the modified part is not adversely affected and the correct result is obtained?

- a) Function test
- b) Integration test
- c) Regression test
- d) Exception test

Method of calculating breakeven point

$$\text{Breakeven sales} = \frac{\text{Fixed cost}}{1 - \text{Proportion of variable cost}} = \frac{\text{Fixed cost}}{1 - (\text{Variable cost}/\text{Sales})}$$

Check!

Q4-14 □□□

Which of the following is a test that is conducted to verify interfaces between modules and between subsystems?

- a) Operational test
- b) Integration test
- c) System test
- d) Unit test

Q4-15 □□□

An integration test of software that is composed of module groups with a hierarchical structuring is conducted from higher level modules. In such a test, which of the following is the test module that is used as a substitute for lower level modules?

- a) Emulator
- b) Simulator
- c) Stub
- d) Driver

Q4-16 □□□**Mandatory question**

Which of the following is a test that is conducted in the system test phase when a new system is developed?

- a) Load test
- b) Interface test between modules
- c) Operation check test based on module specifications
- d) Regression test

Q4-17 □□□

Which of the following is the test data that should be prepared when a system qualification test is conducted?

- a) Data that is actually used in operations and data that is processed as an exception during operations
- b) Data to detect errors related to interfaces between software units
- c) Data that passes through all branches of a software unit once or more
- d) Data that executes all instructions inside a software unit once or more

Main SQL Syntax 1

Extraction by specifying column name `SELECT Column Name 1, Column Name 2 ... FROM Table`

Check!

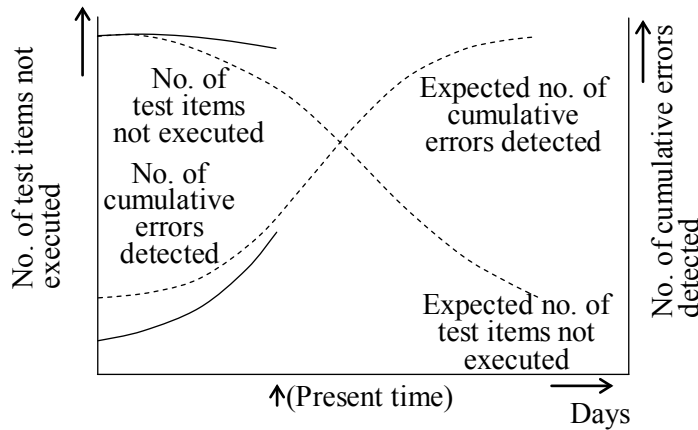
Q4-18 □□□

Which of the following is the primary objective for a migration test of a system?

- a) To check the procedure for the switch over from the existing system to the new system and the problems that accompany the changeover, from the viewpoint of safety and efficiency
- b) By using a copy of database of the existing system, to check that sufficient performance is obtained in the new system as well
- c) To check the consistency of interfaces between the existing program and the newly developed program
- d) To check that the new system satisfies all the required functions

Q4-19 □□□

Which of the following is an appropriate interpretation of the quality management chart for a test process as shown below and future actions to be taken?

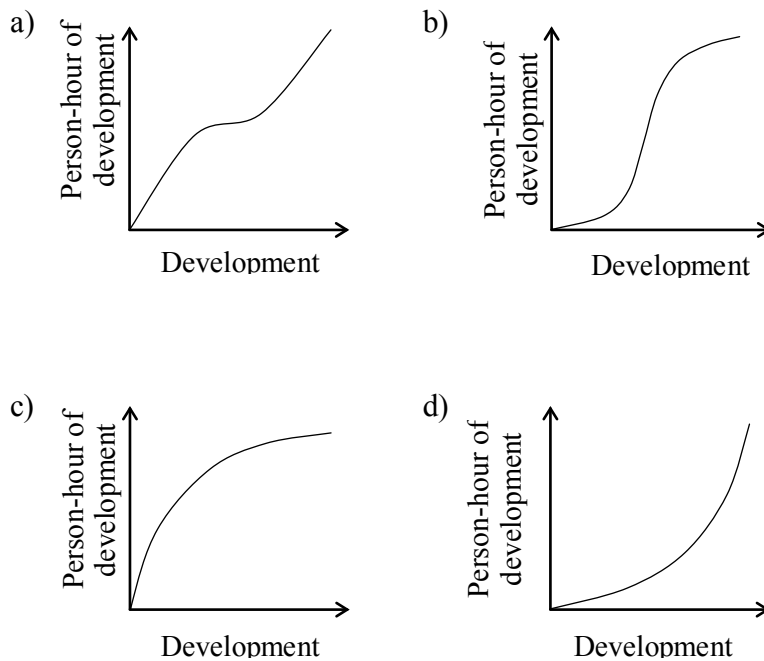


- Since it can be determined that development quality is poor, focused measures are needed for areas with many errors. The overall quality of the previous phase should be reviewed, and the previous phase should be repeated if necessary.
- Test items are executed slowly, and it is necessary to consider the required measures for deficiencies in the test environment and a lack of development personnel at this point in time. Since more errors were detected than expected, quality is not a problem.
- Test items are executed quickly, and detection of errors is faster than expected. Since this is the first half of the test, it is better to continue the test without changes and monitor the situation.
- The detection of errors is progressing faster than the execution of test items, and testing is progressing efficiently. Although attention is not currently required, keeping track of the progress of error resolution is necessary so that unresolved bugs do not remain unaddressed for a long time.

4.2

Software Development Management Techniques**Q4-20** □□□

Which of the following is a graph that indicates the relationship between development scale and person-hour of development for software?

**Q4-21** □□□**Mandatory question**

Which of the following is an explanation of CMMI?

- a) It is a model for evaluating the maturity level of a software development organization and project processes.
- b) It is a type of process model for software development.
- c) It is a common frame for software-based system development and transactions.
- d) It is a model that defines the procedure of software development according to the maturity level of a project.

Main SQL Syntax 2

Extract all columns `SELECT * FROM Table`

Check!

Q4-22 □□□

JIS X 0160 (Software Life Cycle Process) stipulates not only the responsibilities of a supplier in a software transaction but also the responsibilities of a buyer. Which of the following is appropriate as the responsibility of a buyer?

- a) Clear specification of acceptance criteria and procedures
- b) System operations
- c) Correction of product defects
- d) Implementation of an internal quality audit

Q4-23 □□□

Which of the following is a technique that analyzes source code or object code, and extracts information about program specifications and design?

- a) Reengineering
- b) Restructuring
- c) Reverse engineering
- d) Refactoring

Q4-24 □□□

When programs are written in Java, which of the following specifications is used to create frequently-used functions and other features as reusable components?

- a) JavaBeans
- b) JavaScript
- c) Java application
- d) Java applet

Q4-25 □□□

Which of the following is the most appropriate description of maintenance management in the development environment for an embedded system that is used in the development of a certain product?

- a) Even if the development environment is not used frequently, it should be maintained by upgrading to the latest development environment.
- b) As the development environment will not be needed again after the product is developed, maintenance of the development environment is not necessary.
- c) Irrespective of the frequency of use, the development environment should be maintained by checking operations periodically.
- d) A development environment borrowed from a rental company is maintained indefinitely under the rental company's responsibility.

Main SQL Syntax 3

Conditional data extraction

```
SELECT Column Name 1, Column Name 2 ... FROM Table WHERE Extraction Condition
```

Check!

Section 4 Development Technology List of Answers

Q4-1	c)
Q4-2	a)
Q4-3	c)
Q4-4	a)
Q4-5	d)
Q4-6	d)
Q4-7	c)
Q4-8	c)
Q4-9	a)
Q4-10	a)
Q4-11	b)
Q4-12	c)
Q4-13	c)
Q4-14	b)
Q4-15	c)
Q4-16	a)
Q4-17	a)
Q4-18	a)
Q4-19	a)
Q4-20	d)
Q4-21	a)
Q4-22	a)
Q4-23	c)
Q4-24	a)
Q4-25	c)

Management

Morning Exam

Section 5

Project Management

Learning Objectives

1. Be able to provide an overview of project integration management.
2. Understand the basics of project scope management.
3. Understand an overview of project time management and project cost management.
4. Understand an overview of project quality management.
5. Understand the basics of project human resources management and communications management.
6. Understand an overview of project risk management
7. Understand an overview of project procurement management.

Chapter 1 Project Management

1.1 Project Integration Management

[Learning objectives]

- Understand the purpose and concept of project management, and also the outline of the process group and knowledge area.
- Understand the outline of project frameworks, and the necessity and content of self-management.
- Understand the purpose and concept of project integration management, and also the outline of processes.

Keywords

- ☐ PMBOK (Project Management Body of Knowledge)
- ☐ Initiating process group ☐ Planning process group
- ☐ Executing process group ☐ Controlling process group
- ☐ Closing process group ☐ Project integration management
- ☐ Project scope management ☐ Project time management
- ☐ Project cost management ☐ Project quality management
- ☐ Project human resources management
- ☐ Project communications management
- ☐ Project risk management ☐ Project procurement management
- ☐ Project frameworks (functional, matrix, and projectized)
- ☐ Activity planning ☐ Communication
- ☐ Progress management ☐ Project charter
- ☐ Scope ☐ Project charter preparation
- ☐ Preparation of a preliminary project scope description document
- ☐ Preparation of a project management plan
- ☐ Direction and management of project implementation
- ☐ Controlling of project activities ☐ Integrated change control
- ☐ Project termination ☐ Change form
- ☐ CCB (Change Control Board)

- ▶ Q5-1 and Q5-2

1.2 Project Scope Management

[Learning objectives]

- Understand the purpose and concept of project scope management.
- Understand the purpose and characteristics of WBS.
- Understand the outline of processes in project scope management.

□ Keywords

- | | | |
|---------------------------------------|---|---|
| <input type="checkbox"/> Scope | <input type="checkbox"/> WBS | <input type="checkbox"/> WBS dictionary |
| <input type="checkbox"/> Work package | <input type="checkbox"/> Scope planning | <input type="checkbox"/> Scope definition |
| <input type="checkbox"/> WBS creation | <input type="checkbox"/> Scope verification | <input type="checkbox"/> Scope control |

► Q5-3 and Q5-4

1.3 Project Time Management ★★★

[Learning objectives]

- Understand the purpose and concept of project time management, and apply them to associated matters.
- Understand the purpose, basic role and function of each process in project time management, and apply them to associated matters.
- Understand the types of schedules and the typical management techniques, and apply them to associated matters.

□ Keywords

- | | |
|---|--|
| <input type="checkbox"/> Activity | <input type="checkbox"/> Activity definition |
| <input type="checkbox"/> Activity sequencing | <input type="checkbox"/> Activity resource estimating |
| <input type="checkbox"/> Activity duration estimating | <input type="checkbox"/> Arrow diagram |
| <input type="checkbox"/> Gantt chart | <input type="checkbox"/> Schedule development |
| <input type="checkbox"/> Schedule control | <input type="checkbox"/> Master schedule |
| <input type="checkbox"/> Intermediate schedule | <input type="checkbox"/> Detailed schedule |
| <input type="checkbox"/> Progress report | <input type="checkbox"/> EVM (Earned Value Management) |

► Q5-5 through Q5-8

1.4 Project Management

[Learning objectives]

- Understand the purpose and concept of project cost management, and apply them to associated matters.
- Understand the purpose, basic role, and function of each process in project cost management, and apply them to associated matters.
- Understand typical cost estimating techniques and cost management techniques, and apply them to associated matters.

☐ Keywords

- | | | |
|---|---|---|
| <input type="checkbox"/> Cost baseline | <input type="checkbox"/> Cost estimation | <input type="checkbox"/> Cost budgeting |
| <input type="checkbox"/> Cost control | <input type="checkbox"/> FP (Function Point) method | |
| <input type="checkbox"/> Three-point estimate | <input type="checkbox"/> Analogous estimating | |
| <input type="checkbox"/> Bottom-up estimating | <input type="checkbox"/> LOC (Lines of Code) method | |
| <input type="checkbox"/> COCOMO (Constructive Cost Model) | <input type="checkbox"/> EVM | |

► Q5-9 through Q5-13

1.5 Project Quality Management

[Learning objectives]

- Understand the purpose and concept of project quality management, and apply them to associated matters.
- Understand the purpose, basic role, and function of each process in project quality management, and apply them to associated matters.
- Understand the typical quality management techniques, and apply them to associated matters.

☐ Keywords

- | | |
|--|---|
| <input type="checkbox"/> JIS Q 9000 family standards | <input type="checkbox"/> Quality planning |
| <input type="checkbox"/> Quality assurance | <input type="checkbox"/> Quality management |
| <input type="checkbox"/> Benchmark | <input type="checkbox"/> Quality index |
| <input type="checkbox"/> Control chart | |

► Q5-14

1.6 Project Human Resources Management

[Learning objectives]

- Understand the purpose and concept of project human resources management.
- Understand the outline of processes in project human resources management.

□ Keywords

- | | |
|---|--|
| <input type="checkbox"/> Project manager | <input type="checkbox"/> Project member |
| <input type="checkbox"/> Human resources planning | <input type="checkbox"/> Project team organization |
| <input type="checkbox"/> Project team development | <input type="checkbox"/> Project team management |

► Q5-15

1.7 Project Communications Management

[Learning objectives]

- Understand the purpose and concept of project communications management, and apply them to associated matters.
- Understand the processes in project communications management, and apply them to associated matters.

□ Keywords

- | | |
|---|--|
| <input type="checkbox"/> Stakeholder | <input type="checkbox"/> Communications planning |
| <input type="checkbox"/> Information distribution | <input type="checkbox"/> Performance reporting |

1.8 Project Risk Management

[Learning objectives]

- Understand the purpose and concept of project risk management.
- Understand the outline of processes in project risk management.

□ Keywords

- | | |
|--|--|
| <input type="checkbox"/> Risk | <input type="checkbox"/> Risk management planning |
| <input type="checkbox"/> Risk identification | <input type="checkbox"/> Qualitative risk analysis |
| <input type="checkbox"/> Quantitative risk analysis | <input type="checkbox"/> Risk response planning |
| <input type="checkbox"/> Risk monitoring and control | |

► Q5-16

1.9 Project Procurement Management

[Learning objectives]

- Understand the purpose and concept of project procurement management.
- Understand the outline of processes in project procurement management.

☐ Keywords

- | | |
|--|---|
| <input type="checkbox"/> Buyer | <input type="checkbox"/> Supplier |
| <input type="checkbox"/> Plan purchases and acquisitions | <input type="checkbox"/> Plan contracting |
| <input type="checkbox"/> Request seller response | <input type="checkbox"/> Select seller |
| <input type="checkbox"/> Contract administration | <input type="checkbox"/> Contract closure |

► Q5-17

5.1**Project Management****Q5-1** ☐☐☐

Which of the following is an explanation of a project organization?

- a) It is an organization in which members belong to both a specific functional department and another department that is involved in a specific business.
- b) It is an organization that is composed of departments based on the nature of work, such as purchase, production, sales, and finance.
- c) It is a temporary and flexible organization that is formed for a set period and for a set goal and is composed of specialists from various departments, in order to handle a specific issue.
- d) It is an organization that can perform self-contained management activities by having functions required for profit responsibilities and business operations grouped by product, customer, or region.

Q5-2 ☐☐☐

Which of the following is an appropriate combination of constraints that a project manager should consider in managing a project?

- a) Scope, schedule, and budget
- b) Scope, schedule, and risk
- c) Scope, budget, and risk
- d) Schedule, budget, and risk

Q5-3 ☐☐☐ **Mandatory question**

Which of the following is an appropriate description of the effect of using a WBS (Work Breakdown Structure)?

- a) The details and scope of each activity can be organized systematically, so it becomes easier to grasp an overview of all activities.
- b) Software, hardware, and other system components can be managed more efficiently.
- c) The project structure is represented hierarchically, so the line of command becomes clear.
- d) It makes it possible to determine whether activities are appropriately assigned to each staff member.

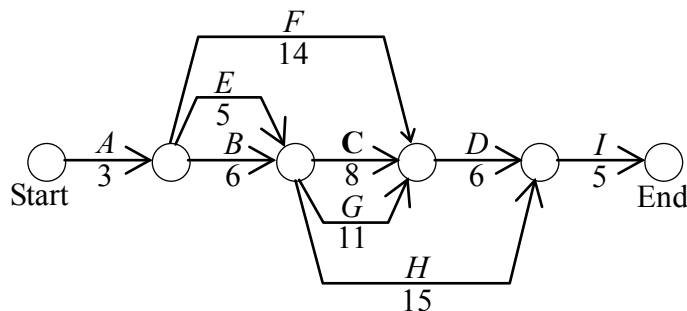
Q5-4 □□□

Which of the following is an appropriate purpose of using a WBS (Work Breakdown Structure) in software development?

- a) To aim for total cost optimization when there is a trade-off relationship between the number of days and the cost that are required for development
- b) To understand the critical path that should be managed with particular consideration, by clarifying the sequential relationship of activities
- c) To clarify the starting and ending points of each activity and the progress at the current point in time by representing the schedule of each activity with a crossbar
- d) To divide activities into hierarchical levels and then subdivide them into smaller and manageable segments

Q5-5 □□□

The figure below shows the activities (*A* through *I*) and the number of working days required for a project. What is the minimum number of days that is required until the completion of the project?



- a) 27
- b) 28
- c) 29
- d) 31

Main SQL syntax 4

Extraction process satisfying
all of multiple conditions

```

SELECT column_1, column_2 ... FROM table_name
WHERE extraction condition 1
AND extraction condition 2
  
```

Check!

Q5-6 □□□

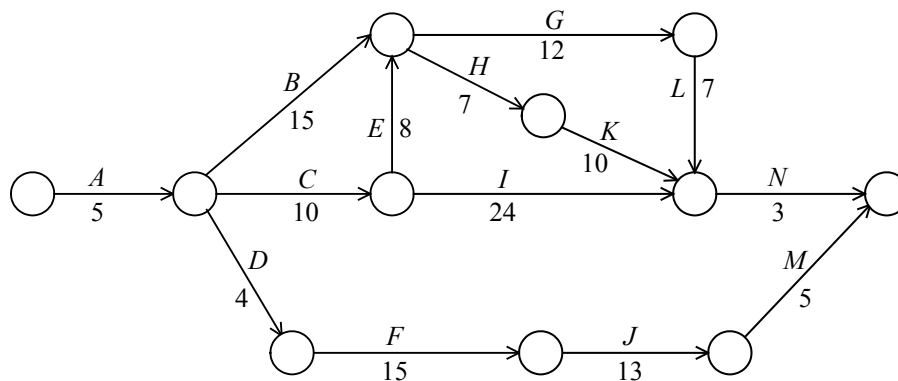
The allocation of person-days for a project is as shown in the table below. The phases from basic design to program design are completed as planned. In the programming phase, there are 3,000 programs, of which 1,200 are completed. Which of the following is the current percentage of completion for the entire project?

Basic design	Detailed design	Program design	Programming	Testing
0.08	0.16	0.20	0.25	0.31

- a) 40 b) 44 c) 54 d) 59

Q5-7 □□□ **Mandatory question**

The arrow diagram below shows the development activities in a system. Which of the following is the critical path? Here, the number shown beside each arrow indicates the number of days required for each activity.



- a) A-B-G-L-N b) A-B-H-K-N
c) A-C-E-G-L-N d) A-C-I-N

Q5-8 □□□

Among the descriptions concerning the characteristics of process control charts below, which of the following is a characteristic of the Gantt chart?

- a) It is suitable for understanding important points for process management, and is used for progress management of an individual or such other management.
- b) It enables an understanding of information including the temporal relationship, number of days, and float (or slack) time for each activity.
- c) It enables an understanding of information including the planned and actual start and finish dates of activities, as well as the work items that are currently in progress.
- d) It is suitable for representing the time-based changes in the amount of work done, and enables simultaneous execution of cost management and progress management.

Q5-9 □□□

In the FP (Function Point) method, which of the following is used to estimate the development scale of a system?

- | | |
|----------------------------|----------------------|
| a) Number of developers | b) Number of screens |
| c) Number of program steps | d) Number of users |

Q5-10 ☐☐☐ **Mandatory question**

In a certain application program, the number of functions and weighting factor of each user function type based on the FP (Function Point) method are as shown in the table below. What is the number of function points of this application program? Here, the correction coefficient of complexity is 0.75.

User function type	Number of functions	Weighting factor
External input	1	4
External output	2	5
Internal logical file	1	10
External interface file	0	7
External inquiry	0	4

- a) 18 b) 24 c) 30 d) 32

Q5-11 ☐☐☐ **Mandatory question**

Which of the following is an appropriate description concerning methods of estimating the workload (i.e., person-hours) for system development?

- a) The collection of a company's own productivity data is indispensable for using COCOMO.
- b) Since the skills of the development staff vary, the scale of the programs developed in the past is referenced for estimate but the person-hours are not referenced.
- c) The estimate of person-hours is useful for the progress management of an activity, but is not related to the quality management of software.
- d) When the person-hours are estimated based on the FP (Function Point) method, the number of program steps needs to be determined.

Main SQL syntax 5

Extraction process satisfying
any one or all of multiple conditions

```
SELECT column_1, column_2 ... FROM table_name
WHERE extraction condition 1
OR extraction condition 2
```

Check!

Q5-12 □□□

The estimated development workload of an entire development project is 88 person-months. 10 staff members per month have been assigned to the project since it started in January. At the end of May, only a total of 40 person-months of work are completed. In order to complete the project by the end of August, how many additional staff members are required from June onward? Here, the working efficiency of each staff member from June onward is the same as that of the staff up to the end of May.

- a) 6 b) 10 c) 16 d) 20

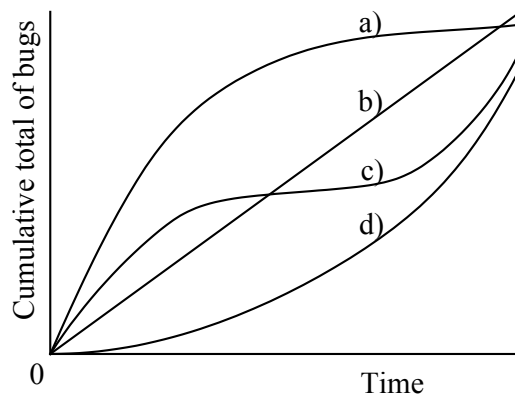
Q5-13 □□□

In the software development that uses the waterfall model, which of the following is the most appropriate description concerning the cost of fixing errors detected during an operational test?

- a) External design and internal design errors affect not only the program but manuals or such other documents, so these errors cost more to fix than coding errors.
- b) Coding errors affect the work scope for all succeeding phases, so these errors cost more to fix than the requirement definition errors.
- c) Test case errors require more work than only the correction and re-execution of the test cases, so these errors cost more to fix than external and internal design errors.
- d) Requirements definition errors can usually be detected during the design review, so these errors cost less to fix than coding errors.

Q5-14 □□□

A system has four subsystems a) through d) and is under development. The graph below represents the cumulative total of bugs detected in the test process of each subsystem. Which of the following is the subsystem that has the best quality? Here, all the bugs detected are fixed, and the development scale, development period, and number of staff members in each subsystem are almost the same.



Q5-15 □□□

When the development department and operation department of a system are organized separately, which of the following is an appropriate method for moving smoothly and effectively from development to operation?

- After the completion of the operational test, the development department explains the system specifications and operating methods to the operation department.
- In order to perform the operational test efficiently, the operation department performs the test without the support of the development department.
- The operation department also participates actively in system development, and provides advice from the viewpoint of operability.
- The development department creates an operation manual after the operational test is performed, and passes it on to the operation department.

Main SQL syntax 6

Extraction process that does not satisfy any condition

```
SELECT column_1 column_2 ...
FROM table_name
WHERE NOT extraction condition
```

Check!

Q5-16 □□□

Which of the following is an appropriate description concerning an organizational structure for risk management?

- a) Authority and functions are concentrated in the risk management director, who performs the entire risk management process from the detection or identification of a risk up to its evaluation.
- b) Since security control is considered as part of risk management, no other departments except those specializing in risk management should be involved in risk management.
- c) Since risk processing is related to insurance and business resource management, the finance department should play a specialized role as a risk management department.
- d) Measures against risks should be performed by each department that has the authority and functions, and overall management should be performed by the risk management department that is directly linked to the managerial level.

Q5-17 □□□ **Mandatory question**

Which of the following is the main purpose of the ISO 9000 series?

- a) To provide standards for a quality management system that is aimed at improving the customer satisfaction level
- b) To provide the latest quality management methodologies and tools
- c) To provide software development processes and activities
- d) To provide quality management activities that should be performed in the project

Section 5 Project Management List of Answers

Q5-1	c)
Q5-2	a)
Q5-3	a)
Q5-4	d)
Q5-5	d)
Q5-6	c)
Q5-7	c)
Q5-8	c)
Q5-9	b)
Q5-10	a)
Q5-11	a)
Q5-12	b)
Q5-13	a)
Q5-14	a)
Q5-15	c)
Q5-16	d)
Q5-17	a)

Management

Morning Exam

Section 6

Service Management

Learning Objectives

1. Understand the significance and purpose of service management, as well as the basics of ITIL content.
2. Be able to explain the service support content including the service desk, incident management, and risk management.
3. Be able to explain an overview of service delivery, such as the service level management, availability management, and IT service continuation management.
4. Understand an overview of service management foundation and facility management.

Chapter 1 Service Management

1.1 Service Management ★★

[Learning objectives]

- Understand the purpose and concept of service management.
- Understand the outline of ITIL, and the purpose and concept of an SLA.
- Understand the outline of the role of the system operations manager, evaluation and verification of operations assessment indicators, and handover of operations.

□ Keywords

- | | | |
|---|--|--------------------------------------|
| <input type="checkbox"/> Service quality | <input type="checkbox"/> Service management | <input type="checkbox"/> JIS Q 20000 |
| <input type="checkbox"/> ISO/IEC 20000 | <input type="checkbox"/> ITIL (Service support and service delivery) | |
| <input type="checkbox"/> System operations management | <input type="checkbox"/> SLA | |
| <input type="checkbox"/> SLM (Service Level Management) | | |

- ▶ Q6-1 through Q6-3

1.2 Operations Design and Tools

[Learning objectives]

- Understand the basic work content with regard to design, installation, and migration of system operations, and apply them to associated matters.
- Learn the types and characteristics of operations support tools, and apply them to associated matters.

□ Keywords

- | | |
|---|---|
| <input type="checkbox"/> Schedule design | <input type="checkbox"/> Operating method during failures |
| <input type="checkbox"/> System installation and migration | |
| <input type="checkbox"/> Operations support tools (Monitoring tools and Diagnostic tools) | |

1.3 Service Support ★★

[Learning objectives]

- Understand the purpose and concept of service support, and apply them to associated matters.
- Understand the role and concept of processes that constitute service support.
- Understand the basic activity details of risk management and computer operations management, and apply them to associated matters.

□ Keywords

- ☐ Service desk (Customer support and SPOC (Single Point of Contact))
- ☐ Incident management (Fault management) (Incident, Service request, Service quality, and Escalation)
- ☐ Problem management (Problems, Known errors, and RFC (Request For Change))
- ☐ Configuration management (Configuration items and CMDB (Configuration Management Database))
- ☐ Change management (Emergency changes and Change records)
- ☐ Release management (Releases, Emergency releases, and Distribution)
- ☐ Risk management (Risks to information assets, Security risk management, and Information security management)
- ☐ Computer operations management (Operations management, Job management, Data management, and Security management)

- ▶ Q6-4 through Q6-6

1.4 Service Delivery ★★

[Learning objectives]

- Understand the considerations for system operations, and apply them to associated matters.
- Understand the role and concept of processes constituting service delivery, and apply them to associated matters.
- Understand the purpose of an SLA and SLM in service delivery, and apply it to associated matters.
- Understand the purpose of user management, system resource management, and information asset management, and apply them to associated matters.

□ Keywords

- ☐ System operations (Job scheduling, Data input/output, and Operations manual)
- ☐ Service level management (Service reporting and Periodic review)
- ☐ Capacity management (CPU utilization rate, memory utilization rate, file usage, network utilization rate)
- ☐ Availability management (Availability, Reliability, and Maintainability)
- ☐ User management (Access management, User authentication, Password, Administrator privileges)
- ☐ System resource management
- ☐ Information asset management

- ▶ Q6-7 through Q6-10

1.5 Service Management Foundation

[Learning objectives]

- Understand the concept of IT service management foundation, and the outline of techniques.

□ Keywords

- ☐ JIS Q 20000
- ☐ ISMS (Information Security Management System)

▶ Q6-11

1.6 Facility Management

[Learning objectives]

- Understand the outline of facility management.

□ Keywords

- ☐ Customer service
- ☐ UPS
- ☐ Private power generator
- ☐ Security cable
- ☐ Maintenance and protection of facilities (Inspection, Amortization, Migration, and Disposal)

▶ Q6-12 and Q6-13

Chapter 2 System Audit

2.1 System Audit ★★★

[Learning objectives]

- Understand the purpose and types of audits.
- Understand the purpose, procedures, and target operations of system audits, and the concept of system auditability.
- Understand the concept of system audit plans, as well as the concept of implementation, reporting, and evaluation of system audits.
- Understand the outline of system audit standards.

□ Keywords

- | | | |
|--|---|--|
| <input type="checkbox"/> Accounting audit | <input type="checkbox"/> Operations audit | <input type="checkbox"/> System audit |
| <input type="checkbox"/> Information security audit | <input type="checkbox"/> Statutory audit | <input type="checkbox"/> Voluntary audit |
| <input type="checkbox"/> System auditor | <input type="checkbox"/> System audit standards | <input type="checkbox"/> Audit evidence |
| <input type="checkbox"/> Documented system audit plan | | <input type="checkbox"/> System audit techniques |
| <input type="checkbox"/> Audit working papers | <input type="checkbox"/> System audit report | <input type="checkbox"/> Assurance opinion |
| <input type="checkbox"/> Advisory opinion | <input type="checkbox"/> Recommended improvements | |
| <input type="checkbox"/> Information Security Audit Standards | | |
| <input type="checkbox"/> System Management Standards | | |
| <input type="checkbox"/> Information Security Management Standards | | |

► Q6-14 through Q6-19

2.2 Internal Control ★★

[Learning objectives]

- Understand the purpose and concept of internal control and IT governance in companies.

□ Keywords

- | | |
|--|---|
| <input type="checkbox"/> Compliance | |
| <input type="checkbox"/> COSO (Committee of Sponsoring Organizations of the Treadway Commission) framework | |
| <input type="checkbox"/> Companies Act | <input type="checkbox"/> Financial Instruments and Exchange Law |
| <input type="checkbox"/> IT governance (Preventive control and Detective control) | |

► Q6-20 through Q6-22

6.1**Service Management****Q6-1** ☐☐☐

Which of the following is a standard based on ITIL (Information Technology Infrastructure Library), the best practice of IT service management, which “promotes the adoption of an integrated process approach to effectively deliver managed services to meet business and customer requirements, standardize the mechanism for continuously improving the service quality, rationalize production and usage, and achieve improved quality?”

- a) ISO 9001
- b) ISO 14001
- c) ISO/IEC 15408
- d) ISO/IEC 20000

Q6-2 ☐☐☐**Mandatory question**

Which of the following is appropriate to be included in an SLA?

- a) The objectives and scope of responsibilities for the service agreed upon by the client and the service provider
- b) The distribution of roles between the service desk and the IT support department
- c) The characteristics, components, and fee of all services provided by a service provider
- d) The operational requirements of the users for an IT service

Q6-3 □□□

There is a concept called an SLA (Service Level Agreement) concerning the operations of a corporate information system. Which of the following is an appropriate description concerning an SLA?

- a) It is a form of new operational service contract with an external subcontractor, which protects corporate secrets by incorporating detailed items, such as stipulations for leakage of confidential information, into the contract.
- b) It is a set of performance indicators that is used by management to evaluate the information systems department and shows the target values to be achieved by the information systems department in an annual plan. For example, it includes the development budget, the development productivity, and the number of problems.
- c) It is a written agreement that the staff of the information systems department make with the company, which stipulates the applicable pay system, the working hours, and the method of handling an emergency situation such as a system failure, for the information systems staff whose work environment is complex.
- d) It is an agreement exchanged between the user department and the information systems department, which includes some terms, such as billing items, inquiry period, and recovery time from an online system failure. A penalty for a breach of the agreement may also be included.

Q6-4 □□□

Which of the following is an appropriate description concerning the updating of an application system?

- a) The details of the application change are always recorded because they are useful for investigating the cause of a failure.
- b) Since it is time consuming to investigate the priority of change requests, the change activity is performed in order of arrival.
- c) Since it is difficult to estimate the scope of impact caused by the change activity, all employees are always informed of the changes.
- d) The release to the production environment is always performed late at night so as not to affect users.

Main SQL Syntax 7

Extraction by
comparing the values
of the specified
columns

```
SELECT column_name_1, column_name_2 ...
FROM table_name
WHERE column_name comparison operator value
```

Comparison =, >, <
operator : >=, <=,
 <>

Check!

Q6-5 ☐☐☐ **Mandatory question**

In IT service management, which of the following is included in the incident management process?

- a) A training request for a person who is new to an IT service
- b) An inquiry about an IT service or a function or usage method of a system
- c) A significant delay in the response of an application
- d) A request for the provision of an IT service to a new sales office

Q6-6 ☐☐☐

Which of the following is a role of configuration management in service support?

- a) To manage the information of predefined IT assets
- b) To manage an incident from the time of occurrence until it is resolved
- c) To manage the staff members of service support
- d) To actually implement and record the approved changes to a system

Q6-7 ☐☐☐

Which of the following is the most appropriate description concerning the operations of a distributed system?

- a) An administrator is not deployed at each site, but the users involved in the operations are trained thoroughly and operations are assigned to them.
- b) The distribution of information resources makes it difficult for a malicious network intrusion to occur, and thus the security management load is reduced.
- c) In order to manage common resources, such as the database, a specialized administrator is deployed in the same way as in a centralized system.
- d) The scope of responsibility of users is clarified so that each user can manage the network configuration.

Q6-8 □□□

Which of the following is an appropriate concept for performing hardware maintenance activities?

- a) Maintenance activities are performed only when a malfunction occurs.
- b) Planned maintenance activities are performed even when a malfunction does not occur.
- c) Even when a sensory-change such as “the operating noise louder than usual” is felt, periodic inspection is waited for.
- d) Maintenance activities are necessary only for the printer and storage associated with the mechanical operation.

Q6-9 □□□

Which of the following is the most appropriate description concerning changes in a network configuration after the start of operations?

- a) As the network configuration becomes more complex, the execution of management by network management software becomes difficult, and as a result, an experienced person in charge must change the configuration.
- b) The network configuration must be changed, after all business applications are stopped in order to secure network security.
- c) The network configuration must be examined sufficiently at the time of network construction so that the configuration is not changed after the start of operations.
- d) It is necessary to update the equipment management register and network diagrams in a timely manner so that the network configuration can be changed at any time as needed.

Main SQL Syntax 8

Extracts records that are equal to or within the range of the specified values

```
SELECT column_name_1, column_name_2 ... FROM table_name
WHERE column_name BETWEEN value_1 AND value_2
```

Check!

Q6-10 □□□

Mandatory question

Which of the following is an appropriate concept of operations and maintenance of an application program?

- a) All codes used for error log extraction and trace that are written in an application program for investigating the cause of an error must be removed when operations start even if they do not cause a decline in the data processing efficiency during operations.
- b) Mastering an application program makes operations management easy, but since all persons in charge cannot become skilled, it is necessary to prepare an operations manual.
- c) When an error occurs during the operations of an application program, the operations manager should himself correct the problem as long as it can be corrected immediately so that the business operations are not hindered.
- d) When an application program is corrected as a result of changes in the procedure of data processing, it is desired to conduct a confirmation test with only the test data during the development of the source program, and then resume the operations.

Q6-11 □□□

Which of the following is the procedure for the implementation of IT service management?

- A*: Reviewing the methods for continuous improvement
 - B*: Understanding the current status
 - C*: Having a clear vision
 - D*: Reviewing the methods for understanding the objectives accomplishment status
 - E*: Reviewing the methods for accomplishing the objectives
 - F*: Setting the objectives
- a) $B \rightarrow C \rightarrow E \rightarrow F \rightarrow D \rightarrow A$
 - b) $B \rightarrow F \rightarrow C \rightarrow A \rightarrow D \rightarrow E$
 - c) $C \rightarrow B \rightarrow F \rightarrow E \rightarrow D \rightarrow A$
 - d) $C \rightarrow F \rightarrow B \rightarrow A \rightarrow D \rightarrow E$

Q6-12 □□□

Which of the following is an appropriate description concerning degraded operation that is one of the measures for the failure of an information system?

- a) It refers to rescheduling the jobs that are planned to be executed on a particular day, in order to shorten the operation time.
- b) It refers to continuing the operation of a system when a running program terminates abnormally, so as to avoid any impact on the other programs.
- c) It refers to partially isolating the failed portion so that the system can be operated even when its functions and throughput are cut down.
- d) It refers to sequentially stopping a process in stages rather than stopping it at once.

Q6-13 □□□**Mandatory question**

Which of the following is included within the scope of facility management for an information system?

- a) Monitoring and improving IT-related facilities constantly to ensure that they are used in the most appropriate manner
- b) Using computers and networks to control factory production lines so that comprehensive management can be accomplished
- c) Managing customer information in a customer database to build a long-term relationship between the company and its customers
- d) Using IT in business activities such as orders between business partners, material procurement, inventory control, and product delivery so that comprehensive management can be accomplished

Main SQL Syntax 9

Extraction when the value of the specified column is blank data

```
SELECT column_name_1, column_name_2 ... FROM table_name
WHERE column_name IS NULL
```

Check!

6.2 System Audit

Q6-14 ☐☐☐

Which of the following is an explanation of the auditability of an information system?

- a) Sufficiency of audit evidence and completeness of audit reports must be secured.
- b) A company must recognize the importance of a system audit and be able to acquire the active cooperation of the departments to be audited.
- c) A system auditor must have the ability to perform effective audits that conform to the purpose of the audit subject.
- d) An information system must be designed and operated so that the correctness of a process and internal control can be audited effectively.

Q6-15 ☐☐☐ **Mandatory question**

Which of the following is a situation in which the independence of a system auditor is secured?

- a) The staff members of the sales department are appointed as members of the audit team, and are asked to audit the personal information protection measures of the sales department.
- b) A system auditor is recruited from an auditing firm and placed as an internal auditor, and is asked to audit the business system development of the company.
- c) The staff members of the systems department are moved to the audit department, and are put in charge of auditing the maintenance of the system in whose development they participated while they worked in the system department.
- d) The audit department of the IT vendor to whom the business system operations of the company are consigned is requested and put in charge of external auditing of the business system operations of the company.

Q6-16 □□□

Which of the following is an appropriate description concerning operations of a quality management system based on JIS Q 9001 (ISO 9001)?

- a) There are several activities in an organization, and even when the activity content varies depending on the department, setting the quality objectives in a consolidated manner is effective for securing quality.
- b) Even when there are many cases where the quality manuals cannot be followed in reality, such manuals are used continuously for a fixed period of time.
- c) Since the quality management system is established to conform to international standards, the operations of the current quality management system should be continued regardless of the implementation status of the process.
- d) If any undesirable events are seen in the operational stage of a quality management system that has been created after thorough examination, changes are made through the regular procedures.

Q6-17 □□□

Which of the following corresponds to a third-party audit defined in “JIS Q 9000:2000 (ISO 9000:2000) Quality management system – Fundamentals and vocabulary”?

- a) A parent company audits the quality management system of a subsidiary company.
- b) A customer audits the quality management system of a trading partner company.
- c) A company audits its own quality management system for internal purposes.
- d) A certification body audits the quality management system of a client company.

Main SQL Syntax 10

Extraction of
fuzzy
references

```
SELECT column_name_1,
       column_name_2 ...
FROM table_name
WHERE column_name
LIKE 'pattern'
```

Pattern: % ... Any optional character string
 containing 0 or more characters
 _ ... Any optional single character

Check!

Q6-18 ☐☐☐ **Mandatory question**

From the viewpoint of internal control, which of the following is an organizational framework that can secure data integrity with a check-and-balance system in the organization?

- a) In order to implement an efficient data entry system in accordance with business needs, the information systems department develops a data entry system and enters data.
- b) The staff members of the information systems department are assigned to the same department for a long time so that they can secure data integrity in system development by taking advantage of their experience.
- c) When staff members of the information systems department move to another department, they are provided with related data so that they can make contributions in an emergency such as a system failure.
- d) The information systems department is independent from the user department that enters data so that the user department can maintain the correctness and accuracy of data.

Q6-19 ☐☐☐

Which of the following corresponds to software management according to the operation activities stipulated by “System Management Standards”?

- a) Recording the usage status of information output from a program, and analyzing it periodically
- b) Controlling access to data files used in a program
- c) Providing training so that illegal copies of a program are not made
- d) Recording and storing the test results of a program

Q6-20 □□□

Which of the following is an explanation of IT governance?

- a) It is a framework that comprehensively compiles best practices (excellent examples) concerning the management and operations rules of IT services.
- b) It is the organizational capability of a company to guide the development and implementation of its IT strategy in the desired direction in order to establish competitive superiority.
- c) It is the specification used by a company to request a specific system proposal from an IT vendor with whom an order is to be placed, when the company is to procure an information system and IT services.
- d) It is a written mutual agreement in which a service provider clearly defines the service level objectives that are provided in order to guarantee quality.

Q6-21 □□□

When IT control is classified into preventive control and detective control, which of the following corresponds to the detective control of errors or inaccuracies in data entry?

- a) Designing the data entry screen so that an operational error cannot occur easily
- b) Matching the output list with the input form after the entry of data
- c) Limiting the number of data entry staff, and granting them access permission
- d) Preparing a data entry manual, and providing training for data entry staff

Q6-22 □□□

Which of the following is a term associated with the organizational capability of a company to guide the development and implementation of its IT strategy in the desired direction in order to establish competitive superiority?

- a) IT governance
- b) IT service
- c) IT skill
- d) IT literacy

Main SQL Syntax 11

Joining tables of SQL87 format

```
SELECT table_name_1.*, table_name_2.*
FROM table_name_1, table_name_2
WHERE joining_condition
```

Check!

Section 6 Service Management List of Answers

Q6-1	d)
Q6-2	a)
Q6-3	d)
Q6-4	a)
Q6-5	c)
Q6-6	a)
Q6-7	c)
Q6-8	b)
Q6-9	d)
Q6-10	b)
Q6-11	c)
Q6-12	c)
Q6-13	a)
Q6-14	d)
Q6-15	b)
Q6-16	d)
Q6-17	d)
Q6-18	d)
Q6-19	c)
Q6-20	b)
Q6-21	b)
Q6-22	a)

Strategy

Morning Exam

Section 7

System Strategy

Learning Objectives

1. Understand the flow of system planning.
2. Understand asset management methods such as software procurement and procurement management.

Chapter 1 System Strategy

1.1 Information systems strategy ★★

[Learning objectives]

- Understand the purpose and concept of information systems strategy, and also the outline of its development procedures.
- Understand the outline of techniques of enterprise architecture.
- Understand the outline of program management, frameworks, quality control, and information systems strategy management.

□ Keywords

- | | |
|--|--|
| <input type="checkbox"/> Information systems strategy evaluation | <input type="checkbox"/> CIO (Chief Information Officer) |
| <input type="checkbox"/> Total computerization planning | <input type="checkbox"/> Total optimization goals |
| <input type="checkbox"/> IT governance policy | |
| <input type="checkbox"/> Ideal information system (To-be model) | |
| <input type="checkbox"/> Information security policy | |
| <input type="checkbox"/> Standardization policy and quality policy for system construction and operations | |
| <input type="checkbox"/> Computerization investment policy | <input type="checkbox"/> Mission critical system |
| <input type="checkbox"/> Computerization planning | <input type="checkbox"/> ERP |
| <input type="checkbox"/> CRM | <input type="checkbox"/> SFA |
| <input type="checkbox"/> Enterprise architecture (work and system optimization, as-is model, to-be model, best practices) | <input type="checkbox"/> Models |
| <input type="checkbox"/> Business architecture (business operations description, DMM (Diamond Mandala Matrix), DFD, WFA (Work Flow Architecture), UML) | |
| <input type="checkbox"/> Data architecture (data definition table, information systemization summary chart, E-R diagram) | |
| <input type="checkbox"/> Application architecture (information system relationship diagram, information system function configuration diagram) | |
| <input type="checkbox"/> Technology architecture (hardware, software, and network configuration) | |
| <input type="checkbox"/> PMO (Program Management Office) | |
| <input type="checkbox"/> COBIT (Control Objectives for Information and related Technology) | |
| <input type="checkbox"/> System management standards | <input type="checkbox"/> SLCP-JCF2007 |
| <input type="checkbox"/> KGI (Key goal indicator) | |
| <input type="checkbox"/> KPI (Key performance indicator) | |
| <input type="checkbox"/> Quality control framework | <input type="checkbox"/> Management process |
| <input type="checkbox"/> Monitoring index | <input type="checkbox"/> Variance analysis |
| <input type="checkbox"/> Response to risk | |

- Q7-1 through Q7-7

1.2 Business process ★★

[Learning objectives]

- Understand the outline of business process improvement and problem solving.

□ Keywords

- ☐ BPR (Business Process Reengineering)
- ☐ BPMS (Business Process Management System)
- ☐ BPO (Business Process Outsourcing)
- ☐ Workflow system ☐ SFA
- ☐ JIT (Just in time)

► Q7-8 through Q7-10

1.3 Solution business ★★

[Learning objectives]

- Understand the fundamental concepts of the solution business and the outline of typical services.

□ Keywords

- ☐ Solution ☐ Solution provider ☐ Business system proposal
- ☐ Business package ☐ Support for problem solving
- ☐ Systems integration ☐ SaaS (Software as a Service)
- ☐ ASP ☐ MSP ☐ Outsourcing service ☐ Hosting service
- ☐ Housing service ☐ SOA (Service Oriented Architecture)
- ☐ Security solution ☐ CRM solution

► Q7-11 through Q7-15

1.4 System utilization promotion and evaluation

[Learning objectives]

- Understand the concept of information systems utilization promotion and evaluation
- Understand the importance of objectively evaluating, verifying, and improving the status of information system usage.
- Understand the concept of information system disposal.

□ Keywords

- ☐ Information literacy ☐ System operations manual
- ☐ Business operations manual ☐ e-Learning ☐ Seminar
- ☐ Log analysis ☐ Log monitoring
- ☐ Learning management system ☐ System life cycle
- ☐ Information security policy ☐ Data erasing

► Q7-16

Chapter 2 System Planning

2.1 Computerization planning ★★

[Learning objectives]

- Understand the purpose and fundamental concept of computerization initiatives and computerization planning, and the outline of their procedures.

□ Keywords

- | | |
|---|--|
| <input type="checkbox"/> System optimization technique | <input type="checkbox"/> Shared computerization initiative |
| <input type="checkbox"/> System design | <input type="checkbox"/> Total computerization planning |
| <input type="checkbox"/> Individual computerization planning | <input type="checkbox"/> System application scope |
| <input type="checkbox"/> Total development scheduling | <input type="checkbox"/> Development project framework |
| <input type="checkbox"/> Staff training planning | <input type="checkbox"/> Return on development investment |
| <input type="checkbox"/> System life cycle | |
| <input type="checkbox"/> Information systems installation risk analysis | |

- ▶ Q7-17 and Q7-18

2.2 Requirements definition

[Learning objectives]

- Understand the purpose, fundamental concept, and procedures of requirements analysis and requirements definition, and apply these to associated matters.

□ Keywords

- | | | |
|---|---|---|
| <input type="checkbox"/> User needs study | <input type="checkbox"/> Current state analysis | <input type="checkbox"/> Definition of issues |
| <input type="checkbox"/> Requirements specification | <input type="checkbox"/> Stakeholders | |
| <input type="checkbox"/> DOA (Data Oriented Approach) | | |

- ▶ Q7-19

2.3 Procurement planning and implementation ★★

[Learning objectives]

- Understand the outline of procurement planning and the purpose and fundamental concept of procurement implementation.

□ Keywords

- | | |
|--|---|
| <input type="checkbox"/> Internal and external manufacturing criteria | <input type="checkbox"/> Software supply chain management |
| <input type="checkbox"/> Proposal competition | <input type="checkbox"/> Open bidding |
| <input type="checkbox"/> RFI (Request For Information) | <input type="checkbox"/> RFP (Request For Proposal) |
| <input type="checkbox"/> RFQ (Request For Quotation) | |
| <input type="checkbox"/> Software development outsourcing model contract | |
| <input type="checkbox"/> Information system/model transaction contract | |
| <input type="checkbox"/> (Quasi-)mandate contract | <input type="checkbox"/> Underpinning contract |
| <input type="checkbox"/> Intellectual property right license agreement | |

- ▶ Q7-20 and Q7-21

7.1

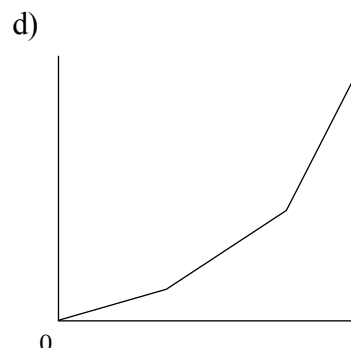
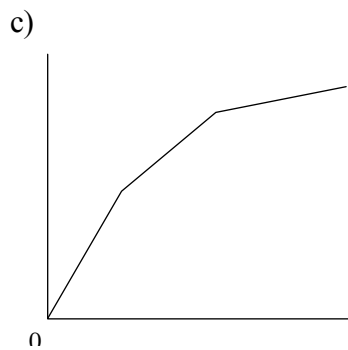
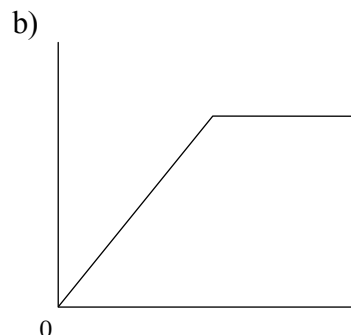
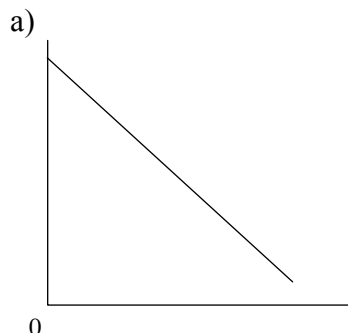
System Strategy**Q7-1** □□□

When a company's information strategy is developed, which of the following is the most important item to be considered?

- a) Evolution in IT
- b) Consistency with business strategy
- c) Consistency with existing systems
- d) Competitors' information strategies

Q7-2 □□□

When a computer system's usage fee is calculated using the declining metered rate method, which of the following is an appropriate graph that shows this method? The horizontal axis is usage and the vertical axis is usage fee.



Q7-3 ☐☐☐ **Mandatory question**

Which of the following is an explanation of EA (Enterprise Architecture)?

- a) A technique for analyzing and designing a system by using model diagrams such as a class diagram, which unifies and standardizes various methods for supporting object-oriented design
- b) A technique for clarifying relationships between data structures and data items by representing conceptual data models using entities and relationships
- c) A technique for reviewing business operations and information systems from the perspective of overall optimization through analysis of four key architectures—business, data, application, and technology
- d) A technique for representing a company's business processes by abstracting them as four basic elements of data flow, process, file, data source/data sink

Q7-4 ☐☐☐

Which of the following is developed as a deliverable of business architecture that is one of the four architectures contained in Enterprise Architecture?

- a) Work flow diagram
- b) Entity-relationship diagram
- c) Information system relationship diagram
- d) Software configuration diagram

Q7-5 ☐☐☐

Which of the following is an explanation of application architecture, a component of Enterprise Architecture?

- a) It systematically defines the details of data necessary for business, and the relationships and structures between data.
- b) It systematically defines the functions and configuration of systems that support business processes.
- c) It systematically defines the technical components necessary for the construction and operation of information systems.
- d) It systematically defines the business processes and information flow necessary for business strategy.

Q7-6 □□□

When a mission-critical business system is reconstructed by installing an ERP package, which of the following is a point to be noted?

- a) It is important to install and operate all required business systems at once rather than in stages.
- b) It is important to fully respect the opinions of frontline users and to customize the ERP package for consistency with existing business processes.
- c) It is important to install an accounting system first and to install other business systems afterward.
- d) It is important to consider the business model that is a prerequisite for the package, and to redesign the entire company's business processes.

Q7-7 □□□**Mandatory question**

Which of the following is an explanation of SFA?

- a) It is a method that aims to improve the efficiency and quality of sales by utilizing IT in sales activities and to increase sales and profits.
- b) It is a method and concept for the effective and comprehensive planning and management of the company-wide management resources to improve the efficiency of business.
- c) It is a system to support the business activities of retail stores, for the purpose of expanding the company's business transactions with wholesalers and manufacturers by growing the sales and profits of retail stores.
- d) It is to conduct commercial transactions with consumers or between businesses by utilizing an electronic network such as the Internet.

Main SQL Syntax 12

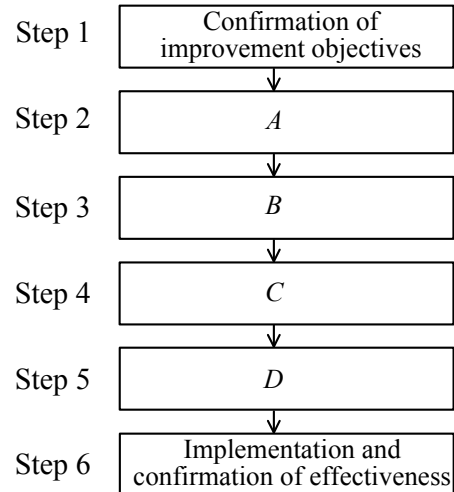
Joining tables in SQL92
(Exam standard; however, includes SQL87
format)

```
SELECT table_name_1.*, table_name_2.*
FROM table_name_1 JOIN table_name_2
ON joining_condition
```

Check!

Q7-8 □□□

The diagram below shows a business improvement process broken down into six steps. When activities a) through d) are to be inserted into *A* through *D*, which of the following is the activity that should be inserted into *C*?



- a) Creation of improvement proposals
- b) Evaluation of improvement proposals
- c) Setting of improvement objectives
- d) Understanding of problems

Main SQL Syntax 13

Grouping

```

SELECT column name, or partial column, or set function for grouping
FROM table name
GROUP BY column name for grouping
HAVING condition for narrowing after grouping
  
```

Check!

Q7-9 ☐☐☐ **Mandatory question**

In information system planning for an entire company, it is important to conduct business model development for the entire company. Which of the following is an appropriate description of business model development for a company?

- a) Business functions and the business processes to achieve business functions both represent a series of business activities having continuity, and there is no need to define starting points and ending points for business activities.
- b) Business functions change according to the environment of the company, and as they are not constant, it is advisable to create a business model with priority on analysis of current business operations.
- c) The essential needs sought by information system construction must be made clear by clarifying the objectives of business through analysis of business functions.
- d) In order to clarify business functions, it is insufficient to consider only what is performed; rather, how the business is performed must be considered.
- e) It is advisable to create a business model in units of the applications to be constructed.

Q7-10 ☐☐☐

The table below shows the result of analyzing the activities of a sales representative on a particular day. By implementing SFA (Sales Force Automation), preparation time for customer calls can be reduced by 0.1 hours per customer call. In order to increase the number of customer calls to six per day without changing the total working hours and the hours per customer call, how many hours must be reduced from “Other jobs”?

Analysis table of the working hours for a day					Number of customer calls per day
Total working hours					
	Customer call	Office work			
			Preparation for customer calls	Other jobs	
8.0	5.0	3.0	1.5	1.5	5

- a) 0.3
- b) 0.5
- c) 0.7
- d) 1.0

Q7-11 □□□

Which of the following is an appropriate explanation of solution business?

- a) Installation is rapid with ASP and SaaS, but operations management must be performed in-house.
- b) Initial costs and maintenance costs can be reduced with ASP, SaaS, and other solution business.
- c) As SaaS cannot adapt to sharp increases or decreases in users, acceptance of users must be limited through prior applications.
- d) SOA is developed under the concept of calling and linking “services” offered over a network on a large system. Users construct systems by selecting from among business processes created in advance as models.

Q7-12 □□□**Mandatory question**

Among outsourcing services, which of the following is a service that is provided by an MSP (Managed Service Provider)?

- a) A service to manage servers and provide an environment for Internet connectivity
- b) A service to provide personnel, accounting, sales, logistics, and other business processes
- c) A service to manage the operations of an IT infrastructure, including networks, servers, and storage, through networks
- d) A service to provide network-based standard application services through a flat-rate or other billing method

Q7-13 □□□

Which of the following is a form of software usage by which users do not construct and install applications as independent systems, but rather select from among necessary functions provided as services?

- a) SaaS
- b) SAN
- c) SOA
- d) SLA

Main SQL Syntax 14

Sum of
specified
column

```
SELECT SUM(grouped column name) FROM
table name
GROUP BY column name for grouping
```

Here, if “GROUP BY” is not included
it is treated as one group

Check!

Q7-14 □□□

Which of the following is an explanation of housing service?

- a) A service by which the service provider provides business software over the Internet
- b) A service by which the service provider performs planning, development, operations, management, and maintenance work for other companies' information systems
- c) A service by which the service provider leases out servers and communication equipment installed in the provider's building
- d) A service by which the service provider installs and operates the user's communications equipment and servers in the provider's building

Q7-15 □□□

Which of the following **is not appropriate** as an application for embedded systems?

- a) Systems to control FA devices or medical devices
- b) Systems to control audio and visual devices
- c) Bank ATM terminal systems
- d) Host systems to manage train seat reservations

Q7-16 □□□

A company launched a data warehouse, but it was not used. Hearings revealed that the skill level of users was lower than expected. Which of the following is an appropriate improvement measure to promote usage?

- a) Providing notifications through administrators to promote usage
- b) Preparing standard templates according to data extraction and analysis patterns
- c) Providing data on a more real-time basis, and improving the accuracy of data
- d) Adding further data that is thought to be required by users

7.2**System Planning****Q7-17** □□□

Which of the following is the item that should be considered in the drafting of computerization planning?

- a) Investigating so that the company's own employees can conduct development as much as possible, in consideration of operations
- b) Surveying other companies in the same industry and using the same system, in order to avoid failures
- c) Representing computerization initiative, operations manuals, and failure measures, in specific terms
- d) Making the efficacy and investment effect of the information system clear

Q7-18 □□□

Which of the following is a business model that is developed at the time of making an overall plan for an information system?

- a) Defining the functions of a mission-critical system and their necessary data items
- b) Defining the relationships between existing information systems and databases
- c) Associating organizational functions with forms
- d) Associating business processes with data classes

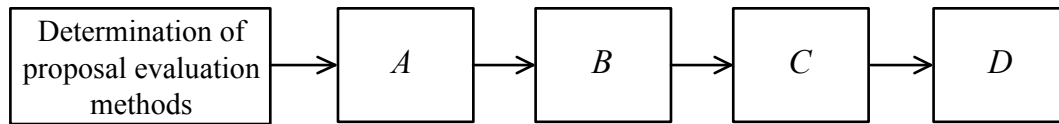
Q7-19 □□□**Mandatory question**

Which of the following is an activity that is included in the requirements definition process?

- a) Creating and approving a computerization plan
- b) Implementing detailed system design
- c) Forecasting system investment effect and computerization cost
- d) Organizing system user needs

Q7-20 □□□

The procurement process, which begins with “determination of proposal evaluation methods,” is broken down into “selection of procurement source,” “implementation of procurement,” “issuance of RFP (Request For Proposal),” and “evaluation of proposals,” and then put in order. Which of the following is inserted into blank *C*?



- a) Selection of procurement source
- b) Implementation of procurement
- c) Issuance of RFP (Request For Proposal)
- d) Evaluation of proposals

Q7-21 □□□

Which of the following is an explanation of RFI?

- a) A contract document between a service provider and a customer, which predefines the scope of warranty and penalties concerning the details and quality of services to be provided
- b) A document which presents technical requirements or service level requirements from the procurer and asks vendors to propose effective implementation plans within a specified period of time, prior to purchasing a system
- c) A document which asks vendors to provide information about implementation methods, such as technologies and products available under current conditions, as well as vendors' implementation experiences, in order to achieve user requirements
- d) A document which provides an overview of business processes, a list of I/O information, and data flow, in order to make them consistent with requirements definitions and to make them shared among the users, developers, and operating staff

Main SQL Syntax 15

Average of
specified
column

```
SELECT AVG(grouped column name)
FROM table name
GROUP BY column name for grouping
```

However, if GROUP BY is not included
it is treated as one group

Check!

Section 7 System Strategy List of Answers

Q7-1	b)
Q7-2	c)
Q7-3	c)
Q7-4	a)
Q7-5	b)
Q7-6	d)
Q7-7	a)
Q7-8	a)
Q7-9	c)
Q7-10	c)
Q7-11	b)
Q7-12	c)
Q7-13	a)
Q7-14	d)
Q7-15	d)
Q7-16	b)
Q7-17	d)
Q7-18	d)
Q7-19	d)
Q7-20	a)
Q7-21	c)

Strategy

Morning Exam

Section 8

Business Strategy

Learning Objectives

1. Be able to understand an overview of business management and computerization strategy concerning the information strategy.
2. Be able to understand the basic items of financial accounting and management accounting concerning corporate accounting.
3. Be able to understand the basic items of IE and OR concerning management engineering.
4. Be able to understand case examples in the engineering field and business field concerning the utilization of an information system.
5. Be able to explain an overview concerning related laws, with the focus on intellectual property rights as well as laws and regulations on labor.

Chapter 1 Business Strategy Management

1.1 Business strategy techniques ★★★

[Learning objectives]

- Understand the basic concept concerning management strategy.
- Understand the outline of corporate strategy, enterprise strategy, and the typical business strategy techniques.

□ Keywords

- | | | |
|--|--|---------------------------------------|
| <input type="checkbox"/> Corporate philosophy | <input type="checkbox"/> Diversification | <input type="checkbox"/> Benchmarking |
| <input type="checkbox"/> Best practice | <input type="checkbox"/> Competitive superiority | |
| <input type="checkbox"/> CS (Customer Satisfaction) | <input type="checkbox"/> Group management | |
| <input type="checkbox"/> Core competence | <input type="checkbox"/> Outsourcing | |
| <input type="checkbox"/> M&A (Mergers and Acquisitions) | <input type="checkbox"/> Alliance | |
| <input type="checkbox"/> PPM (Product Portfolio Management) | | |
| <input type="checkbox"/> Cost leadership strategy | <input type="checkbox"/> Niche strategy | |
| <input type="checkbox"/> Differentiation strategy | <input type="checkbox"/> Focus strategy | |
| <input type="checkbox"/> SWOT (Strength, Weakness, Opportunity, Threat) analysis | | |
| <input type="checkbox"/> Value chain analysis | <input type="checkbox"/> Growth matrix | |

► Q8-1 through Q8-8

1.2 Marketing

[Learning objectives]

- Understand the basic concept of marketing and the basic concept of typical marketing techniques.

□ Keywords

- | | | |
|--|---|---|
| <input type="checkbox"/> 3C (Customer, Competitor, Company) analysis | | |
| <input type="checkbox"/> Market research | | |
| <input type="checkbox"/> Segmentation | <input type="checkbox"/> Targeting | <input type="checkbox"/> Positioning |
| <input type="checkbox"/> Sampling | <input type="checkbox"/> Questionnaire | <input type="checkbox"/> Observational method |
| <input type="checkbox"/> Experimental technique | <input type="checkbox"/> Merchandising | <input type="checkbox"/> Customer loyalty |
| <input type="checkbox"/> Brand strategy | <input type="checkbox"/> Mass marketing | <input type="checkbox"/> One-to-one marketing |
| <input type="checkbox"/> Relationship marketing | <input type="checkbox"/> Direct marketing | <input type="checkbox"/> Market test (Test marketing) |

► Q8-9

1.3 Business strategy and goal/evaluation ★★

[Learning objectives]

- Understand the outline of business strategy and target setting, and the purpose, concept, and procedure of evaluation.
- Understand the outline of the typical information analysis techniques for target setting and evaluation.

□ Keywords

- | | |
|--|---|
| <input type="checkbox"/> CSF (Critical Success Factors) | <input type="checkbox"/> KGI (Key Goal Indicator) |
| <input type="checkbox"/> KPI (Key Performance Indicator) | <input type="checkbox"/> Monitoring |
| <input type="checkbox"/> Needs/wants analysis | <input type="checkbox"/> Competitive analysis |
| <input type="checkbox"/> Value engineering | <input type="checkbox"/> Six sigma |
| <input type="checkbox"/> TQM (Total Quality Management) | |

► Q8-10

1.4 Business management system ★★

[Learning objectives]

- Understand the outline of a typical business management system.

□ Keywords

- | | |
|--|------------------------------|
| <input type="checkbox"/> ERP | <input type="checkbox"/> SFA |
| <input type="checkbox"/> KM (Knowledge Management) | |
| <input type="checkbox"/> CRM | <input type="checkbox"/> SCM |

► Q8-11 through Q8-14

Chapter 2 Technological Strategy Management

2.1 Planning of technology development strategy ★★

[Learning objectives]

- Understand the purpose and basic concept of the technology development strategy.

□ Keywords

- | | |
|---|---|
| <input type="checkbox"/> MOT (Management of Technology) | <input type="checkbox"/> Core technology |
| <input type="checkbox"/> Technology research | <input type="checkbox"/> Technology acquisition |
| <input type="checkbox"/> Technology licensing | <input type="checkbox"/> Technological tie-up |
| <input type="checkbox"/> Industry-academia-government collaboration | <input type="checkbox"/> Standardization strategy |
| <input type="checkbox"/> TLO (Technology Licensing Organization) | |

- ▶ Q8-15 and Q8-16

2.2 Technology development plan

[Learning objectives]

- Understand the purpose and basic concept of a technology development plan.

□ Keywords

- | | |
|---|---|
| <input type="checkbox"/> Technology development investment planning | |
| <input type="checkbox"/> Technology development site planning | <input type="checkbox"/> Digital divide |
| <input type="checkbox"/> Human resources planning | |
| <input type="checkbox"/> Optimal distribution of management resources | <input type="checkbox"/> Return on investment |
| <input type="checkbox"/> Concurrent engineering | <input type="checkbox"/> Pilot production |
| <input type="checkbox"/> Intellectual property right management | <input type="checkbox"/> Market needs |
| <input type="checkbox"/> Road map | |

- ▶ Q8-17

Chapter 3 Business Industry

3.1 Business system

[Learning objectives]

- Understand the types and characteristics of typical information systems used in various business areas.

Keywords

- | | |
|--|---|
| <input type="checkbox"/> Bookkeeping/accounting/financial system | <input type="checkbox"/> XBRL |
| <input type="checkbox"/> Human resource/payroll system | <input type="checkbox"/> SFA (Sales Force Automation) |
| <input type="checkbox"/> Groupware | <input type="checkbox"/> Workflow system |
| <input type="checkbox"/> Distribution information system | <input type="checkbox"/> Logistics information system |
| <input type="checkbox"/> Over-the-counter sales management | <input type="checkbox"/> Sales management |
| <input type="checkbox"/> Ordering management | <input type="checkbox"/> Inventory control |
| <input type="checkbox"/> Customer management | <input type="checkbox"/> Financial information system |
| <input type="checkbox"/> Medical information system | <input type="checkbox"/> POS system |
| <input type="checkbox"/> Production management system | <input type="checkbox"/> ERP package |
| <input type="checkbox"/> Operations-specific package | <input type="checkbox"/> Industry-specific package |
| <input type="checkbox"/> e-Japan initiative | <input type="checkbox"/> e-Gov |
| <input type="checkbox"/> Electronic government | <input type="checkbox"/> Electronic local government |
| <input type="checkbox"/> LGWAN (Local Government Wide Area Network) | |
| <input type="checkbox"/> Basic resident register network | |
| <input type="checkbox"/> EDINET (Electronic Disclosure for Investors' NETwork) | |
| <input type="checkbox"/> Public information system | |
| <input type="checkbox"/> GPS (Global Positioning System) application system | |

- ▶ Q8-18 and Q8-19

3.2 Engineering system ★★

[Learning objectives]

- Understand the purpose and basic concept of development and design in an engineering system.
- Understand the purpose and basic mechanism of automatic production control, production systems, production management, and computer-aided systems.

□ Keywords

<input type="checkbox"/> Production system	<input type="checkbox"/> Production line organization
<input type="checkbox"/> JIT (Just In Time)	<input type="checkbox"/> NC (Numerical Control)
<input type="checkbox"/> Automatic monitoring equipment	<input type="checkbox"/> Automated guided vehicle
<input type="checkbox"/> Automated warehouse	<input type="checkbox"/> CAP (Computer Aided Planning)
<input type="checkbox"/> CAPP (Computer Aided Process Planning)	<input type="checkbox"/> MRP
<input type="checkbox"/> FMS (Flexible Manufacturing System)	<input type="checkbox"/> FMC (Flexible Manufacturing Cell)
<input type="checkbox"/> Productivity indicator	<input type="checkbox"/> CAD
<input type="checkbox"/> CAE	<input type="checkbox"/> CAM
<input type="checkbox"/> PDM (Product Data Management)	<input type="checkbox"/> CIM

3.3 e-business ★★

[Learning objectives]

- Understand the mechanism and characteristics of e-businesses, such as EC and EDI, performed over the Internet.
- Understand the typical standards of data exchange.

□ Keywords

<input type="checkbox"/> On-line mall	<input type="checkbox"/> On-line shopping
<input type="checkbox"/> Electronic bidding	<input type="checkbox"/> Financial trading
<input type="checkbox"/> Internet banking	<input type="checkbox"/> EFT (Electronic Fund Transfer)
<input type="checkbox"/> Smart card	<input type="checkbox"/> IC card/RFID application system
<input type="checkbox"/> SSL	<input type="checkbox"/> Internet business
<input type="checkbox"/> BtoB (Business to Business)	<input type="checkbox"/> BtoC (Business to Consumer)
<input type="checkbox"/> CtoC (Consumer to Consumer)	<input type="checkbox"/> GtoB (Government to Business)
<input type="checkbox"/> GtoC (Government to Citizen)	<input type="checkbox"/> e-marketplace
<input type="checkbox"/> Web-EDI	<input type="checkbox"/> JIS X 7011-1 <input type="checkbox"/> JIS X 7012-1
<input type="checkbox"/> STEP (Standard for the Exchange of Product Model Data)	
<input type="checkbox"/> Japanese Bankers Association protocol	<input type="checkbox"/> XML-EDI <input type="checkbox"/> XBRL
<input type="checkbox"/> Information communication protocol	<input type="checkbox"/> Information representation protocol
<input type="checkbox"/> Task operation protocol <input type="checkbox"/> Basic transaction protocol	
<input type="checkbox"/> JCA (Japan Chain stores Association) protocols	

- ▶ Q8-20 through Q8-26

3.4 Consumer appliances

[Learning objectives]

- Understand the outline of embedded systems.
- Understand the characteristics, trends, and typical examples of consumer appliances.

☐ Keywords

- | | | |
|--|--|---------------------------------------|
| <input type="checkbox"/> Embedded system | <input type="checkbox"/> Embedded OS | <input type="checkbox"/> Real-time OS |
| <input type="checkbox"/> Real-time control | <input type="checkbox"/> Event | <input type="checkbox"/> Sensor |
| <input type="checkbox"/> Firmware | <input type="checkbox"/> Computer peripherals/OA equipment | |
| <input type="checkbox"/> Consumer communications terminals | <input type="checkbox"/> Intelligent home appliances | |
| <input type="checkbox"/> Home network | <input type="checkbox"/> Ubiquitous computing | |
| <input type="checkbox"/> Wearable computer | <input type="checkbox"/> Sensor network | |

3.5 Industrial devices

[Learning objectives]

- Understand the characteristics, trends, and typical examples of industrial electronic devices.

☐ Keywords

- | | | |
|---|--|---|
| <input type="checkbox"/> Industrial robots | <input type="checkbox"/> Automated warehouse | <input type="checkbox"/> Vending machines |
| <input type="checkbox"/> ATM (Automated Teller Machine) | <input type="checkbox"/> Medical devices | |
| <input type="checkbox"/> Patient monitoring equipment | | |

8.1

Business Strategy Management**Q8-1** □□□

In competitive strategy, which of the following is a characteristic of the niche strategy?

- a) It aims at the deployment of a differentiation strategy targeted at improving the market position and capturing the top share.
- b) It aims at the acquisition of new demands while the share is retained through the expansion of the total market size.
- c) It aims at higher profit margins by specializing in a specific market where other competitors have difficulty participating.
- d) It aims at the cost reduction of product development by observing the actions of leaders and imitating them promptly.

Q8-2 □□□

Which of the following is an explanation of a management principle?

- a) It is the basic concept that acts as a guideline for the working of a company, and indicates the significance of existence and sense of values of the company.
- b) It refers to the resources utilized by a company for building competitive superiority, and is generally classified into humans, material, money, and information.
- c) It is a decision-making plan for materializing the vision of a company showing its future directionality, and is created as a long-term, mid-term, or short-term plan.
- d) It refers to the individuality and unique corporate identity of a company, which is also called corporate culture, and is generated and established through years of corporate activities.

Main SQL Syntax 16

Maximum value
of the specified
column

```
SELECT MAX (Grouping_column_name)
FROM Table_name
GROUP BY Grouping_column_name
```

Here, if “GROUP BY” does not exist,
the table is considered as a single group.

Check!

Q8-3 □□□

Which of the following is a merit of M&A?

- a) By performing function-specific division of labor, knowledge and experience can be accumulated based on specialization, and economies of scale can be obtained.
- b) By acquiring technologies and know-how that a company does not possess, new businesses can be realized in a short period of time.
- c) High psychological energy that comes from autonomy can be made use of, and the influence of the existing companies can be minimized.
- d) By segmenting businesses based on products and markets in order to achieve a self-sustaining accounting system, the profit responsibility can be clarified.

Q8-4 □□□

When several companies work in cooperation as a result of an alliance, which of the following is the most appropriate risk that can be expected to be reduced?

- a) Business investment risk
- b) Information leakage risk
- c) Brain drain risk
- d) Fraud risk

Q8-5 □□□ **Mandatory question**

In business administration, which of the following is a purpose of placing importance on stakeholders?

- a) To prevent the occurrence of a scandal by a manager or an employee, which can lead to a going-concern risk
- b) To secure management resources that act as a source of differentiation from competitors, and strengthen competitiveness
- c) To check the use of power by a manager, and to create a mechanism that enables healthy management
- d) To improve the satisfaction level of concerned parties, such as customers, shareholders, and employees, and to aim for continuous growth and expansion of the company

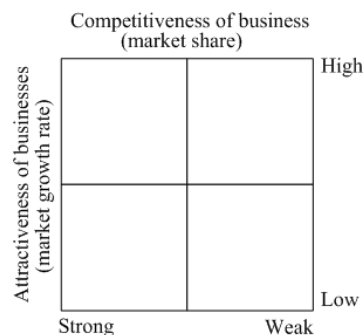
Q8-6 □□□

Which of the following is an explanation of benchmarking that is used in business administration?

- a) It is to achieve an improvement in management efficiency by effectively and comprehensively planning and managing the allocation of management resources of the entire company.
- b) It is to drastically reform the quality and structure of the company by redesigning business processes and taking full advantage of information technology.
- c) It is to qualitatively and quantitatively understand products, services, and operations in comparison to the strongest competitor or an advanced company.
- d) It is to concentrate the management resources on in-house skills and technologies that can bring profit and are superior to those of other companies.

Q8-7 □□□

A portfolio categorization matrix is shown below. Which of the following is the purpose of using this matrix to analyze business plans and competitive superiority?



- a) To evaluate the current position of the organization, so as to measure the achievement of the target promotional effect
- b) To evaluate the current position of the organization as the basis for setting goals and prioritizing resource allocation
- c) To evaluate tactics for maintaining a competitive edge in the market by setting a goal and improving product quality
- d) To evaluate the change in the market by considering seasonal fluctuation factors and geographical distribution, so as to set a goal

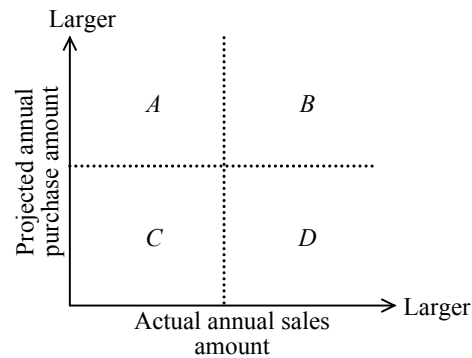
Main SQL Syntax 17

Minimum value of the specified column	<pre>SELECT MIN (Grouping_column_name) FROM Table_name GROUP BY grouping_column_name</pre>	Here, if "GROUP BY" does not exist, the table is considered as a single group.
---	--	---

Check!

Q8-8 □□□

The projected annual purchase amount of each customer and the actual annual sales amount of a company with those customers are plotted on a graph as shown below. Which of the following is the appropriate description concerning the future business policy of the company?



- a) A customer in area *A* is a potential large-volume customer. Reinforcing sales efforts towards the customer is worthwhile.
- b) A customer in area *B* can be regarded as a regular customer. Sales efforts towards the customer should be minimized.
- c) A customer in area *C* has little potential for becoming a large-volume customer, but is a prospective regular customer. Reinforcing sales efforts towards the customer is worthwhile.
- d) A customer in area *D* can be expected to increase the amount of purchases. Reinforcing sales efforts toward the customer is worthwhile.

Q8-9 □□□ **Mandatory question**

Which of the following is an explanation of marketing mix?

- a) It is a process concerning the purchase psychology of customers, and is composed of attention, interest, desire, memory, and action.
- b) It is a criterion for market segmentation, and is composed of geographic, demographic, psychographic, and behavioral factors.
- c) It is a means for satisfying market needs, and is composed of products, prices, place (distribution), and promotion.
- d) It is a process from the introduction of a product until its withdrawal, and is composed of introduction, growth, maturity, and decline.

Q8-10 □□□

Which of the following is an explanation of a Balanced Score Card?

- a) It is a management technique that involves examining from the four perspectives of finance, customer, internal processes, and learning and growth, and materializing an action plan in order to achieve the vision and strategy of the company.
- b) It is a management technique that involves classifying business environment analysis into the four categories of strengths, weaknesses, opportunities, and threats, and providing business opportunities for a company.
- c) It is a management technique that involves classifying products into the four stages of introduction stage, growth stage, maturity stage, and decline stage, and designing the optimum business strategy for the company.
- d) It is a management technique that involves classifying the business into the four categories of question mark, star, cash cow, and dog, and examining the balance of management resources allocation.

Q8-11 □□□ **Mandatory question**

Which of the following is an appropriate explanation of CRM?

- a) It is a production management technique by which a company determines the order quantity and ordering period of resources based on a parts list and inventory information, in order to accomplish the production plan.
- b) It is a technique and system for managing information about management resources accumulated by the company in an integrated manner, and improving the efficiency of business administration activities.
- c) It is a corporate strategy by which information is shared not only in the sales department but among all customer channels within the company, so as to raise the level of service and improve customer satisfaction leading to better business performance.
- d) It is a business management technique by which excess inventory is reduced through integrated management of all management activities from the procurement of raw material until production and distribution by making use of computers, in order to aim for cost reduction.

Main SQL Syntax 18

Number of rows
in the table

```
SELECT COUNT (*) FROM Table_name
        GROUP BY
        Grouping_column_name
```

Here, if "GROUP BY" does not exist,
the table is considered as a single group.

Check!

Q8-12 □□□

Which of the following is the most appropriate effect of implementing CRM?

- a) CRM makes it easy to understand the payment status of the customer for accounts receivable.
- b) CRM makes it easy to reduce the time period from the time the customer places an order until delivery.
- c) CRM makes it easy to share the method of approaching customers within the entire sales department.
- d) CRM makes it easy to build a long-term relationship with the customer as a result of deepened understanding of customer's needs and desires.

Q8-13 □□□

Which of the following is an effect of supply chain management?

- a) Sales information about the products of a retail store can be known immediately.
- b) Knowledge and understanding are stored as a database, and can be utilized effectively for business.
- c) The series of processes from procurement to manufacturing, materials flow, and sales can be improved, and the delivery period and cost can be optimized.
- d) Various inquiries from the customer received through several means, including phone, fax, and e-mail can be answered promptly.

Q8-14 □□□

When a mission-critical business system is reconstructed by installing an ERP package, which of the following is a point to be noted?

- a) It is important to install and operate all of the necessary business systems simultaneously and not in phases.
- b) It is important to respect the opinions of the actual users and customize the ERP package to match the current business processes.
- c) It is important to install the accounting system first, followed by the other business systems.
- d) It is important to redesign the business processes across the entire company, with consideration for the business model that the ERP package is based on.

8.2

Technology Strategy Management**Q8-15** □□□

Which of the following is the term for technical development involving fundamental research and purpose specific application research so as to develop new products with the aim of securing future competitiveness in the market?

- a) M&A b) MOT c) OEM d) R&D

Q8-16 □□□ **Mandatory question**

Which of the following is an appropriate explanation of the role of an organization approved or accredited under the TLO (Technology Licensing Organization) law?

- a) The organization acts as a contact between companies and universities to coordinate sponsored or collaborative research projects
- b) The organization awards grant money to applied researchers to promote advanced research
- c) The organization acts as an intermediary between businesses and universities to patent research findings or to promote technology transfer from universities to businesses
- d) The organization finds sleeping patents held by private companies to license them for use by other companies

Q8-17 □□□

Which of the following is an explanation of a digital divide?

- a) It refers to the generation of an economical or social gap due to differences in the ability and opportunities of using PCs and communications.
- b) It refers to the availability of citizens to directly participate in the political measures of the government and autonomous bodies by making use of the Internet.
- c) It refers to communications and broadcast services that can be used equally, without any regional disparity, by any citizen of the country through adequate charges.
- d) It refers to the provision of all services for each event in the daily life of citizens or each field of corporate activities, at one place.

Main SQL Syntax 19

Subquery

```
SELECT Column_name_1, Column_name_2 ... FROM Table_name
WHERE Column_name_n IN (subquery statement)
```

Check!

8.3

Business Industry**Q8-18** ☐☐☐ **Mandatory question**

Which of the following is an appropriate application for groupware?

- a) Aggregate processing of end-of-term exam scores
- b) Aggregate processing of month-end sales
- c) Air traffic control processing
- d) Reservation processing of internal conference rooms

Q8-19 ☐☐☐

In order to uniquely identify a product in the POS system, which of the following is a code that is printed on the product as a bar code?

- a) JAN
- b) JAS
- c) JIS
- d) QR

Q8-20 ☐☐☐

Which of the following is a settlement method of a debit card?

- a) Settlement is performed through a post-payment method.
- b) The balance amount is managed within the card so that the card can be used as a wallet.
- c) Settlement is performed through a pre-payment method.
- d) The amount of money used is deducted immediately from a savings account.

Q8-21 ☐☐☐ **Mandatory question**

Which of the following is a mechanism for data exchange between companies that is used in e-commerce?

- a) CA
- b) EDI
- c) SET
- d) SSL

Q8-22 □□□

Which of the following corresponds to B-to-C in EC (Electronic Commerce)?

- a) CALS
- b) Web-EDI
- c) Virtual company
- d) Virtual mall

Q8-23 □□□

An agreement necessary for performing e-commerce with EDI includes four protocols: the basic transaction protocol, task operation protocol, information representation protocol, and information communication protocol. Which of the following is an appropriate description concerning these protocols?

- a) The task operation protocol defines communication methods such as TCP/IP and JCA procedure.
- b) The information communication protocol defines the method of connection via a communication line.
- c) The information representation protocol defines the system operating time and failure measures.
- d) The basic transaction protocol defines the data format.

Q8-24 □□□

When a credit card is used, which of the following can provide an online capability to check the validity or credit limit of the card?

- a) ACR
- b) CAT
- c) GPS
- d) PDA

Main SQL Syntax 20

Sorting of
retrieved data

```
SELECT Column_name_1, Column_name_2 ...
FROM Table_name
ORDER BY column_name_n order
```

Order: Ascending order
... ASC, default
Descending order
... DESC

Check!

Q8-25 □□□

Which of the following is an appropriate description concerning the comparison of safeguard against the counterfeiting of an IC card and a magnetic card?

- a) In comparison with a magnetic card, an IC card is difficult to counterfeit because information is stored in an IC chip and is also encrypted.
- b) In comparison with a magnetic card, an IC card is difficult to counterfeit because it uses a two-dimensional code for recording information.
- c) In comparison with an IC card, a magnetic card has a complex mechanism of information protection by storing information in magnetic stripes, and is therefore difficult to counterfeit.
- b) In comparison with an IC card, a magnetic card is difficult to counterfeit because it uses a bar code for recording information.

Q8-26 □□□**Mandatory question**

Which of the following is a characteristic of an IC tag (RFID)?

- a) An IC tag uses GPS and displays the location information.
- b) An IC tag handles a large amount of information, so it uses an external storage device for storing information.
- c) An IC tag is embedded in a plastic card, and is used by insertion into a dedicated reader.
- d) An IC card is highly resistant to dirt, and recorded information can be read even from outside the packaging.

Section 8 Business Strategy List of Answers

Q8-1	c)
Q8-2	a)
Q8-3	b)
Q8-4	a)
Q8-5	d)
Q8-6	c)
Q8-7	b)
Q8-8	a)
Q8-9	c)
Q8-10	a)
Q8-11	c)
Q8-12	d)
Q8-13	c)
Q8-14	d)
Q8-15	d)
Q8-16	c)
Q8-17	a)
Q8-18	d)
Q8-19	a)
Q8-20	d)
Q8-21	b)
Q8-22	d)
Q8-23	b)
Q8-24	b)
Q8-25	a)
Q8-26	d)

Strategy

Morning Exam

Section 9

Corporate and Legal Affairs

Learning Objectives

1. Understand basic points concerning intellectual property rights.
2. Understand the outline of laws on security.
3. Understand an overview of laws on labor and transactions.
4. Understand other related laws.
5. Be able to explain the role and types of standardization organizations, and an outline of various standards.
6. Be able to understand the outline of standardization of development and transactions.
7. Be able to understand the outline of standardization of information systems infrastructure.
8. Be able to understand the outline of standardization of data.
9. Be able to understand the outline of standardization and organizations.

Chapter 1 Corporate Activities

1.1 Management and organization theory ★★

[Learning objectives]

- Understand the outline of corporate activities, business management, and management organization.
- Understand changes and issues in the business environment.
- Understand the necessity and value of computer literacy.

Keywords

- | | |
|--|--|
| <input type="checkbox"/> Corporate philosophy | <input type="checkbox"/> CSR (Corporate Social Responsibility) |
| <input type="checkbox"/> Membership company ((limited) partnership) | <input type="checkbox"/> Stock company |
| <input type="checkbox"/> Corporate governance | <input type="checkbox"/> IR (Investor Relations) |
| <input type="checkbox"/> BCP (Business Continuity Plan) | <input type="checkbox"/> Business objectives |
| <input type="checkbox"/> Financial affairs management, asset management, human resource management, information management | |
| <input type="checkbox"/> PDCA | <input type="checkbox"/> TQM (Total Quality Management) |
| <input type="checkbox"/> Human resources management | <input type="checkbox"/> OJT |
| <input type="checkbox"/> Performance-based system | <input type="checkbox"/> Competency |
| <input type="checkbox"/> Work-life balance | <input type="checkbox"/> Case study |
| <input type="checkbox"/> e-Learning | <input type="checkbox"/> Logical thinking |
| <input type="checkbox"/> Brainstorming | <input type="checkbox"/> Hygiene theory <input type="checkbox"/> XY theory |
| <input type="checkbox"/> ISO/TC 223 | <input type="checkbox"/> Hierarchical organization (pyramid organization) |
| <input type="checkbox"/> Functional organization | <input type="checkbox"/> Line and staff organization |
| <input type="checkbox"/> Divisional system organization | <input type="checkbox"/> Matrix organization |
| <input type="checkbox"/> Company system organization | <input type="checkbox"/> Project organization |
| <input type="checkbox"/> CFO (Chief Financial Officer) | |
| <input type="checkbox"/> COO (Chief Operating Officer) | |
| <input type="checkbox"/> CIO (Chief Information Officer) | |
| <input type="checkbox"/> SRI (Socially Responsible Investment) | |
| <input type="checkbox"/> Satellite office | <input type="checkbox"/> Telecommuting |
| <input type="checkbox"/> SOHO (Small Office Home Office) | <input type="checkbox"/> Computer literacy |

- Q9-1 through Q9-4

1.2 OR/IE ★★★

[Learning objectives]

- Understand basic techniques for typical OR and IE, and apply them to associated matters.
- Understand basic techniques for collecting, sorting, analyzing, and visually representing data, and apply them to associated matters.

□ Keywords

<input type="checkbox"/> Simplex method	<input type="checkbox"/> Allocation problem	<input type="checkbox"/> Transportation problem
<input type="checkbox"/> Safety stock	<input type="checkbox"/> EOQ (Economic Ordering Quantity)	
<input type="checkbox"/> Order point	<input type="checkbox"/> Scheduling	<input type="checkbox"/> Arrow diagram
<input type="checkbox"/> Critical path	<input type="checkbox"/> Zero sum game	
<input type="checkbox"/> Maximin principle	<input type="checkbox"/> Decision tree	<input type="checkbox"/> Work time analysis technique
<input type="checkbox"/> PTS (Predetermined Time Standard) technique		
<input type="checkbox"/> Work sampling technique	<input type="checkbox"/> Therblig	<input type="checkbox"/> Work analysis
<input type="checkbox"/> Operation analysis	<input type="checkbox"/> Fraction defective	
<input type="checkbox"/> Failure rate curve (bathtub curve)		
<input type="checkbox"/> Quality characteristics		<input type="checkbox"/> Quality function deployment
<input type="checkbox"/> Fraction defective estimation		<input type="checkbox"/> Time series analysis
<input type="checkbox"/> Least squares method	<input type="checkbox"/> Correlation coefficient	<input type="checkbox"/> Moving-average method
<input type="checkbox"/> Pareto analysis	<input type="checkbox"/> Focus group	<input type="checkbox"/> Radar chart
<input type="checkbox"/> Cluster analysis method	<input type="checkbox"/> Delphi method	<input type="checkbox"/> Monte Carlo method
<input type="checkbox"/> Decision tree		

- Q9-5 through Q9-13

1.3 Accounting and financial affairs ★★

[Learning objectives]

- Understand basic approaches to sales-profit relationships, procedures for corporate accounting, and financial statements, and apply them to associated matters.
- Understand the purpose and concept of financial accounting and management accounting, and cash flow accounting, and apply them to associated matters.
- Understand the purpose and concept of cash planning and cash management, and asset management, and apply them to associated matters.

□ Keywords

<input type="checkbox"/> Opportunity loss	<input type="checkbox"/> Break-even point	<input type="checkbox"/> Journal book
<input type="checkbox"/> General ledger	<input type="checkbox"/> Trail balance sheet	<input type="checkbox"/> Work sheet
<input type="checkbox"/> Financial statements	<input type="checkbox"/> Balance sheet	<input type="checkbox"/> Income statement
<input type="checkbox"/> Cash flow statement	<input type="checkbox"/> Current assets	<input type="checkbox"/> Fixed assets
<input type="checkbox"/> Deferred assets	<input type="checkbox"/> Current liability	<input type="checkbox"/> Fixed liability
<input type="checkbox"/> Net assets	<input type="checkbox"/> Capital stock	<input type="checkbox"/> Cost
<input type="checkbox"/> Income	<input type="checkbox"/> Selling, general and administration expense	
<input type="checkbox"/> Non-operating profit and loss	<input type="checkbox"/> Extraordinary items	<input type="checkbox"/> Accounting standards
<input type="checkbox"/> Financial indicator	<input type="checkbox"/> Profit indicator	<input type="checkbox"/> ROE (Return On Equity)
<input type="checkbox"/> ROA (Return On Assets)	<input type="checkbox"/> Safety index	<input type="checkbox"/> Equity to total asset
<input type="checkbox"/> Current ratio	<input type="checkbox"/> Cash flow management	
<input type="checkbox"/> Cash management	<input type="checkbox"/> Inventory valuation	<input type="checkbox"/> First-in first-out method
<input type="checkbox"/> Periodic average method	<input type="checkbox"/> Moving average method	

- Q9-14 through Q9-20

Chapter 2 Legal Affairs

2.1 Intellectual property rights ★★

[Learning objectives]

- Understand the basic concept of intellectual property rights, and apply them to associated matters.
- Understand the basic concept concerning the protection and violation of copyright, and apply them to associated matters.
- Understand the basic concept concerning the protection and violation of rights based on the four laws that form the basis of industrial property rights (Patent Act, Utility Model Act, Design Act, Trademark Act), and apply them to associated matters.
- Understand the basic concept of the Unfair Competition Prevention Act, and apply them to associated matters.

□ Keywords

- | | |
|--|--|
| <input type="checkbox"/> Intellectual Property Strategy Headquarters | <input type="checkbox"/> Intellectual Property Basic Act |
| <input type="checkbox"/> Industrial Property Law | <input type="checkbox"/> Patent right |
| <input type="checkbox"/> Utility model right | <input type="checkbox"/> Design right <input type="checkbox"/> Trademark right |
| <input type="checkbox"/> Copyright | <input type="checkbox"/> Circuit layout right |
| <input type="checkbox"/> Copyright Act (moral right (right of publication, right of name announcement, and right of avoidance of modification), copyright and property rights (right of reproduction, right of public transmission, right of public exhibition, right of distribution, right of transfer of ownership, right of public rental), employee work, derivative work, transmittable, quote, private use, library, educational institution, examination question) | |
| <input type="checkbox"/> Industrial Property Law (invention, device, design, trademark, software patent, patent for a business method) | |
| <input type="checkbox"/> Unfair Competition Prevention Act | <input type="checkbox"/> Trade secrets |
| <input type="checkbox"/> Illicit obtainment of a domain name | |
| <input type="checkbox"/> Cancel of copy guard | <input type="checkbox"/> Volume license agreement |
| <input type="checkbox"/> Site license agreement | <input type="checkbox"/> Shrink-wrap license |
| <input type="checkbox"/> OSS (Open Source Software) license | |
| <input type="checkbox"/> CAL (Client Access License) | <input type="checkbox"/> Free software |
| <input type="checkbox"/> Shareware | <input type="checkbox"/> GPL (General Public License) |
| <input type="checkbox"/> LGPL (Lesser General Public License) | |
| <input type="checkbox"/> Copyleft | |

- Q9-21 through Q9-24

2.2 Laws on security

[Learning objectives]

- Understand the outline of the Act on the Prohibition of Unauthorized Computer Access.
- Understand the outline of the Act on Electronic Signatures and Certification Business.
- Understand the outline of the Act on the Limitation of Liability for Damages of Specified Telecommunications Service Providers and the Right to Demand Disclosure of Identification Information of the Senders.

□ Keywords

- | | |
|---|---|
| <input type="checkbox"/> Access control function | <input type="checkbox"/> Unauthorized access |
| <input type="checkbox"/> Act that helps unauthorized accesses | |
| <input type="checkbox"/> Accredited certification business operator | <input type="checkbox"/> Electronic certificate |

► Q9-25

2.3 Laws on labor and transaction ★★

[Learning objectives]

- Understand the outline of laws on labor and transactions.
- Understand the outline of typical contracts associated with transactions between businesses.

□ Keywords

- ☐ Labor Standards Act (Article 36 agreement, discretionary labor system, flexible working hours system, maternity protection)
- ☐ Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers (temporary worker dispatch contract, employment agreement, authority to provide instructions, disguised contract work, prohibition of secondary dispatch of temporary worker)
- ☐ Industrial Safety and Health Act
- ☐ Act on Securing, Etc. of Equal Opportunity and Treatment between Men and Women in Employment
- ☐ Act on the Welfare of Workers Who Take Care of Children or Other Family Members Including Child Care and Family Care Leave
- ☐ Act on Improvement, etc. of Employment Management for Part-Time Workers
- ☐ Act against Delay in Payment of Subcontract Proceeds, Etc. to Subcontractors (manufacturing contract, service contract, information-based product, main subcontracting entrepreneur, subcontractor, capital)
- ☐ Civil law((quasi-)mandate contract, underpinning contract, authority to provide instructions, responsibility for completing deliverables)
- ☐ Commercial law
- ☐ Act on Special Provisions to the Civil Code Concerning Electronic Consumer Contracts and Electronic Acceptance Notice
- ☐ Act on Specified Commercial Transactions
- ☐ NDA (Non-Disclosure Agreement)
- ☐ Software development outsourcing model contract
- ☐ Information system/model transaction contract

► Q9-26 through Q9-28

2.4 Other laws, guidelines, and engineer ethics

[Learning objectives]

- Understand the outline of the Basic Act on the Formation of an Advanced Information and Telecommunications Network Society.
- Understand the outline of compliance, engineer's ethics, and laws and standards that should be obeyed.

□ Keywords

- ☐ IT Strategic Headquarters (the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society)
- ☐ Formation of an advanced information and telecommunications network society
- ☐ Promotion of electronic commerce
- ☐ Computerization of the administration
- ☐ Use of the information and communication technology in the public sector
- ☐ Corporate ethics
- ☐ Export-related laws and regulations
- ☐ Software Management Guidelines
- ☐ Social responsibility of engineers
- ☐ Professionalism
- ☐ Act on the Protection of Personal Information (a business operator handling personal information, Guidelines on Personal Information Protection)
- ☐ Privacy mark
- ☐ Radio Law
- ☐ Act on the Limitation of Liability for Damages of Specified Telecommunications Service Providers and the Right to Demand Disclosure of Identification Information of the Senders
- ☐ Law on Communications Interception During Criminal Investigations
- ☐ Computer Crime Prevention Law
- ☐ Standards for Measures against Computer Viruses
- ☐ Standards for Measures against Unauthorized Access to Computers
- ☐ Standards for Information System Safety Measures
- ☐ Financial Instruments and Exchange Act (annual securities report, internal control report)
- ☐ Companies Act (stockholders' meeting, director, executive officer, auditor, company with committees, business report, internal control)
- ☐ Corporation Tax Act
- ☐ System Management Standards
- ☐ Code of ethics for engineers
- ☐ Morals (awareness of conformity)
- ☐ Telecommunications Business Law
- ☐ Consumption Tax Law
- ☐ Electromagnetic records

- ☐ Product Liability Act
- ☐ Computer fraud
- ☐ Obstruction of business through destruction of a computer, etc.
- ☐ Unauthorized creation and use of electromagnetic records
- ☐ Unauthorized creation of electromagnetic records for cards for payment

► Q9-29 through Q9-31

2.5 Standardization

[Learning objectives]

- Understand the outline of typical standards, standardization organizations, and the framework of international certification.

☐ Keywords

- ☐ JIS X series (information processing)
- ☐ JIS Q series (management systems)
- ☐ JIS Q 9000
- ☐ JIS Q 15001
- ☐ JIS Q 20000
- ☐ JIS Q 27001
- ☐ JSA (Japanese Standards Association)
- ☐ International certification
- ☐ ISO 9000
- ☐ ISO 14000
- ☐ ISO/IEC 27001
- ☐ ITU (International Telecommunication Union)
- ☐ IEC (International Electrotechnical Commission)
- ☐ IETF (Internet Engineering Task Force)
- ☐ ANSI (America National Standards Institute)
- ☐ IEEE (Institute of Electrical and Electronics Engineers)
- ☐ W3C (World Wide Web Consortium)
- ☐ De jure standard
- ☐ SLCP-JCF2007
- ☐ JIS X 0160
- ☐ JIS X 0170
- ☐ ISO 14000
- ☐ JIS Q 14001
- ☐ ISO/IEC 15408
- ☐ JIS X 5070
- ☐ De facto standards
- ☐ CORBA
- ☐ OMG
- ☐ EJB (Enterprise JavaBeans)
- ☐ Character and other codes
- ☐ JIS code
- ☐ Unicode
- ☐ JAN code
- ☐ QR code
- ☐ ITF code
- ☐ ISBN code
- ☐ Conformity assessment
- ☐ Conformity assessment body
- ☐ Accreditation body
- ☐ Certification body
- ☐ Inspection body

► Q9-32 through Q9-34

9.1

Corporate activities**Q9-1** □□□

Which of the following is the highest decision making body of a stock company?

- a) Stockholders' meeting
- b) Management conference
- c) Managing committee
- d) Board of directors

Q9-2 □□□**Mandatory question**

Which of the following is an explanation of a BCP in the context of corporate activity?

- a) BCP is efforts that are made by a company to take responsibility for the effects of its business activities on society, and ensure it fulfills its responsibility to provide an explanation in response to a request from any stakeholder.
- b) BCP is a management technique for managing a business while new knowledge is created by the sharing and utilization of a wide range of knowledge, including not only formal knowledge but also implicit knowledge.
- c) BCP is an action plan that is prepared in advance in order to keep critical business functions in operation even in the case of an unexpected event such as a disaster or a system failure.
- d) BCP is a technique for identifying, evaluating, and optimizing the risks involved in organizational activities in an integrated, comprehensive, and strategic manner, so as to maximize value.

Q9-3 □□□

Which of the following is an activity that is performed in the PLAN phase of the PDCA model of the ISMS process?

- a) Management of operational status
- b) Implementation of measures for improvement
- c) Review of implementation status
- d) Risk assessment of information assets

Q9-4 □□□

Which of the following is an appropriate explanation concerning the characteristics of project organization in the development of an information system.

- a) Committee organization has the advantages of a clear system of authority and responsibility, flexible personnel assignment, and simple coordination of related departments, but it has disadvantages such as difficulty of formation and operations.
- b) Functional organization has the advantages of a clear coordination function by a dedicated project manager, swift decision making, and a clear system of authority and responsibility, but it has disadvantages such as inefficiency of personnel assignment.
- c) Task force organization has the advantages of the potential for technique accumulation, efficient personnel assignment, and simple progress management, but has the disadvantage of a high possibility of a delay in decision making.
- d) Matrix organization has the advantages of a clear system of authority and responsibility, swift problem resolution, and efficient personnel assignment, but has the disadvantages including a high possibility of a collision between managers of functional departments.

Q9-5 □□□

Company *A* and Company *B* can expect payoff as shown in the table when each of them implements two different strategies. Which of the following is the payoff for Company *A* when both companies carry out a maximin strategy? Here, in the table, the left value indicates the payoff for *A*, and the right value indicates the payoff for *B*.

		Company <i>B</i>	
		Strategy B1	Strategy B2
Company <i>A</i>	Strategy A1	−15, 15	20, −20
	Strategy A2	5, −5	0, 0

- a) −15
- b) 0
- c) 5
- d) 20

Q9-6 ☐☐☐

Under the conditions in the table below, how much more or less is the annual total of the purchase cost, order cost, and storage cost when the quantity for a single order is 40 units as compared to when the quantity for a single order is 100 units? Here, the inventory decreases at a fixed rate, and the next shipment arrives at the same time when the inventory runs out.

Annual order quantity	400 units
Purchase cost per unit	50,000 yen
Order cost per order	20,000 yen
Annual storage cost per unit	10,000 yen
Bulk order discount (for a single order of 100 or more units)	10% of purchase cost

- a) 1,820,000 yen less b) 1,520,000 yen less
c) 1,520,000 yen more d) 1,820,000 yen more

Q9-7 ☐☐☐ **Mandatory question**

Which of the following is an activity for which the application of game theory is appropriate?

- a) A decision on the number of entry gates for an event venue
- b) An analysis of the selling factors of hot-selling products
- c) The development of a sales strategy for a competitive market place
- d) An estimate for the demand for a newly developed product

Q9-8 □□□

Factory *X* produces three types of products *A*, *B*, and *C* from a certain raw material. The table below shows the production time, required quantity of raw material, and profit per unit quantity of each product. For this factory, the monthly total production time is a maximum of 240 hours, and a monthly total of 150 kg of the raw material can be used.

Under these conditions, it is required to know how many of *A*, *B* and *C* should be produced so as to yield the highest profit. Which of the following is an appropriate method for solving this problem?

Product	<i>A</i>	<i>B</i>	<i>C</i>
Production time (hours)	2	3	1
Required quantity of raw material (kg)	2	1	2
Profit (thousands of yen)	8	5	5

- a) Moving average method b) Least squares method
c) Linear programming method d) Fixed quantity ordering method

Q9-9 □□□

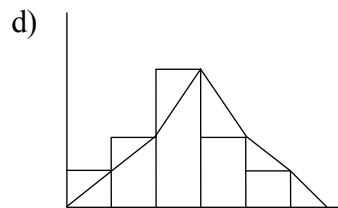
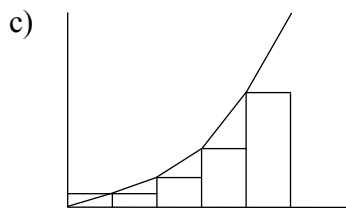
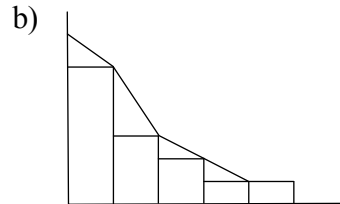
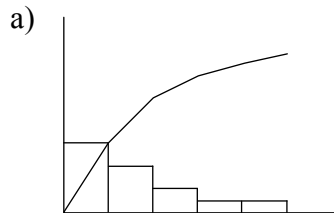
When handled products are analyzed with ABC analysis, which of the following is the combination of the product numbers of the products that are subject to management in group A?

Product number	Annual sales quantity	Unit price	Annual sales
1	110	2	220
2	60	40	2,400
3	10	4	40
4	130	1	130
5	50	12	600
6	1	25	25
7	10	2	20
8	150	2	300
9	20	2	40
10	50	1	50
Total	591		3,825

- a) 1 and 2 b) 2 and 5 c) 2 and 6 d) 4 and 8

Q9-10 ☐☐☐ **Mandatory question**

A factory records the number of occurrences of defective products by the cause of defect. Based on this record, which of the following is a chart that shows the cause of defect occupying the top position and its proportion?

**Q9-11** ☐☐☐

In the operation design of a system, in order to prevent mistakes in operation, design that assumes all possible situations is important. It is necessary to leverage experience gained in order to foresee an unknown situation before it occurs, investigate procedures for countermeasures, and confirm the whereabouts of the problems. Which of the following is a method that can be used to compile these needs?

- | | |
|------------------------|-------------------------------|
| a) PDPC method | b) Arrow diagram method |
| c) Tree diagram method | d) Association diagram method |

Q9-12 □□□

In a program, it appears that the more steps there are the more errors per step there are, so data is taken for an investigation. Which of the following is the most appropriate for analyzing this data?

- a) Tree diagram
- b) Scatter diagram
- c) Cause and effect diagram
- d) Pareto chart

Q9-13 □□□

Which of the following is an appropriate explanation of a cause and effect diagram?

- a) The relationships between cause and effect are organized in a shape like fish bones and compiled systematically to clarify what kind of cause is related to a result.
- b) Differences in time-series data are represented with a line graph, and these are managed objectively with control limit lines.
- c) Differences in quality can be understood by classifying the collected data into several intervals and drawing a bar graph to show the number of data that belongs to each interval.
- d) Data is categorized into several items and arranged on a bar graph along the horizontal axis in order of magnitude, and the accumulated values are depicted with a line graph to organize the problem areas.

Q9-14 □□□

Which of the following is an appropriate description concerning a financial indicator?

- a) A fixed ratio is the proportion of fixed assets to fixed liabilities, and the smaller the value the higher security.
- b) Equity to total assets is the percentage of equity capital to fixed assets, and the larger the value the higher the solidity.
- c) Total capital profit ratio is the percentage of profit to gross capital, and the larger the value the higher the profitability.
- d) A current ratio is the percentage of current assets to current liabilities, and the smaller the value the higher the security.

Q9-15 □□□ **Mandatory question**

A coffee shop is to be opened for business under the conditions shown in the table. In order to make a monthly profit of 100,000 yen, how many customers are necessary for each seat per day?

Total sales per customer	500 yen
Variable cost per customer	100 yen
Fixed cost	300,000 yen/month
Number of business days per month	20 days
Number of seats	10 seats

- a) 3.75 b) 4 c) 4.2 d) 5

Q9-16 □□□

When production facilities are installed, the estimated profit is as shown in the table. When the expectation principle is used, which of the following gives the largest expected profit among plans *A* through *D*?

Unit: million yen

		Forecast for economic situation			
		Situation 1	Situation 2	Situation 3	Situation 4
Expected probability		0.2	0.3	0.4	0.1
Facility plan	<i>A</i>	40	10	0	-6
	<i>B</i>	7	18	10	-10
	<i>C</i>	8	18	12	-5
	<i>D</i>	2	4	12	30

- a) *A* b) *B* c) *C* d) *D*

Q9-17 ☐☐☐

Among the methods for the calculation of the sales unit price of a material, which of the following is an explanation of the periodic average method?

- a) The sum total of the estimated value of the inventory at the start of the period and the total value of purchased material is divided by the total quantity to calculate the sales unit price.
- b) When a purchase is made, the purchase price is recorded and the average of the purchase price of the material purchased most recently and the material purchased least recently is taken to calculate the sales unit price.
- c) When a purchase is made, the total of the value of the inventory and purchase value is divided by the total of the inventory quantity and purchase quantity to calculate the sales unit price.
- d) The total of the estimated value of the inventory at the start of the period and the end of the period for the previous year is divided by the total of the quantity of the inventory at the start of the period and the inventory at the end of the period to calculate the sales unit price.

Q9-18 ☐☐☐

The table below shows the total sales, cost, and profit of a given product in the current period. When the sales unit price of this product is 5,000 yen, at least how many products should be sold to earn twice or more in profit during the next period?

Unit: thousand yen

Total sales	10,000
Cost	
Fixed cost	2,000
Variable cost	6,000
Profit	2,000

- a) 2,400
- b) 2,500
- c) 3,000
- d) 4,000

Q9-19 ☐☐☐ **Mandatory question**

Which of the following is an explanation of ROE?

- a) An index that shows the profitability of the total assets owned by a company
- b) An index that shows the soundness of financial health from the ratio of equity capital and total capital
- c) An index that measures the level of effective utilization of equity capital and borrowed capital
- d) An index that shows profitability for equity capital

Q9-20 ☐☐☐

When product *A* is evaluated with the first-in first-out method, how much in yen is the estimated value of the inventory at the end of April?

Date	Transaction for product <i>A</i>	Quantity (units)	Price (yen)
4/1	Carry-over inventory	10	100
4/4	Purchased	40	120
4/5	Sold	30	
4/7	Purchased	30	140
4/10	Purchased	10	110
4/30	Sold	30	

- a) 3,300
- b) 3,400
- c) 3,525
- d) 3,900

9.2

Legal affairsQ9-21 ☐☐☐**Mandatory question**

In Japan, which of the following is the combination of four rights known as industrial property rights?

- a) Design right, utility model right, trademark right, and patent right
- b) Design right, utility model right, copyright, and patent right
- c) Design right, trademark right, copyright, and patent right
- d) Utility model right, trademark right, copyright, and patent right

Q9-22 ☐☐☐

Which of the following is an appropriate description concerning a copyrighted work such as a computer program?

- a) The copyright of a program that is jointly developed is assigned in accordance with the proportion of the cost of development that is borne.
- b) The copyright is recognized for a program but it is not recognized for a database.
- c) The copyright act protects a program and the know-how for the the creation of a program.
- d) The programming language and conventions that are used to create a copyrighted work are not protected by the Copyright Act.

Q9-23 ☐☐☐

Which of the following is an appropriate description concerning copyright?

- a) No rights accrue unless a work is registered with the proper authorities.
- b) The authority that has jurisdiction is the Patent Office.
- c) The period of duration for copyright is 20 years.
- d) The copyright occurs as soon as a work is created.

Q9-24 □□□

Which of the following is the “Software Management Guidelines” created by the Ministry of Economy, Trade and Industry?

- a) A minimum collection of items that must be performed by the development manager in the development process of an application
- b) A collection of items that should be implemented when software is used by corporations and groups in order to prevent illegal duplication of the software
- c) A guideline of items that a software manager should check in order to assure the quality of software
- d) A collection of management rules that software managers should establish and the form of software usage procedures in order to promote proper use of the software package

Q9-25 □□□**Mandatory question**

Which of the following conforms to the “Standards for Measures against Unauthorized Access to Computers”?

- a) All networks are interconnected to improve the efficiency of monitoring.
- b) User IDs can be shared between individuals when required for business purposes.
- c) A system administrator can always use a user ID that has all privileges.
- d) The security policy of an organization is documented and training is regularly held.

Q9-26 □□□

In the dispatch of workers based on the Act for Securing the Proper Operation of Worker Dispatching Undertakings and Improved Working Conditions for Dispatched Workers, between which of the following does a temporary worker dispatch contract exist?

- a) The owner of the company receiving the worker and the dispatched worker
- b) The responsible person at the company receiving the worker and the dispatched worker
- c) The owner of the company dispatching the worker and the owner of the company receiving the worker
- d) The owner of the dispatching company and the dispatched worker

Q9-27 □□□

For a dispatched worker who is working under a dispatch agreement, which of the following is an appropriate action by the company that receives the worker? Here, there are no particular arrangements for working conditions, etc.

- a) A dispatched worker who is responsible for the maintenance of a sales information system makes a direct application for paid vacation. It is judged to have no adverse affects on business and is approved.
- b) In order to perform the maintenance of groupware, work instructions are given in the same way as for employees of the company.
- c) After instructions for the entry of data into a production management system are given, defective products are manufactured due to an input mistake, so an attempt is made to place responsibility for the manufactured product with the company dispatching the worker.
- d) The data processing for a sales management system does not finished on time, so the instruction to do overtime work is given in the same way as for employees of the company.

Q9-28 □□□**Mandatory question**

In system development that is performed by Company *A*, which of the following is an appropriate description concerning the contract when external Company *B* is used?

- a) In a mandate contract, Company *B* has no responsibility for completing deliverables, so Company *A* has authority to give direct instructions to employees of Company *B*.
- b) In system development with an underpinning contract, if there are no specific stipulations in the contract, the copyright for the program belongs to Company *B*.
- c) For system development with an underpinning contract or a dispatch agreement, in both cases, Company *B* has the responsibility for the completion of the system.
- d) In a dispatch agreement, when there is a serious defect in a developed program, Company *B* has defect liability.

Q9-29 □□□

Which of the following **is not included** in the “electromagnetic records” mentioned as the crime of unauthorized creation of electromagnetic records in the Penal Code?

- a) IC memory
- b) Telephone card
- c) Bar code
- d) Optical disk

Q9-30 □□□

Which of the following applies to the management measures for physical security in the Ministry of Economy, Trade and Industry’s “Guidelines for the Financial and Economic Fields Regarding the Act on the Protection of Personal Information Held by Administrative Organs”?

- a) Implementation of education and training about the role and responsibilities of employees who are involved in the safe management of personal data
- b) Implementation of a reporting system to parties such as a representative when an incident such as a leak of personal data occurs
- c) Acquisition of records of successful and unsuccessful access to an information system that handles personal data
- d) Installation of an information system that handles personal data in a building that has entrance access control based on IC cards

Q9-31 □□□

Which of the following is personal information that is covered by the Act on the Protection of Personal Information?

- a) Only information concerning customers that is managed by a company
- b) Only information concerning private matters that is made confidential by an individual.
- c) Only information concerning living individuals
- d) Only information concerning individuals with Japanese nationality

Q9-32 □□□

Which of the following should be defined in an information representation protocol for the implementation of EDI?

- a) Details of the contract for transactions between companies
- b) Operation time of the system
- c) Transmission control procedure
- d) Message format

Q9-33 □□□

Which of the following is an appropriate description of a character code used by a computer?

- a) The ASCII character set is composed of alphabetical characters, numerical characters, special characters, and control characters. It has no stipulations concerning Kanji.
- b) EUC is a coding scheme for using 16 or more bits. It was designed as a global standard for character codes, but it has no stipulations concerning Kanji.
- c) Unicode was designed with the aim of understanding if a character is a Kanji from its first byte. It is a coding system where Kanji can be mixed with ASCII code.
- d) The Shift JIS code set was designed as a part of the multi-language support of UNIX, and is standardized as an ISO.

Q9-34 □□□

Which of the following is a description of information barrier-free?

- a) An environment in which information devices can be utilized even when the data entry method is limited, for example, to only voice or hand writing
- b) An environment in which a user in motion can utilize a communication terminal such as cell phone and car telephone
- c) An environment in which a working style without time loss and emotional distress due to commuting is made possible through the use of information communication technology
- d) An environment in which individuals can utilize computers seamlessly by means such as mobile computing and home networks

Section 9 Corporate and legal affairs List of answers

Q9-1	a)	Q9-31	c)
Q9-2	c)	Q9-32	d)
Q9-3	d)	Q9-33	a)
Q9-4	d)	Q9-34	a)
Q9-5	c)		
Q9-6	d)		
Q9-7	c)		
Q9-8	c)		
Q9-9	b)		
Q9-10	a)		
Q9-11	a)		
Q9-12	b)		
Q9-13	a)		
Q9-14	c)		
Q9-15	d)		
Q9-16	c)		
Q9-17	a)		
Q9-18	c)		
Q9-19	d)		
Q9-20	d)		
Q9-21	a)		
Q9-22	d)		
Q9-23	d)		
Q9-24	b)		
Q9-25	d)		
Q9-26	c)		
Q9-27	b)		
Q9-28	b)		
Q9-29	c)		
Q9-30	d)		

Multiple Choice Questions (Computer Systems, Information Security, Software Design, Management, Strategy)

Learning Objectives

(Computer System)

1. Be able to explain the hardware, including the expression of information, operation principle of the CPU, and system configuration, by using examples.
2. Be able to explain the software, including the OS functions, by using examples.
3. Be able to explain the consistency of database, normalization, SQLs, and failure recovery process, by using examples.
4. Be able to explain the network, including the meaning of an IP address, TCP/IP, and the function of a connecting device between LANs, using examples, and be able to calculate the transmission rate, speed, and time.

(Information Security)

5. Be able to specifically explain information security, including the mechanism of encryption and authentication. Be able to explain the security management of an organization, including access management, permissions, antivirus measures, and security policies, by using examples.

(Software Design)

6. Be able to explain the software design, including the structured design (DFD and module structure diagram), object orientation, as well as the creation of test data and execution of a test, by using examples.

(Management)

7. Be able to understand examples of project management, including the scope (WBS creation) schedule and cost management.
8. Be able to explain service management, including the system performance and reliability, as well as the role of service desk and service level management.

(Strategy)

9. Be able to explain the business and information strategy, including improvement of business operations and business strategy techniques, by using examples. Be able to understand examples of linear programming, inventory control, and quality inspection techniques, as an optimization strategy.
10. Be able to explain finance and accounting, including the profit and break-even point, and calculation of the cost, by using examples. Be able to explain the content of the Labor Law and the Copyright Act, by using examples.

10.1

Selected Questions (Computer System)**Q10-1** □□□

Read the following description of the execution of hardware instructions, and then answer the Subquestion.

- (1) One word consists of 16 bits, and the instruction length is 1 word. Fig. 1 shows the instruction format.

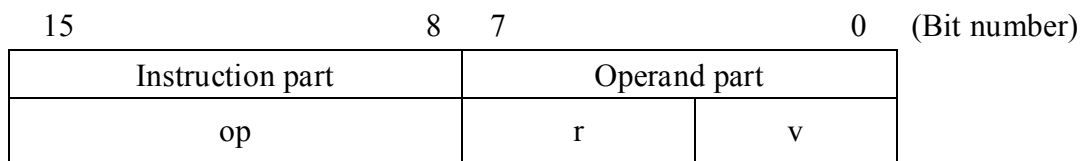


Fig. 1 Instruction format

- (2) Table 1 shows the meanings of op, r and v.

There are 16 registers (register numbers 0 to F), each 1 word in length. op, r, v and the register contents are all described in hexadecimal notation.

Table 1 Meanings of op, r and v

	Meaning
op	Operation code ($00 \leq \text{op} \leq \text{FF}$)
r	Register number ($0 \leq r \leq \text{F}$)
v	Register number or constant ($0 \leq v \leq \text{F}$)

- (3) Table 2 shows the instruction specifications (partial).

Table 2 Instruction specifications (partial)

Name	op (Operation code)	Operation
LR (Load Register)	10	Sets the contents of register v in register r.
AR (Add Register)	20	Obtains the sum of the register r and register v contents, and sets the results in register r.
OR (Or Register)	30	Obtains the logical sum of the register r and register v contents, and sets the results in register r.
SL (Shift Left)	40	Shifts the contents of register r to the left by the number of bits specified by the constant v, and sets “0” in empty bit positions resulting from the shift.
SR (Shift Right)	50	Shifts the contents of register r to the right by the number of bits specified by the constant v, and sets “0” in empty bit positions resulting from the shift.

Subquestion

From the answer groups below, select the correct answers to insert in the blanks in the following description.

The contents of registers 1 through 5 are as shown in Fig. 2.

(Register number)	Contents
1	1234
2	8361
3	5F2A
4	C38B
5	0010

Fig. 2 Contents of registers 1 through 5

- (1) When the following instruction is executed with the register status as shown in Fig. 2, the contents of register 2 become .

Instruction: 3021

- (2) When the following 4 instructions are executed in order with the register status as shown in Fig. 2, the contents of register 3 become , and the contents of register 4 become .

Instructions: 1034

4038

5048

3043

- (3) When the following 4 instructions are executed in order with the register status as shown in Fig. 2, the contents of register 5 increase by a factor of 10 (Register 5: 0010 → 00A0).

Instructions: 1065

4063

40

2056

Answer group for A:

- | | |
|---------|---------|
| a) 9375 | b) 9395 |
| c) 9575 | d) 9595 |

Answer group for B and C:

- | | |
|---------|---------|
| a) 005F | b) 008B |
| c) 00C3 | d) 2A00 |
| e) 2A5F | f) 8B00 |
| g) 8BC3 | h) C38B |

Answer group for D:

- | | |
|-------|-------|
| a) 51 | b) 52 |
| c) 61 | d) 62 |

Q10-2 □□□

Read the following description concerning a floating point number (IEEE 754) represented by 32 bits, and then answer the Subquestion.

[Explanation of a floating point number]

A floating point number is composed of a sign part, a mantissa part, and an exponent part.

For example, the numeric value 8.625 becomes:

$$8.625 = + 8.625 \times 10^0$$

sign mantissa exponent

and is expressed as a floating point number as follows:

Sign part	Exponent part	Mantissa part
0	1 0 0 0 0 0 1 0	0 0 0 1 0 1 0
31	30	23 22
		0

Fig. 1 Bit position

This is interpreted as below:

- (1) The + sign is expressed by 0 and the – sign is expressed by 1, and these are saved in the most significant bit.

0	1 0 0 0 0 0 1 0	0 0 0 1 0 1 0
---	-----------------	---

Fig. 2 Bit position (sign)

- (2) Perform radix conversion of 8.625 to a binary number.

- (i) Convert the integer part to a binary number.

$$8_{(10)} = 1000_{(2)}$$

- (ii) Convert the decimal fraction part to a binary number. Conversion is performed by lining up the integer parts of values obtained upon multiplication with 2.

For example, in the case of 0.625,

$$\begin{array}{rcl}
 0.625 \times 2 & = & 1.250 \\
 \downarrow & & \\
 0.250 \times 2 & = & 0.500 \\
 \downarrow & & \\
 0.500 \times 2 & = & 1.000 \quad \text{End here because there are no more numbers after the decimal point.} \\
 \downarrow & & \\
 & & 101
 \end{array}$$

$0.625_{(10)} = 0.101_{(2)}$

- (iii) Therefore, when 8.625 are converted to a binary number, it becomes 1000.101, which is a mantissa.

- (3) The exponent part is saved in 8 bits, however, to support the exponent even when it becomes a negative number, 127 is taken as the reference value. That is, if the exponent part is less than 127, the exponent is negative, and if the exponent part is 127 or more, it becomes either 0 or a positive number.

Adjust (normalize) this exponent part such that the integer part of the mantissa becomes 1.

For example, because the mantissa described earlier (in (2)) is 1000.101, the integer part of this mantissa is changed to 1 as follows:

$$1000.101 = 1.000101 \times 2^3$$

which means that the exponent becomes 3, while the mantissa becomes 1.000101. Therefore, with 127 as the reference, $127 + 3 = 130$, and the exponent part becomes 10000010₍₂₎ as a binary number.

0	1 0 0 0 0 0 1 0	0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
---	-----------------	---

Fig. 3 Bit position (exponent part)

- (4) Because the mantissa part is adjusted so that the integer part of the mantissa becomes 1, only the numbers after the decimal point are saved in the mantissa part. That is, when the mantissa is 1.000101, then only 000101 is saved.

0	1 0 0 0 0 0 1 0	0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
---	-----------------	---

▲ (Position of the virtual decimal point)

Fig. 4 Bit position (mantissa part)

Subquestion

The sentences below describe the process of converting data containing a 32-bit floating point number to a 32-bit integer. From the answer group below, select the correct answer to be inserted in the blank in the description below.

0	1 0 0 0 0 1 0 1	0 0 1 1 0 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
---	-----------------	---

Fig. 5 Conversion to an integer (basic)

(1) Sign

The sign bit is 0. Therefore, the sign is positive.

0	1 0 0 0 0 1 0 1	0 0 1 1 0 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
---	-----------------	---

Fig. 6 Conversion to an integer (sign part)

(2) Exponent part

The exponent part is 10000101, which becomes 133 when it is converted to decimal, and is expressed as the A .th power of 2.

0	1 0 0 0 0 1 0 1	0 0 1 1 0 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
---	-----------------	---

Fig. 7 Conversion to an integer (exponent part)

(3) Mantissa part

1 is added to the mantissa part since only the mantissa part is extracted and adjusted such that the integer part becomes 1.

(i)	0	1 0 0 0 0 1 0 1	0 0 1 1 0 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
			↓
(ii)	0	0 0 0 0 0 0 0 1	0 0 1 1 0 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

▲ (Position of the virtual decimal point)

Fig. 8 Conversion to an integer (mantissa part)

(4) Conversion to integer

Because the numeric value is obtained by multiplying the th power of 2 by (ii) of Fig. 8, the position of the virtual decimal point is digits towards the right from (ii) of Fig. 8 ((i) of Fig. 9). Therefore, when the virtual decimal point is shifted bits to the right from (i) of Fig. 9, the decimal point moves to the right end, and the integer part is extracted ((ii) in the figure below).

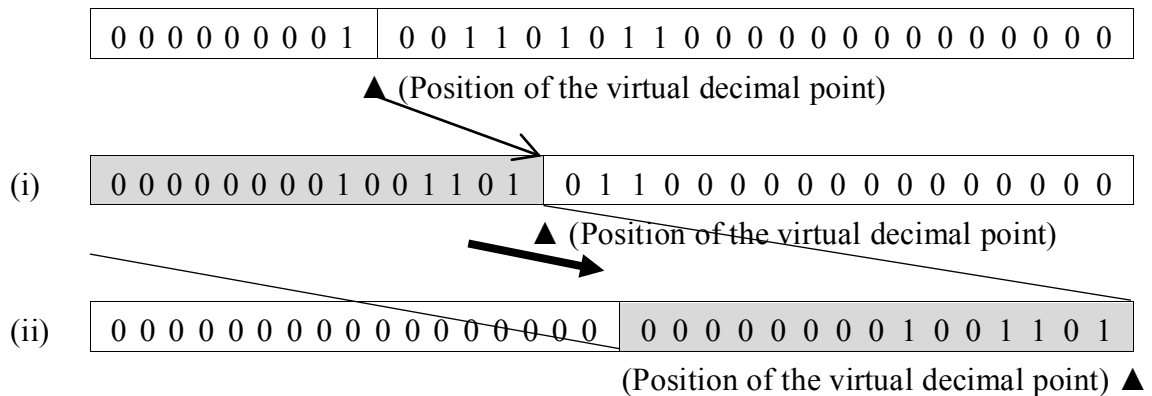


Fig. 9 Conversion to an integer (integer value)

According to this concept, when the power of 2 exceeds , the entire bit must be shifted to the left in order to determine the position of the virtual decimal point. Furthermore, when the power of 2 exceeds , the range that can be displayed as a 32-bit integer value is also exceeded.

(5) Adding a sign

To the value of Fig. 9, add the sign obtained in (1).

Answer group:

- | | | | |
|-------|-------|-------|-------|
| a) 1 | b) 6 | c) 8 | d) 17 |
| e) 22 | f) 23 | g) 30 | h) 31 |

Q10-3 □□□

Read the following description regarding “overlay” and answer Subquestions 1 and 2.

In recent years, overlay has become increasingly necessary as a result of the expansion of the program size used in embedded systems. Overlay means a method by which a program is divided into a number of overlay segments (hereinafter, “segment[s]”), and only those segments which include modules required for the execution of the program at a given time, are read by the OS and loaded into the main memory areas.

- (1) There is a program composed of 10 modules, namely modules A through J. Each module is of a call structure as shown in Fig. 1. For example, module G calls two modules, namely, modules H and I.

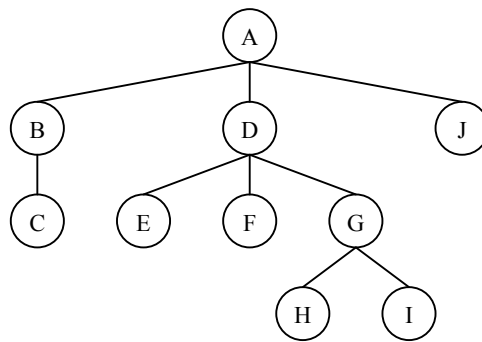


Fig. 1 Call structure for modules

- (2) The execution sequence of the modules in this program is as shown in Fig. 2.

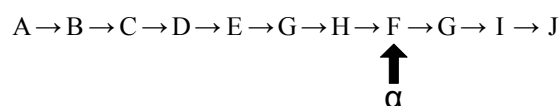


Fig. 2 Execution sequence of modules

- (3) The sizes of main memory required for the execution of individual modules are as shown in the table below. The size of each segment is equal to the sum of the sizes of the modules constituting the segment.

Table Sizes of modules

Module	A	B	C	D	E	F	G	H	I	J
Size (Mbytes)	10	8	6	5	6	4	6	2	3	15

Subquestion 1

From the answer group below, select the correct answer to be inserted into the blank

in the following description.

Fig. 3 below shows a program overlay structure and modules constituting each segment. Fig. 3 signifies that segments P0 and P2 are read into the main memory area when module D is called from module A. Furthermore, it is also shown that segments P1, P2, and P3 are read into spaces starting at the same address in the main memory area.

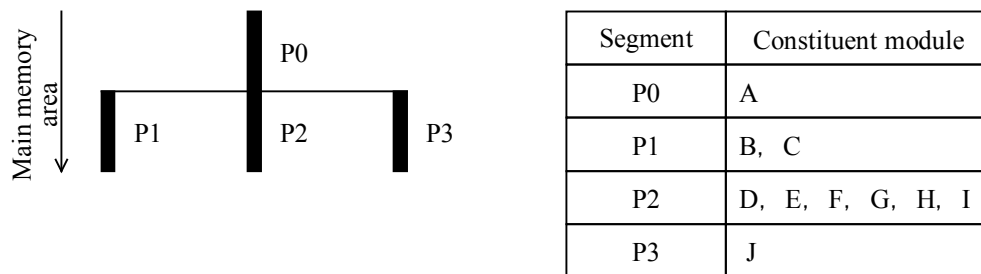


Fig. 3 Overlay structure and segments

When this program is executed, segments P0, P1, P2, and P3 are read into the main memory in this order, resulting in a total of only four loadings by the time the execution of the program is completed. The size of the main memory area required for execution in the overlay structure in Fig. 3 is Mbytes.

Answer group:

- | | | | |
|-------|-------|-------|-------|
| a) 24 | b) 25 | c) 35 | d) 36 |
| e) 37 | f) 38 | g) 39 | h) 40 |

Subquestion 2

From the answer groups below, select the correct answers to be inserted into the blanks in the following description.

It became necessary to reduce the main memory area used during the execution of the program. Therefore, the overlay structure and the segments were reviewed, and two plans were prepared as shown in Figures 4 and 5.

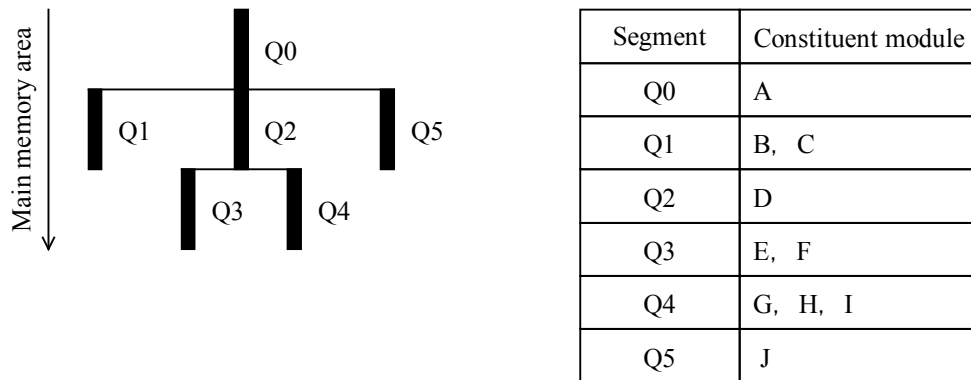


Fig. 4 Plan 1 for overlay structure and segments

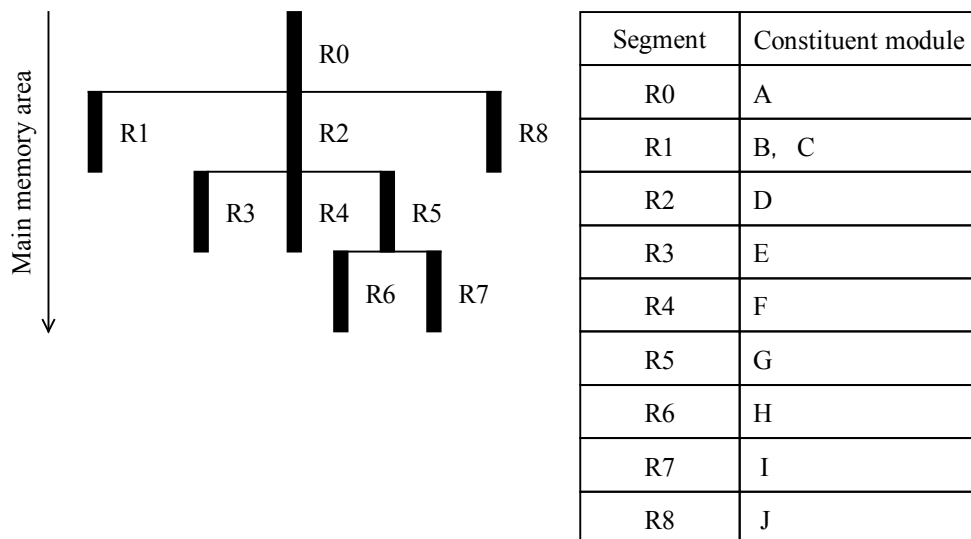


Fig. 5 Plan 2 for overlay structure and segments

In comparison with the overlay structure in Fig. 3, the size of the main memory area used in the execution of the program can be reduced by 10 Mbytes in plan 1 and by

Mbytes in plan 2.

The number of times a segment is loaded into the main memory area by the time the execution of module F located at α in Fig. 2 is completed, is 6 in plan 1 and

in plan 2.

In comparison with the overlay structure in Fig. 3, the number of times the segments are loaded into the main memory area by the time the execution of the program is completed increases by in plan 1 or by 6 in plan 2.

Answer group for A:

- | | | |
|-------|-------|-------|
| a) 10 | b) 11 | c) 12 |
| d) 13 | e) 14 | f) 15 |

Answer group for B and C:

- | | | | |
|------|-------|------|------|
| a) 1 | b) 2 | c) 3 | d) 4 |
| e) 5 | f) 6 | g) 7 | h) 8 |
| i) 9 | j) 10 | | |

Q10-4 □□□

Read the following description concerning task control, and then answer Subquestions 1 through 3.

Task control is one of the functions of an operating system. A task is a processing unit of an operating system, which is also the unit in which the CPU is assigned. Multiprocessing (multi-task) is a function by which several tasks are executed in parallel in a single CPU by performing state transition of tasks. During state transition of a task, a control for assigning the CPU to the task is necessary, which is called task scheduling.

[Explanation of state transition of a task]

There are three (3) states of a task: the running state in which the CPU is assigned to the task, the ready state in which the task is waiting for the CPU to be assigned, and the waiting state in which the task is waiting for the input/output processing to terminate. As shown in Fig. 1, a task transits through these three (3) states.

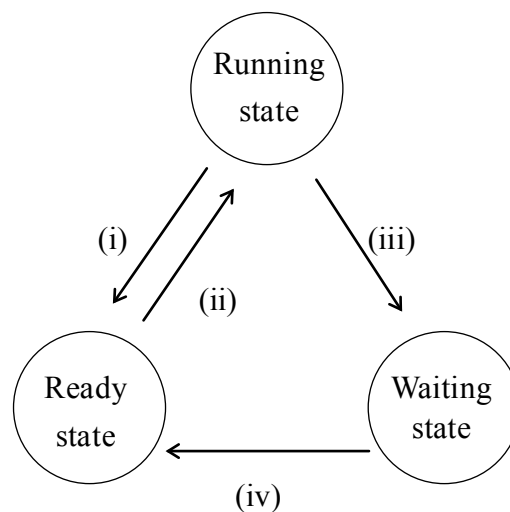


Fig. 1 State transition of the task

The factors responsible for state transition of the task in Fig. 1 are as follows:

- (i) The right to use the CPU is transferred to the task with a higher execution priority.
- (ii) The right to use the CPU is assigned.
- (iii) The task has entered the input/output processing.
- (iv) The input/output processing has terminated.

The state transition described in (iii) is performed when the program requests the input/output processing to the operating system, and occurs. The state transition described in (iv) is performed with , which provides notification of the termination of the input/output processing, as the trigger.

[Explanation of the scheduling method]

Control of the state transition (i) and (ii) in Fig. 1 is referred to as task scheduling. The scheduling methods include the round robin method and the priority scheduling method.

(1) Round robin method

A fixed CPU time is assigned sequentially to the tasks in the ready state. This CPU time is called a time slice. When occurs, and it is determined that the time slice in the handler has been used up, the task in the running state is sent to the end of the ready queue. Thus, the next task changes to the running state. The next task changes to the running state even when it enters the input/output processing before the time slice is used up. Also, once a task in the waiting state is reached, that task is skipped, and the next task is set to the running state.

If the time slice is shortened, generally, the termination time of the task with a CPU processing time is faster as compared to other tasks.

(2) Priority scheduling method

When a task with a higher priority order than a task in the running state is set to the ready state, the task in the running state transits to the ready state. Therefore, the task with a higher priority order transits from the ready state to the running state. When a task in the running state enters the input/output processing and changes to the waiting state, the task with the next priority order is set to the running state.

If the priority order of the task with a CPU processing time is increased, then in comparison with the input/output processing time, generally, the overall throughput improves.

Subquestion 1

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

in the question. However, the answers may be duplicated.

Answer group for A through C:

- | | |
|----------------------------|----------------------|
| a) SVC interrupt | b) Timer interrupt |
| c) I/O interrupt | d) Program interrupt |
| e) Machine check interrupt | |

Answer group for D and E:

- | | |
|---------|----------|
| a) Long | b) Short |
|---------|----------|

Subquestion 2

From the answer group below, select the correct description concerning the number of tasks in the running state and the number of tasks in the ready state, when three (3) tasks are operating simultaneously in a single processor, and then enter the answer in the answer column F. However, input/output processing using the same I/O device (the input/output processing of the other tasks is awaited until the input/output processing of the task that started using the I/O device first is complete) is performed for the three (3) tasks. Here, when the task is in the waiting state, it is waiting only for the input/output processing.

Answer group:

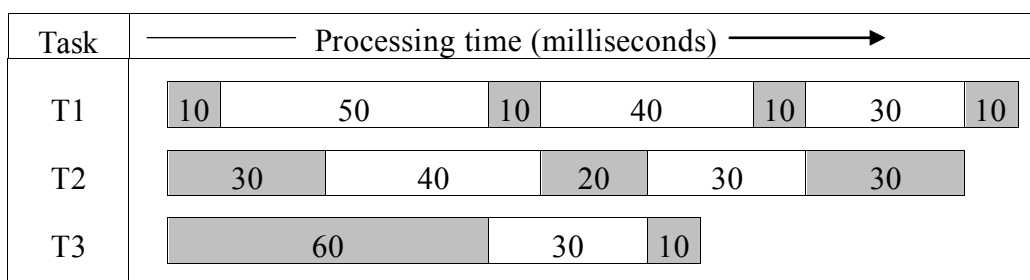
- The number of tasks in the running state is either zero (0) or one (1), and the number of tasks in the ready state is between zero (0) and two (2).
- The number of tasks in the running state is either zero (0) or one (1), and the number of tasks in the ready state is between zero (0) and three (3).
- The number of tasks in the running state is always one (1), and the number of tasks in the ready state is either one (1) or two (2).
- The number of tasks in the running state as well as the number of tasks in the ready state is always one (1).

Subquestion 3

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

in the description below.

There are three (3) tasks T1, T2, and T3. Fig. 2 shows the usage order and processing time of the CPU and the I/O device when each task is executed independently. The processing time is the time from the start of processing of a task until its end. The three (3) tasks use different I/O devices that can be operated separately. There is one (1) CPU. Furthermore, the execution time of the operating system is shorter than the execution time of a task, and is ignored.





In the figure,  indicates that the CPU processing is in progress, and  indicates that the input/output processing is in progress.

Fig. 2 Usage order and processing time of the CPU and I/O device

The three (3) tasks T1, T2, and T3 are executed by the round robin method in the order T1→T2→T3→T1→..... The time slice is 20 milliseconds. In such a case, the task terminating in the end is G and the processing time is H milliseconds.

Answer group for G:

- a) T1 b) T2 c) T3

Answer group for H:

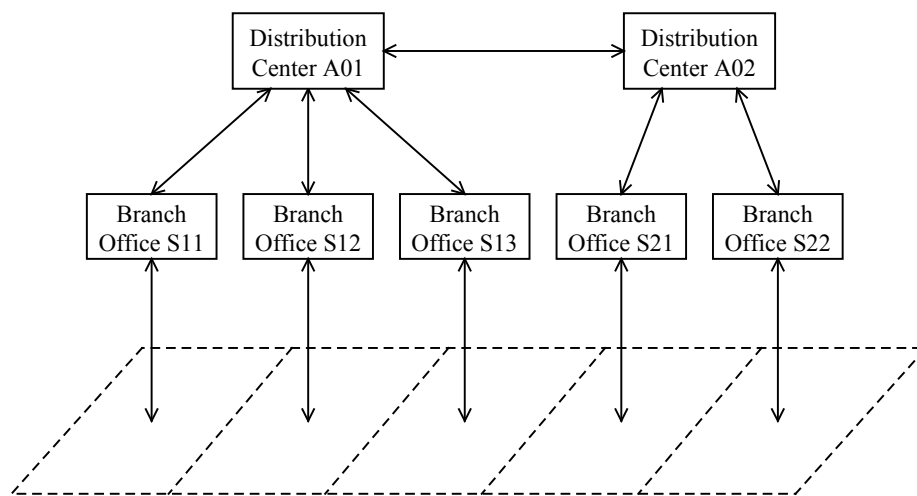
- a) 160 b) 170 c) 180 d) 190
e) 200 f) 210 g) 220 h) 230

Q10-5 □□□

Read the following description of a relational database, and then answer Subquestions 1 through 3.

Company X operates a transport business. There are branch offices strategically located to cover a certain region, and distribution centers that manage these branch offices. A region is divided into districts, and each branch office is responsible for delivery within its district. Branch offices accept parcels from customers for delivery, and issue receipt numbers that are unique numbers throughout Company X.

A branch office delivers a parcel when its destination address is within that branch office's district. Otherwise, a branch office transfers a parcel to its managing distribution center, as there are no transferring paths between any two branch offices. When a distribution center accepts a transferred parcel and the branch office responsible for delivering that parcel is managed by that same distribution center, the distribution center transfers the parcel to that branch office. Otherwise, it transfers the parcel to the distribution center that manages the branch office responsible for delivery. Fig. 1 shows the relationship between the branch offices and distribution centers when transferring parcels.



Note: The dotted line sections represent each branch office's district.

Fig. 1 Relationship between branch offices and distribution centers when transferring parcels

Company X controls the parcel status using a relational database that has the structure shown in Fig. 2. Underlined items in the figure indicate key items.

Delivery Area Table		Branch Office Table	
<u>District</u>	Branch office code	<u>Branch office code</u>	Distribution center code

Parcel Table								
<u>Receipt number</u>	Date and time accepted	Accepting branch office code	Sender district	Sender address	Sender name	Destination district	Destination address	Destination name

Transfer History Table			
<u>Receipt number</u>	<u>Passed date and time</u>	Passed branch office or distribution center code	Status code

Fig. 2 Relational database structure

Delivery Area Table: This table holds the codes (3 characters starting with S) of the branch offices responsible for each district.

Branch Office Table: This table holds the codes (3 characters starting with A) of the distribution centers that manage the branch offices for each branch office code.

Parcel Table: This table holds the parcel sender, destination and other information for each receipt number.

Transfer History Table: This table holds the date and time and the in/out history for each time a parcel enters or leaves a collection and distribution location (branch office or distribution center). 'I' is stored in the status code when a parcel enters, or 'O' when a parcel leaves a collection and distribution location.

Subquestion 1

From the answer group below, select the SQL statement that correctly obtains the number of branch offices managed by the distribution center A01.

Answer group:

- a) `SELECT COUNT (Branch_office_code) FROM Branch_Office_Table
WHERE Distribution_center_code NOT IN ('A01')`
- b) `SELECT COUNT (Branch_office_code) FROM Branch_Office_Table
WHERE Distribution_center_code = 'A01'`
- c) `SELECT COUNT (Branch_office_code) FROM Branch_Office_Table
WHERE Branch_office_code = 'A01'`
- d) `SELECT Branch_office_code FROM Branch_Office_Table
WHERE Distribution_center_code = 'A01'`
- e) `SELECT Distribution_center_code FROM Branch_Office_Table
WHERE Branch_office_code = 'A01' ORDER BY Distribution_center_code`

Subquestion 2

The following SQL statement creates a list of the delivery destinations for parcels delivered directly by branch office S11 from among the parcels accepted by that branch office thus far. From the answer group below, select the correct answer to insert in each blank in the following SQL statement.

```
SELECT Destination_district, Destination_address, Destination_name
FROM  A
WHERE Accepting_branch_office_code = 'S11'  B
Destination_district
 C (SELECT District FROM Delivery_Area_Table
WHERE Branch_office_code = 'S11')
```

Answer group:

- | | |
|---------------------------|------------------------|
| a) Transfer_History_Table | b) Branch_Office_Table |
| c) Delivery_Area_Table | d) Parcel_Table |
| e) AND | f) IN |
| g) NOT IN | h) OR |

Subquestion 3

An inquiry was made to the Transfer History Table using the following SQL statement. From the answer group below, select the correct answer that can be determined from the results of this inquiry.

```
SELECT Passed_date_and_time,
       Passed_branch_office_or_distribution_center_code, Status_code
FROM Transfer_History_Table
WHERE Receipt_number = '0000004' AND
       Passed_date_and_time = (SELECT MAX (Passed_date_and_time)
                              FROM Transfer_History_Table
                              WHERE Receipt_number = '0000004')
```

Answer group:

- a) The branch office that stored the parcel with the receipt number '0000004' for the longest time
- b) The sender of the parcel with the receipt number '0000004'
- c) The entire transfer history of the parcel with the receipt number '0000004'
- d) The most recent collection and distribution location and its passed date and time of the parcel with the receipt number '0000004'
- e) The number of days and hours from acceptance to delivery of the parcel with the receipt number '0000004'

Q10-6 □□□

Read the following description concerning a component order-receiving system using a relational database, and then answer Subquestions 1 through 4.

There is an order-receiving system that handles electric components for consumer electronic appliances. The E-R diagram of this system is shown in the figure. The entities in the E-R diagram are implemented as corresponding tables of the relational database. The entity name and attribute name in the E-R diagram correspond to the table name and item name, respectively, on the relational database. This system performs search of the “Stock” table, allocation from the “Stock” table, creation of the “Stock allocation” table, and creation of the “Receipt of order” table for orders from online terminals of the distributors. The electric components are stocked in multiple warehouses, and as a principle, delivery is made to each distributor from the warehouse with the least transportation cost. The transportation costs between the distributor and warehouse are recorded in the “Transportation cost” table. A maximum of 5 types of alternative components are available for each electric component. Alternative components are registered in the “Component” table. When n types of alternative components are available, they are recorded from alternative component #1 to alternative component # n in the component table, and the alternative component # $n+1$ to alternative component #5 have NULL values. Alternative components of the alternative component are not used as the alternative component of the original component.

[Stock allocation process]

The process of stock allocation is as follows:

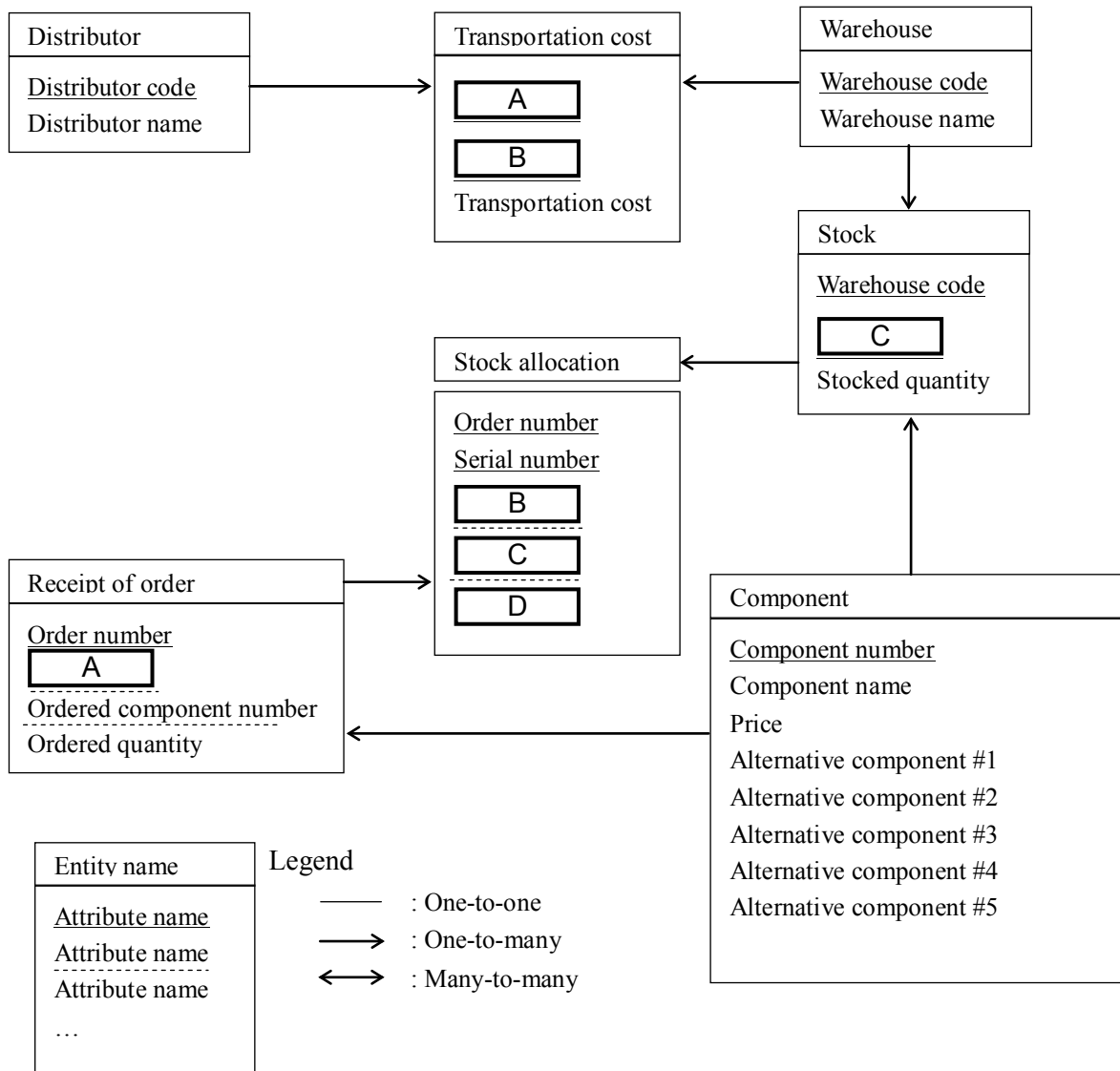
- (1) The ordered quantity of the components ordered is allocated from the stock in the warehouse with the least transportation cost as seen from the distributor.
- (2) When the stocked quantity does not meet the ordered quantity, the amount remaining after the allocation of the stocked quantity is allocated from the alternative components.
- (3) If the alternative components also do not suffice, the lacking amount is allocated from the warehouse with the second least transportation cost. Even in such a case, step (1) is performed first followed by step (2).

[Assignment of a serial number]

An order number is assigned to each order received from the online terminal. In the stock allocation process, if several warehouses or several components are allocated to a single received order, then apart from the order number, a serial number is assigned in a sequence starting from 1, which is registered as a separate line on the “Stock allocation” table. If a

single warehouse and a single component can be allocated to a received order, only a line with the serial number 1 is registered.

The components that are actually allocated to a received order are called the allocated components. If the ordered quantity is not met even after the allocation of all components that can be allocated, the allocated quantity of the “Stock allocation” table becomes less than the ordered quantity of the “Receipt of order” table.



Note: The solid underline _____ of an attribute name indicates the primary key, and the broken underline indicates the external key. For an attribute name which has a solid underline, a broken underline is omitted.

Fig. E-R diagram of the order-receiving system (partially incomplete)

Subquestion 1

From the answer group below, select the appropriate attribute name to be inserted in each blank in the figure.

Answer group:

- | | |
|---------------------|-----------------------|
| a) Stocked quantity | b) Ordered quantity |
| c) Order number | d) Warehouse code |
| e) Distributor code | f) Allocated quantity |
| g) Component number | |

Subquestion 2

From the answer group below, select the relationship (corresponding relationship) between each of the pair of entities (1) and (2) below.

- (1) Warehouse - Component
(2) Distributor - Receipt of order

Answer group:

- a) One-to-one b) One-to-many c) Many-to-one d) Many-to-many

Subquestion 3

A SELECT clause is created to investigate the ordered quantity that is not fulfilled by the allocation of the stock. From the answer group below, select the correct answer to be inserted in each blank in the following SELECT clause.

```
SELECT Receipt_of_order.Order_number, , Ordered_quantity,
       (Allocated_quantity)
FROM Receipt_of_order, Stock_allocation
WHERE Receipt_of_order.Order_number = Stock_allocation.Order_number
GROUP BY Receipt_of_order.Order_number, Ordered_component_number, Ordered_quantity
HAVING Receipt_of_order.Ordered_quantity > (Allocated_quantity)
```

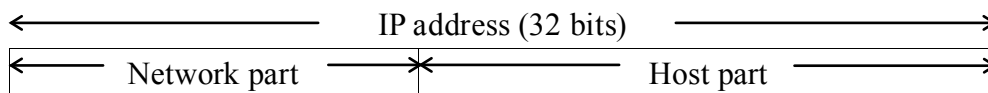
Answer group:

- a) AVG
- b) COUNT
- c) MAX
- d) SUM
- e) order_number
- f) ordered_component_number
- g) warehouse_code
- h) Component_number

Q10-7 □□□

Read the following description concerning an IP address (IPv4), and then answer Subquestions 1 and 2.

An IP address (IPv4) is composed of a network part and a host part, and has a total of 32 bits. Furthermore, the number of bits of the network part and host part is decided based on the class. For example, the number of bits of the network part is eight (8) for class *A*, 16 for class *B*, and 24 for class *C*.



Because an IP address has a large number of bits which make it difficult to use the IP address as is, the 32 bits are divided into four (4) blocks of eight (8) bits each, and each block is represented by a decimal number. Each block is separated from the other by a dot (.). An example of decimal notation is described below.

255	.	255	.	255	.	128	← Decimal notation
11111111		11111111		11111111		10000000	

When all bits of the host part are “0”, the address refers to the network itself, and when all bits of the host part are “1”, the address is used for broadcasting to all hosts connected to the network, and therefore, such addresses cannot be used as the host address.

The host part of class *A* has 24 bits, and therefore, the number of hosts that can be represented is $2^{24} - 2$. Similarly, the number of hosts that can be represented in class *C* is $2^8 - 2$, which implies that class *A* is used for large networks, class *B* for medium-size networks, and class *C* for small-size networks. However, in terms of class *A*, a real problem is that it is difficult to assume that a number of hosts close to the theoretical value exist at all times. Also, in class *C*, if the number of hosts becomes more than $2^8 - 2$, the addresses become insufficient. Therefore, a variable-length subnet mask that enables the bit length of the network address and the host address to be changed flexibly, without being restricted by a class, is available.

By using a variable-length subnet mask, a high-order bit of the host address can be included in the network address, and an IP address assignment method making use of this is called the CIDR (Classless Inter-Domain Routing) method.

A bit array representing how many bits from the first bit of the IP address are to be used as the network part is called the subnet mask, and the part of the bit array of the subnet mask with all bits set to one (1) is the network part, and the part with all bits set to zero (0)

is the host part. The value of the subnet mask in class *B* is “255.255.0.0” in decimal notation since the first 16 bits represent the network part. According to the CIDR method, after the IP address, the bit count of the network part is indicated as the prefix (after the specification of the IP address, a “/” mark is used as a delimiter followed by the specification of the bit count of the network part in decimal notation). For example, the prefix of class *B* is “/16”.

Subquestion 1

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

in the description below.

- (1) For an IP address, when the bit pattern for the first eight (8) bits is **A** , it is the IP address of class *C*. Also, in class *C*, the number of hosts (devices) that can actually be allocated is **B** .
- (2) The number of hosts (devices) connected to a network is 30 or less. When the network address and host address are specified in terms of the least required bit length of the host address, the decimal notation of the subnet mask is **C** . Also, in terms of specification according to the CIDR method, the prefix is **D** .

Answer group for A:

- | | | |
|-------------|-------------|-------------|
| a) 00100100 | b) 01010101 | c) 10010010 |
| d) 10101010 | e) 11011011 | f) 11101110 |

Answer group for B:

- | | | |
|--------|--------|--------|
| a) 126 | b) 127 | c) 128 |
| d) 254 | e) 255 | f) 256 |

Answer group for C:

- | | |
|--------------------|--------------------|
| a) 255.255.255.0 | b) 255.255.255.128 |
| c) 255.255.255.192 | d) 255.255.255.224 |
| e) 255.255.255.240 | f) 255.255.255.248 |

Answer group for D:

- | | | |
|----------|----------|----------|
| a) “/25” | b) “/26” | c) “/27” |
| d) “/28” | e) “/29” | f) “/30” |

Subquestion 2

The management and usage of the IP address based on the CIDR method rather than the class is practically very useful. From the answer group below, select the appropriate description concerning the effect of the CIDR method, and then enter it in the answer column E.

Answer group:

- a) The network part of each class can be recognized immediately.
- b) The management is easy because the subnet masks are different.
- c) The number of useless IP addresses that cannot actually be assigned reduces.
- d) The management is easy because path information such as the network address need not be set in the router.

Q10-8 □□□

Read the following description concerning data transmission and data encoding, and then answer Subquestions 1 through 3.

- (1) Device *A* has a sensor connected to it and retrieves 4-byte signed integer values (hereinafter measurement values) from the connected sensor 100 times per second. Here, 1 byte is 8 bits.
- (2) Device *A* stores measurement values in packets having the structure shown in the figure below, and transmits the packets via the network. Multiple continuous measurement values are stored in a packet. The network has sufficient bandwidth to transmit the data.
- (3) A packet consists of a 150-byte header and a sequence of measurement values. The maximum length of a packet is 1,478 bytes.
- (4) The header holds the number of measurement values that are stored in a packet. The number varies within the range that meets the condition mentioned in (3).
- (5) Device *A* retrieves certain number of measurement values from the sensor, and transmits them without delay.
- (6) Device *A* has sufficient capability to simultaneously retrieve and transmit measurement values.

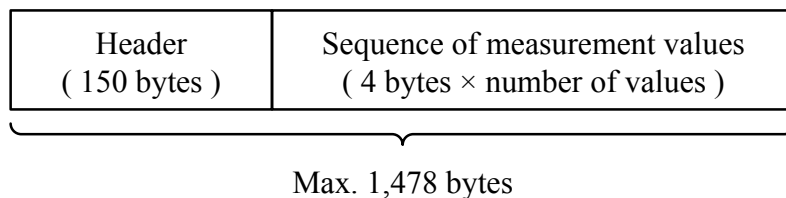


Fig. Structure of a packet

Subquestion 1

From the answer group below, select the correct answer that describes the relationship between the number of measurement values that are stored in a packet and the transmission volume (total volume of the header and measurement values) per unit time.

Answer group:

- a) As the number of measurement values that are transmitted per packet increases, the transmission volume per unit time becomes larger.
- b) As the number of measurement values that are transmitted per packet increases, the transmission volume per unit time becomes smaller.
- c) Even if the number of measurement values that are transmitted per packet changes, the transmission volume per unit time does not change.

Subquestion 2

From the answer groups below, select the correct answer to be inserted in each blank in the following description.

Measurement values of up to A seconds can be stored in a packet.

The network bandwidth w required to transmit measurement values can be represented by the expression below. Here, the number of measurement values that are stored in a packet is n .

$$w = \text{B} \times 8 \times (150 + \text{C}) \text{ bits/second}$$

Answer group for A:

- | | | |
|----------|----------|---------|
| a) 1.66 | b) 3.32 | c) 6.64 |
| d) 13.28 | e) 26.56 | |

Answer group for B and C:

- | | | |
|------------|------------|-----------|
| a) 100 | b) 150 | c) 1,200 |
| d) $4n$ | e) $32n$ | f) $100n$ |
| g) $1/n$ | h) $100/n$ | i) n |
| j) $n/100$ | | |

Subquestion 3

From the answer group below, select the correct answer to be inserted in the blank in the following description.

Measurement values change little with time in many cases. For example, it is known that 70% of all measurement values differ from the preceding measurement value within the range of -128 to 127 (-2^7 to $2^7 - 1$).

Therefore, measurement values are compressed by using the method described below when they are transmitted.

- (1) The measurement value stored at the beginning of the packet is stored as before.
- (2) As for the second or subsequent measurement value to be stored, the difference from the preceding measurement value is encoded into the compressed code as shown in the Table, and then placed bit by bit in the packet. Bit length of the compressed code varies depending on the value of difference. For example, the bit length of the second or subsequent measurement value will be 9 if the difference from the preceding measurement value is 10, or the bit length will be 18 if the difference is 200.

The bit length of the sequence of the compressed measurement values is set in the header.

Table Encoding method of difference and probability of occurrence

Range of difference	-2^7 to $2^7 - 1$	-2^{15} to $2^{15} - 1$ (excluding -2^7 to $2^7 - 1$)	-2^{23} to $2^{23} - 1$ (excluding -2^{15} to $2^{15} - 1$)	-2^{31} to $2^{31} - 1$ (excluding -2^{23} to $2^{23} - 1$)
Compressed code	<div>0 Difference (8 bits)</div>	<div>10 Difference (16 bits)</div>	<div>110 Difference (24 bits)</div>	<div>111 Difference (32 bits)</div>
Bit length of compressed code	9	18	27	35
Probability of occurrence	70 %	25 %	4 %	1 %

When the distribution of differences from the preceding measurement value is as indicated by the “probability of occurrence” in the table above, the expected value of the bit length of the compressed code for the second and subsequent measurement values is D bits per measurement value.

Answer group:

- | | | |
|----------|----------|-----------|
| a) 9.0 | b) 12.23 | c) 15.575 |
| d) 22.25 | e) 32.0 | |

10.2

Selected Questions (Information Security)**Q10-9** □□□

Read the following description concerning packet filtering, and then answer Subquestions 1 and 2.

Company *X* has built a network shown in the figure, and uses it to publish its Web site to the Internet and to exchange e-mails.

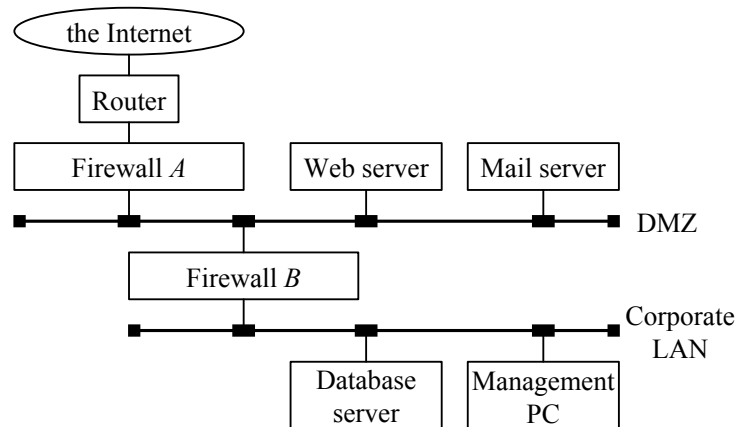


Fig. Network configuration at Company X

Company *X*'s network is divided by 2 firewalls into 2 segments: DMZ and corporate LAN. Web server, Mail server, and Database server (hereinafter referred to as DB server) play the following roles:

(1) Web server

As a Web site, Web server publishes information about the company to the Internet. On Web server, a program for processing transactions with external entities is running. Data used by this program is stored on DB server.

(2) Mail server

Mail server sends and receives e-mails to and from external entities. In addition, it runs a program that automatically distributes e-mails to business partners. The data for distributing e-mails is stored on DB server.

(3) DB server

DB server maintains the data used by Web server and Mail server.

From the management PC connected to the corporate LAN, it is possible to login to each server using SSH, and send and receive e-mails to and from external entities via Mail server. Although it is possible to access the corporate Web server from the management PC, access to external Web sites is not permitted.

Table 1 shows the protocols and port numbers used in the network.

Table 1 Protocols and port numbers

Service	Protocol	Port number
Web	HTTP	80
Mail transfer	SMTP	25
Secure shell (remote login)	SSH	22
Mail reception	POP3	110
DB access	Specific to DB	1999

Subquestion 1

From the answer groups below, select the correct answer to be inserted into each blank in the following description. If needed, select the same answer more than once.

Table 2 shows the packet filtering settings for firewall *A*, which connects the Internet and the DMZ. Table 3 shows the packet filtering settings for firewall *B*, which connects the DMZ and the corporate LAN.

Each filtering rule allows or denies communication by specifying the source IP address, destination IP address, and destination port number. Each rule is examined beginning from the top, and the action of the first row whose condition is met is performed. Here, no settings are required for response packets since they are automatically allowed by the dynamic filtering function.

Table 2 Filtering settings for firewall *A*

Condition			Action
Source	Destination	Port number	
Any	Web server	80	Allow
Any	Mail server	25	Allow
<input type="text"/> A	Any	<input type="text"/> B	Allow
Any	Any	Any	Deny

Table 3 Filtering settings for firewall B

Condition			Action
Source	Destination	Port number	
Web server	DB server	1999	Allow
Mail server	DB server	1999	Allow
Management PC	<div>C</div>	<div>D</div>	Allow
Management PC	Mail server	22	Allow
Management PC	Mail server	25	Allow
Management PC	Web server	80	Allow
Management PC	Web server	22	Allow
Any	Any	Any	Deny

Answer group for A and C

- a) DB server b) Web server c) Management PC
 d) Mail server e) Any

Answer group for B and D

- a) 22 b) 25 c) 80 d) 110 e) 1999

Subquestion 2

In Company X's network, security risks associated with Internet connections are reduced through packet filtering by firewalls, but packet filtering cannot protect the network from all threats. From the answer group below, select the correct answer for the security risks that can be prevented with packet filtering.

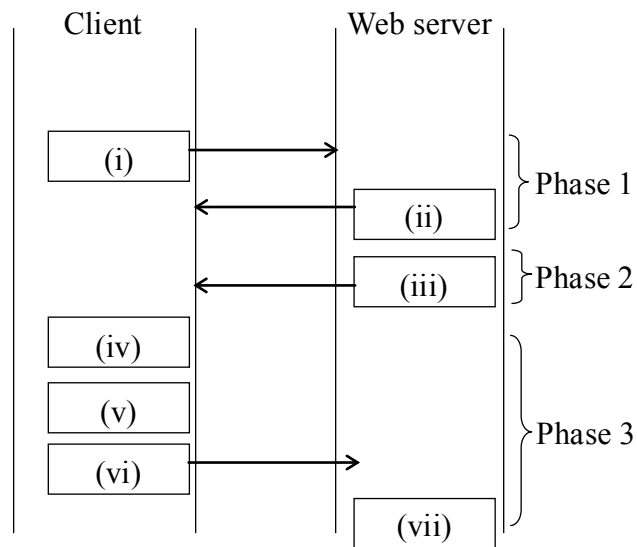
Answer group

- a) Wiretapping and falsification of data exchanged with the Web site
 b) SQL injection attacks on the Web site
 c) Connection attempts from the Internet to servers within the DMZ via unauthorized ports
 d) Attacks by unauthorized access from the Internet to the corporate LAN
 e) Leakage of files from the company via e-mail

Q10-10 □□□

Read the following description concerning a server certificate, and then answer Subquestions 1 and 2.

The figure below shows an overview of the exchange between the client and the server until the actual encryption communication based on SSL (Secure Sockets Layer) communication starts:



The encryption communication starts from here.

Fig. Exchange between the client and server until the start of encryption communication

[Overview of processing]

(1) Phase 1

- (i) The client provides the list of encryption algorithms that the client supports and the list of compression methods to the server.
- (ii) Based on the provided algorithm, the server selects the strongest encryption algorithm it possesses, and notifies the client of it.

(2) Phase 2

- (iii) The entire certificate chain up to the digital certificate of the server (hereinafter, simply the server certificate), and the certificate by A is sent to the client (however, this does not include cases where a certificate does not exist).

(3) Phase 3

- (iv) The appropriateness of the server certificate is checked.
- (v) The of the server is extracted from the server certificate.
- (vi) The of the server is used to encrypt the value that acts as the basis of the used for communication, and is then sent to the server.
- (vii) The server encrypts the received encryption data with its own private key, and safely acquires the premaster secret.

[Verification of the certificate]

The client and the server generate a common key from the premaster secret, and start encryption communication (SSL) with this key. The certificate sent from the server in (iii) is the server certificate issued officially by applying to the certificate authority, and is duly signed by the certificate authority. The signature of the certificate authority indicates that the of the content of the certificate is encrypted by the private key of the certificate authority. Additionally, along with the server certificate, the certificate of the certificate authority is also sent to the client. If the certificate authority that has signed the server certificate is an intermediate certificate authority that has been certified by another certificate authority, the certificate authority also appends the certificate of the higher-level certificate authority from whom it has received the attestation. In this way, finally, the certificate of the is always sent. The browsers and PCs that are used come installed with several certificates from root certificate authorities (hereinafter, root certificates) from the beginning. In (iv), the client ensures that the already installed certificate and the received root certificate are matching, which enables it to check the appropriateness of the received root certificate. After this, it uses the public key in the root certificate to check the lower-level certificate authority that had received the signature of the root certificate authority, or the appropriateness of the server certificate. By repeating this operation, all received certificates are verified.

Subquestion 1

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

in the question.

Answer group for A and D:

- a) MD5
- b) hash value
- c) certificate authority
- d) root certificate authority

Answer group for B and C:

- a) common key
- b) public key
- c) certificate
- d) private key

Subquestion 2

From the answer group below, select two (2) correct answers concerning authentication and cryptography used in SSL, and then enter them in the answer columns E and F.

Answer group:

- a) In SSL-based communication, both public key cryptography and common key cryptography are used.
- b) Common key cryptography is used for checking the appropriateness of the server certificate.
- c) The server certificate is encrypted by the public key of the certificate authority.
- d) Common key cryptography is used for encryption communication after the appropriateness of the server has been confirmed.

10.3

Multiple-choice Questions (Software design)**Q10-11** □□□

Read the following description of program design, and then answer Subquestions 1 through 3.

This is an update program that updates the contents of a master file containing member information with the contents of a transaction file and outputs them to a new master file, at the end of every month.

[File Description]

- (1) Both the master file and the transaction file use the same record format that consists of the following items.

Member number	Name	Email address	Service rank
---------------	------	---------------	--------------

- (2) The member number is a 5-digit number, and is a required item. There is no member with the maximum member number value of 99999.
- (3) Both the master file and the transaction file are sorted in ascending order using the member number as the key.
- (4) Neither the master file nor the transaction file has multiple records with the same member number.
- (5) The transaction file consists of records used to add new members and records used to change member information of already registered members.
- (6) The records used to change member information contain non-blank data in items to be changed, and blank data in items that are not to be changed.

[Process Description]

The following key matching process is performed with the master file records as M and the transaction file records as T.

- (1) When there is a T with the same member number as in M, update items in M corresponding to items in T with non-blank data, but do not update items in M corresponding to items in T with blank data, and output the record to a new master file.
- (2) When there is no T with the same member number as in M, that M is output to the new master file as is.
- (3) When there is no M with the same member number as in T, that T is output to the new master file.

Fig. 1 shows the flow of update program.

The matching keys K_M and K_T hold, respectively, the member number value in M and the member number value in T, or the maximum value 99999 indicating that the corresponding file has been completely read.

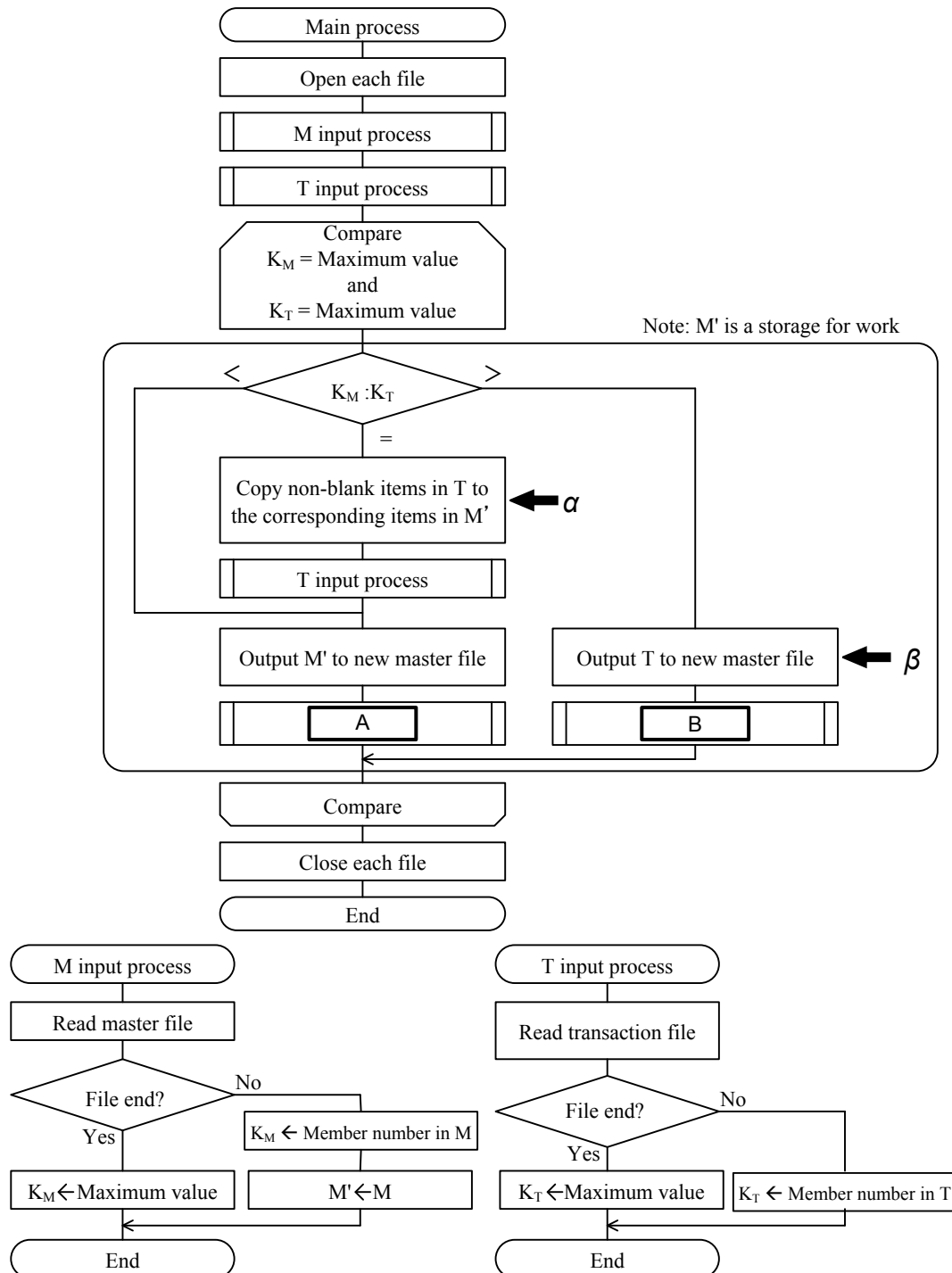


Fig. 1 Flow of update program

Subquestion 1

In Fig. 1, the master file update process using key matching is realized by the portion enclosed by the dotted line.

From the answer group below, select the correct answers to insert in the blanks in Fig. 1.

Answer group:

- a) M' input process b) M input process c) T input process

Subquestion 2

From the answer groups below, select the correct answers to insert in the blanks in the following description.

The following changes (1) to (5) will be made to add a process for member information deletion to this update program

- (1) Add a new item named "Type of transaction" to the transaction file record format.
- (2) Type of transaction "U" indicates new registration or change, and type of transaction "D" indicates deletion.
- (3) Change the processes α and β in Fig. 1 to support the record format change in step (1).
- (4) Change the main process as shown in Fig. 2.
- (5) Add a process to set type of transaction to "U" when the file has been completely read in the T input process.

Here, the error processes 1 and 2 in Fig. 2 display information related to error records. The condition X2 is C , and error process 2 is executed when D .

Answer group for C:

- a) Type of transaction = "D"
- b) Type of transaction = "U"
- c) Type of transaction \neq "D"
- d) Type of transaction \neq "U"
- e) (Type of transaction \neq "D") AND (Type of transaction \neq "U")
- f) (Type of transaction \neq "D") OR (Type of transaction \neq "U")

Answer group for D:

- a) Type of transaction is incorrect
- b) The master file does not contain a record with the member number to be deleted
- c) The master file already contains a record with the member number to be newly registered
- d) The master file does not contain a record with the member number to be changed

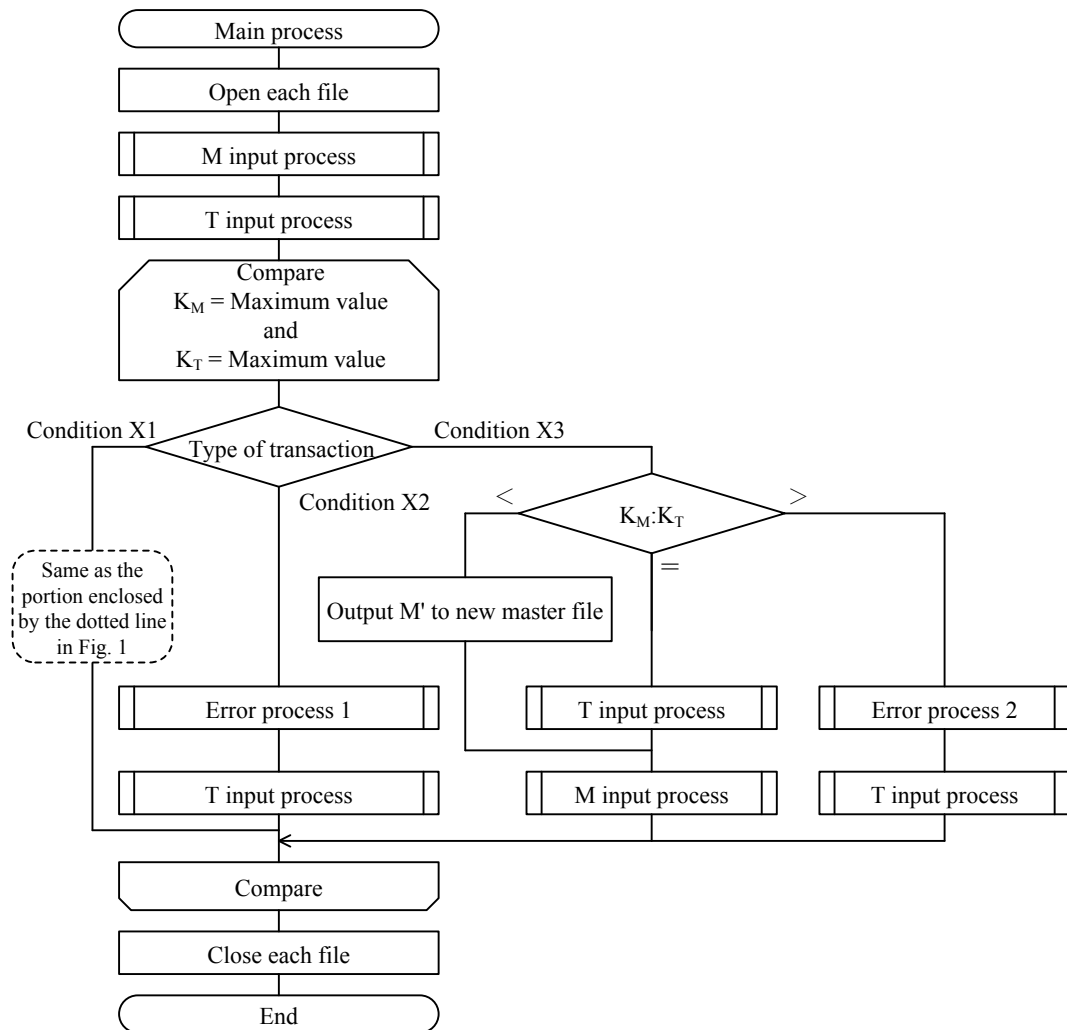


Fig. 2 Flow of update program after change

Subquestion 3

From the answer groups below, select the correct answers to insert in the blanks in the following description.

Change the specification to allow multiple records with the same member number in the transaction file. When multiple records exist, these are processed in order of occurrence of records. To achieve this, the following changes (1) and (2) will be made.

- (1) Add a new item named “Date and time occurred” to the transaction file record format.
- (2) Add a sort program and a record aggregation program to the transaction file process to generate a new transaction file separately from the update program shown in Fig. 2.

The sort program rearranges the records in ascending order of sorting keys. Here, the first sorting key is E and the second sorting key is F .

The record aggregation program has two main functions as follows.

- (i) When type of transaction of all input records with the same member number are “U”, overwrite the contents of change items with non-blank data to work area, and output the final status.
- (ii) When a record with type of transaction “D” is found, output that record. When a record with that same member number is found thereafter, it is not processed and is identified as an error.

The execution order for these programs is as follows.

Execution order: G

Answer group for E and F:

- | | |
|------------------|---------------------------|
| a) Member number | b) Type of transaction |
| c) Service rank | d) Date and time occurred |

Answer group for G:

- a) Update program → Sort program → Record aggregation program
- b) Update program → Record aggregation program → Sort program
- c) Sort program → Update program → Record aggregation program
- d) Sort program → Record aggregation program → Update program
- e) Record aggregation program → Update program → Sort program
- f) Record aggregation program → Sort program → Update program

Q10-12 □□□

Read the following description concerning program design, and then answer the Subquestions 1 through 3.

Company C offers a music download system (hereinafter called the system) where members can download digital music.

[Description of the system]

- (1) The information of each piece of music is stored in a music management file using a music number as a key. The music number is a unique number assigned to each music data. The record format of the music management file is shown in Fig. 1.

<u>Music number</u>	Music name	Artist name	Playing time	Production company	Genre	Size of the music data	Storing location of the music data
---------------------	------------	-------------	--------------	--------------------	-------	------------------------	------------------------------------

Note: An underlined part indicates a key item.

Fig. 1 The record format of the music management file

- (2) The information of each member is stored in a member file using a member number as a key. The member number is assigned uniquely to each member. The member file stores the encrypted passwords, names, and admission dates as well as member numbers. The record format of the member file is shown in Fig. 2.

<u>Member number</u>	Encrypted password	Name	Admission date
----------------------	--------------------	------	----------------

Note: An underlined part indicates a key item.

Fig. 2 The record format of the member file

- (3) The members must enter their member numbers and passwords to login to the system.

- (4) The system searches the member file using the member number entered at (3) as a key. It extracts the encrypted password in the record whose member number is matched. When both the encrypted password and the entered password that is encrypted match with each other, login is allowed, and the music search screen opens. When they are not matched, the login refusal message is displayed, and the process is finished.
- (5) The music search screen displays the items from Music name to Genre (hereinafter called search items) in the music management file. A member who is logged in specifies search conditions by entering search words for one or more search items. When multiple search conditions are specified, all the conditions entered are joined with AND for search. When searching is unnecessary, the member selects “Logout”.
- (6) The system searches the music management file using the search words entered in (5). It extracts all the records that match the conditions and displays the music numbers, the music names, and the artist names on the music selection screen. When no record matches the conditions, it displays a message on the music search screen as a notification.
- (7) As soon as the member selects one music name on the music selection screen displayed in (6), downloading the music is started. When the member selects “New search”, the screen returns to the music search screen.
- (8) When the download is completed, the download date and time are stored in a download result file. The system displays the download completion message and returns to (5). The record format of the download result file is shown in Fig. 3.

<u>Member number</u>	<u>Download date</u>	<u>Download time</u>	Music number
----------------------	----------------------	----------------------	--------------

Note: Underlined parts indicate key items.

Fig. 3 The record format of the download result file

- (9) The screen transition and the module structure of the system are shown in Fig. 4 and Fig. 5, respectively.

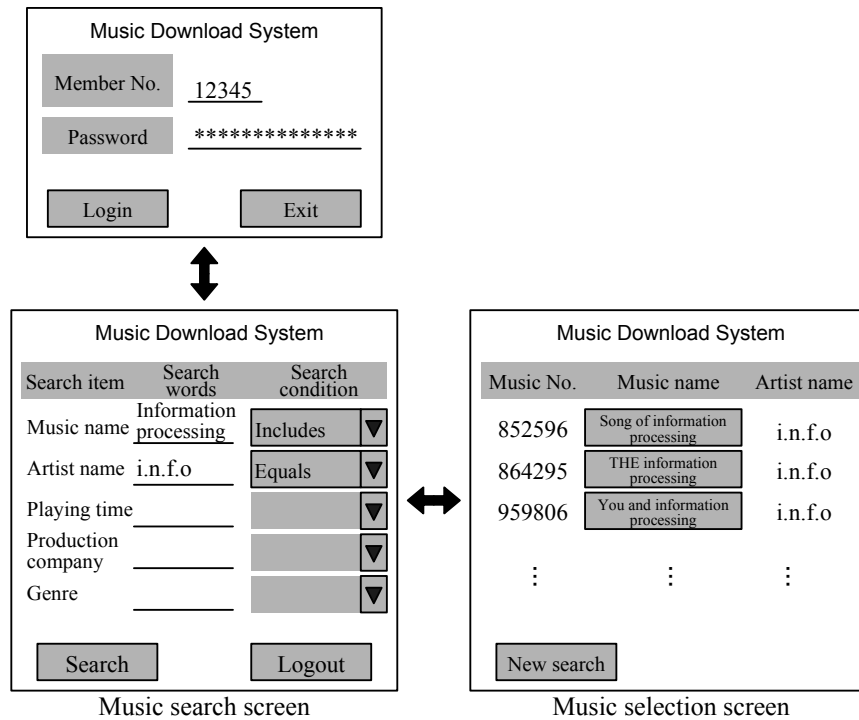


Fig. 4 Screen transition of the system

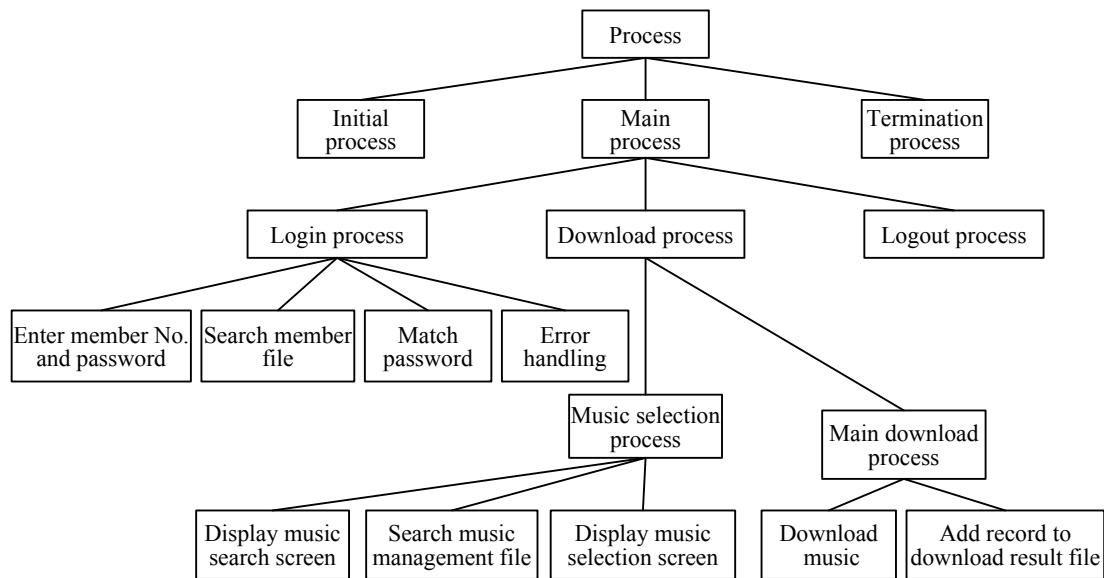


Fig. 5 Module structure of the system

Subquestion 1

A new function is designed to limit the number of music that a member can download in one day up to the allowable number specified by the system. From the answer groups below, select the correct answers to be inserted in the blanks in the following description of the procedure for obtaining the download count on that day by a member who logged in.

The current date is obtained from the system. Then, A of the logged in member and the current date are used as keys to search the download result file for counting the number of records. If the date has changed until downloading since logged in, the download count must be obtained for the new date. Therefore, the module to obtain the download count must be performed just before the B module.

Answer group for A:

- | | | |
|------------------|---------------------------|-----------------|
| a) Member number | b) Size of the music data | c) Music number |
| d) Download date | e) Admission date | f) Password |

Answer group for B:

- | | |
|--------------------------------|-----------------------------------|
| a) Search member file | b) Search music management file |
| c) Display music search screen | d) Display music selection screen |
| e) Download music | |

Subquestion 2

A new function is designed to add the last download date for music that the member has already downloaded to the items displayed on the music selection screen. From the answer groups below, select the correct answers to be inserted in each blank in the following description.

The music management file is searched using the search words entered by the member to extract all the records that match the conditions. Whether the music numbers of the extracted records are those of the music that the member has already downloaded can be checked by searching the download result file with C . In search of download results by the member, the number of corresponding records in the download result file is D per one record extracted from the music management file.

Answer group for C:

- a) Member number
- b) Member number and Music number
- c) Member number, Music number and Download date
- d) Member number and Download date
- e) Music number
- f) Music number and Download date
- g) Download date

Answer group for D:

- | | | |
|------|--------------|-----------|
| a) 0 | b) 0 or more | c) 0 or 1 |
| d) 1 | e) 2 or more | |

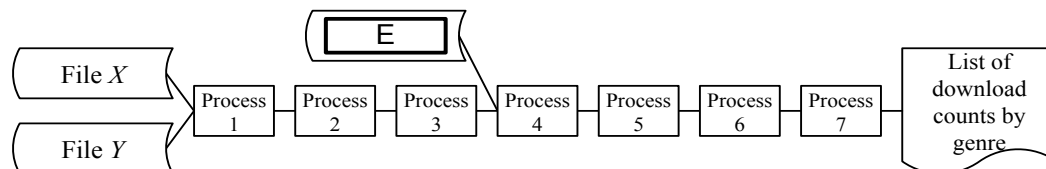
Subquestion 3

A new list, which displays download counts by genre for the downloads done by all members during their first week after they have admitted, is designed in order to grasp the download status of members just after admission. Fig. 6 shows an example of the list of download counts by genre. Fig. 7 shows the flow for creating the list of download counts by genre, and the table shows the description of each process. From the answer groups below, select the correct answers to be inserted in the blanks in the table.

As shown in Fig.6, the list of download counts by genre displays the download counts and the number of downloaded music by genre.

List of download counts by genre		
2008-10-19		
Genre	Download count	No. of music
Classical	23,456	54
Jazz	4,012	130
Pops	123,456	434
Country	34,567	120
Folk song	7,410	87
⋮	⋮	⋮

Fig. 6 Example of the list of download counts by genre



Note: Each of files X and Y represents one of three files; the music management file, member file, and download result file.

Intermediate files created during the processes are omitted.

Fig. 7 Flow for creating the list of download counts by genre

Q10-13 □□□

Read the following description concerning the business system of a distribution center (warehouse), and then answer Subquestions 1 through 3.

In Company *A*, goods are directly delivered to customers, in addition to the head office, from 3 distribution centers (warehouses) spread across the country. Each distribution center has 3 to 10 delivery staff members. Company *A* is facing a problem with complaints from customers about significant delays in deliveries. As a result of organizing and analyzing the business operations, it comes to light that in the slip-based delivery process; there are areas that are prone to errors. Therefore, Company *A* decided to automate the conventional paper based processing of slips for receiving and dispatch operations.

[Details of current operations]

(1) Consignment

Consignment refers to an actual individual package, and every consignment has good codes indicating the type of goods. Furthermore, every consignment is linked to a consignee and destination address by the mission-critical system installed in the head office, and these details are printed on a delivery slip.

(2) Receipt of consignments in a warehouse

Consignments are loaded onto large trucks, and are transported to the relevant distribution centers. At this time, delivery slips for the relevant consignments are handed over by the driver to the delivery staff in the distribution center. After that, the delivery staff stores the respective consignments on racks inside the distribution center, and delivery slips are stored in the delivery slip box of the corresponding rack number.

(3) Retrieval and dispatch of consignments

When a small truck that is delivering packages to customers arrives, a delivery staff member picks up delivery slips for consignments in the truck's area from the delivery slip box. Based on the delivery slips, the relevant goods are loaded onto the truck and the slips are handed over to the driver of the small truck. After that, the delivery slips and consignments are delivered to the relevant customers.

[New system]

Based on an analysis of the current situation, it comes to light that a problem lies in the manual search of delivery slips at the time of retrieval and dispatch of consignments. In order to improve this, the decision is made to perform online management of the slips handled by the distribution centers. The changes described below are incorporated during the implementation of the new system.

(1) Facilities at distribution centers

A warehouse management server and handheld terminals are installed in the distribution centers. The handheld terminals are equipped with a bar code reader, and delivery staff can move around with these terminals by attaching them to their belt.

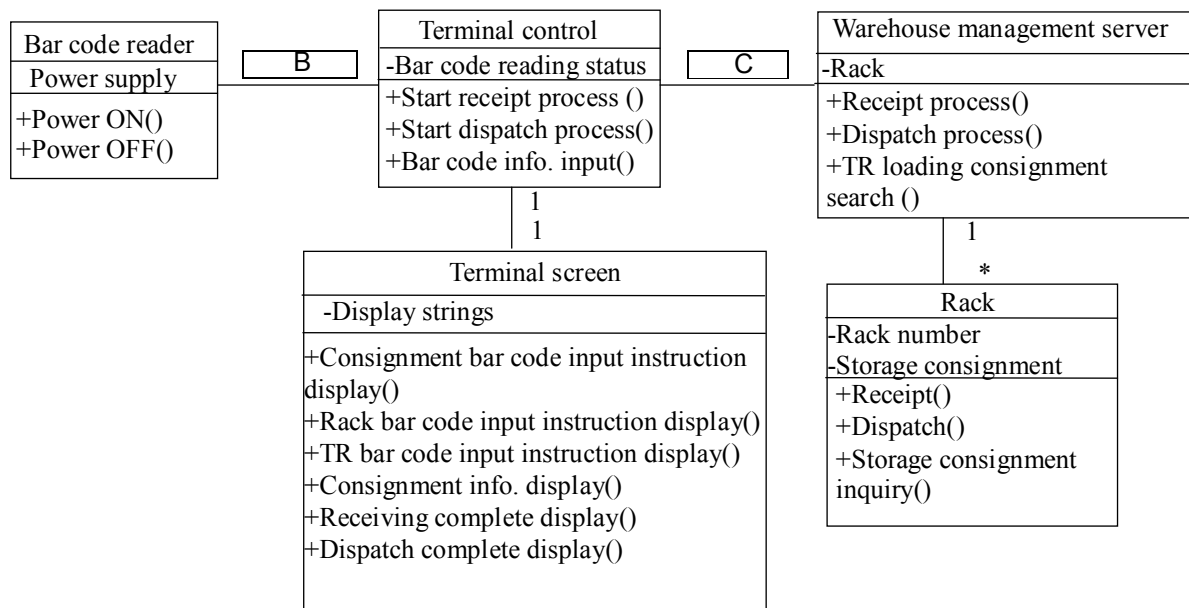
(2) Receipt of consignments in warehouse

Once delivery slips are handed over by driver to the delivery staff of the distribution center, a delivery staff member starts the process of receiving consignments in the warehouse with handheld terminals. First, a bar code reader reads the bar codes that are printed on slips and that indicate consignment codes. Next, bar codes that are affixed to the storage racks and that indicate the rack number are read. Because the coding system for codes indicating consignment goods and the coding system for codes indicating rack number are different, reading these codes in the incorrect sequence results in error. Furthermore, the information concerning rack numbers where consignments are stored is managed by the system installed at distribution centers in order to minimize the addition of functions to the mission-critical system.

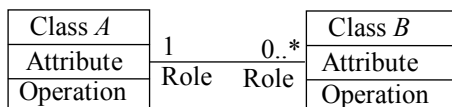
(3) Retrieval and dispatch of consignments

When a small truck delivering packages to customers arrives, the bar code reader on the handheld terminal of the delivery staff reads the TR bar code (indicating the truck number) carried by the truck driver. Consignments to be loaded onto the corresponding truck are managed by the mission-critical system. The warehouse management system creates the list of consignments using the truck number as a key and displays this list on the handheld terminals of the delivery staff. The decision is also made to use the mission-critical system to manage information about which truck is to be used for loading the consignments. After that, the delivery staff reads the bar code of consignments to be loaded and completes the retrieval and dispatch process. Since it is expected that multiple consignments will be loaded, bar code input is allowed multiple times. Upon the completion of the loading process with the handheld terminals, the bar code input of consignments to be retrieved and dispatched is completed.

Based on these system requirements, a class diagram for the new system was created and cardinality between classes was defined.



(Legend)



- * A rectangular box indicates a class. A line connecting two classes indicates a relation between those classes.
- * Cardinality between classes is shown above or on the left side of a direct line. In this legend, it indicates that 1 object of class A is related to 0 or more objects of class B.
- * Near each class, the role is written on the opposite side of cardinality.

Fig. 1 Class diagram

Creation of a class diagram allows the methods of the relevant class to be designed. Therefore, based on the precondition of using the methods defined in class diagram, a sequence diagram for the process of receiving consignments in a warehouse is prepared.

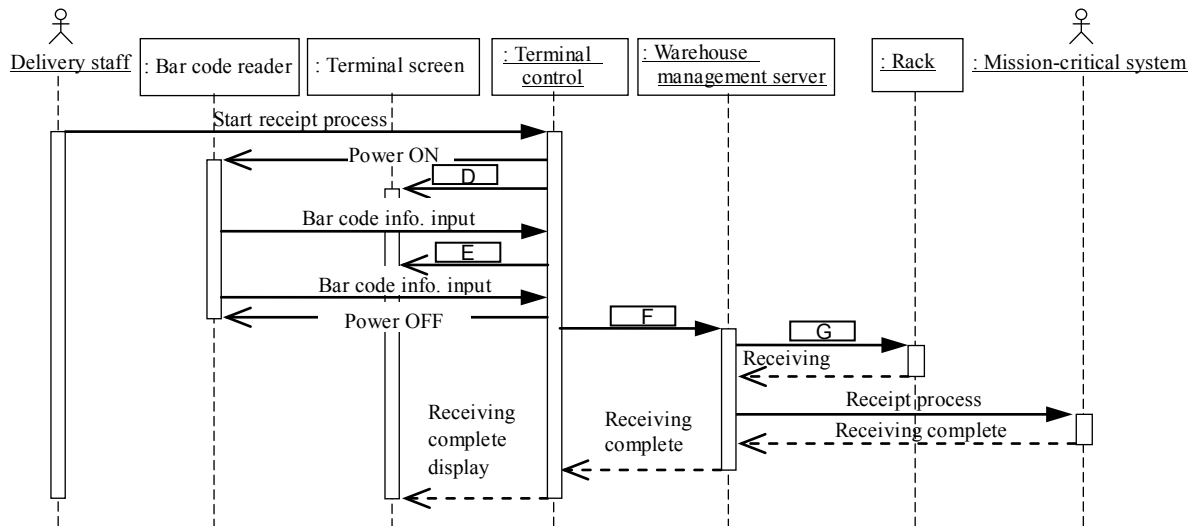


Fig. 2 Sequence diagram of the receiving process

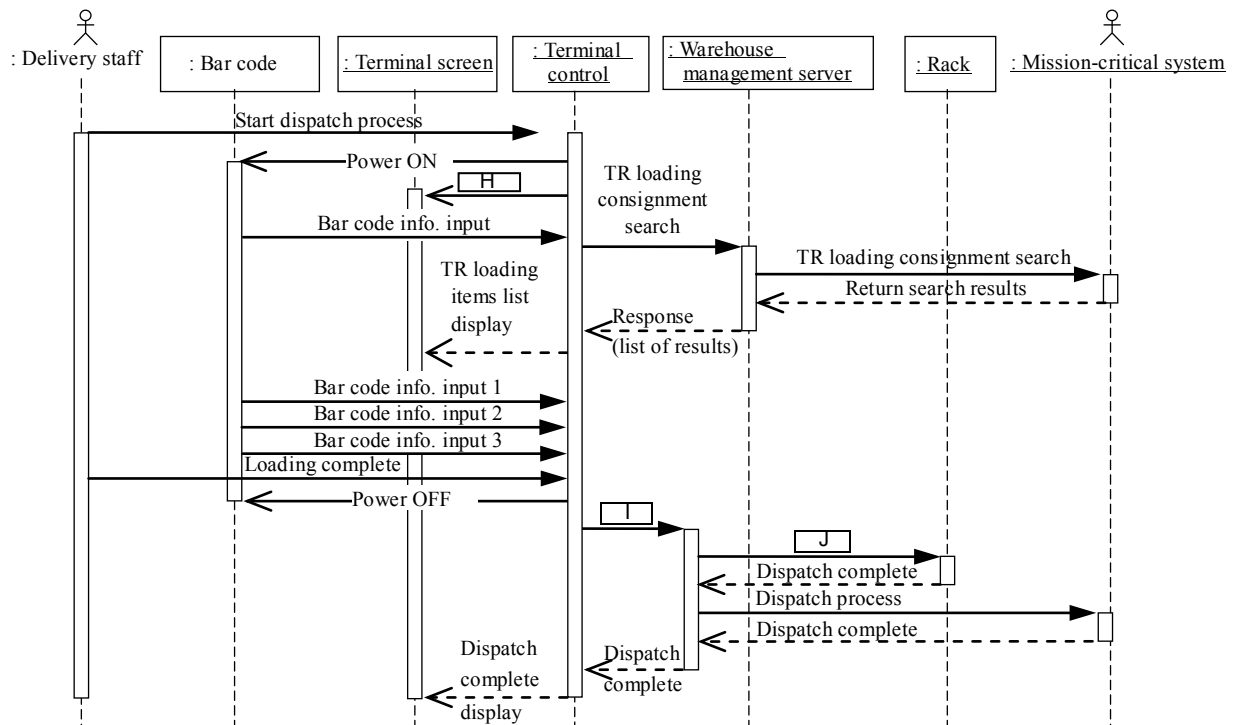


Fig. 3 Sequence diagram of the dispatch process

Subquestion 1

From the answer group below, select the appropriate description which states the root cause of the problem in the current operations.

Answer group:

- a) The names and addresses of customers are linked in the mission-critical system.
- b) Delivery slips are handed over manually by the delivery staff to the truck driver at the time of retrieval and dispatch of consignments.
- c) Delivery slips are searched for manually at the time of retrieval and dispatch of consignments.
- d) Delivery slips are handed over manually by the truck driver to the delivery staff at the time of receipt of consignments at the warehouse.

Subquestion 2

From the answer group below, select the appropriate cardinality description to be inserted in each blank in the class diagram of Fig. 1.

Answer group:

- a) * *
- b) * 1
- c) 1 *
- d) 1 1

Subquestion 3

From the answer group below, select the appropriate terms and phrases to be inserted in each blank in the sequence diagrams of Fig. 2 and Fig. 3.

Answer group:

- a) TR loading consignment search
- b) TR bar code input instruction display
- c) Dispatch
- d) Dispatch process
- e) Rack bar code input instruction display
- f) Receipt
- g) Receipt process
- h) Consignment bar code input instruction display

10.4

Multiple Choice Questions (Management)**Q10-14** □□□

Read the following description of risk management in a project, and then answer Subquestions 1 through 4.

Company *E* is a medium-sized software development company. Company *E* receives an inquiry about the development of a sales management system from Company *L*, a company that manufactures everyday products, and then Company *L* places an order. Company *E* appoints Mr. *O* as the project manager for this system development.

The schedule for the project is as shown below:

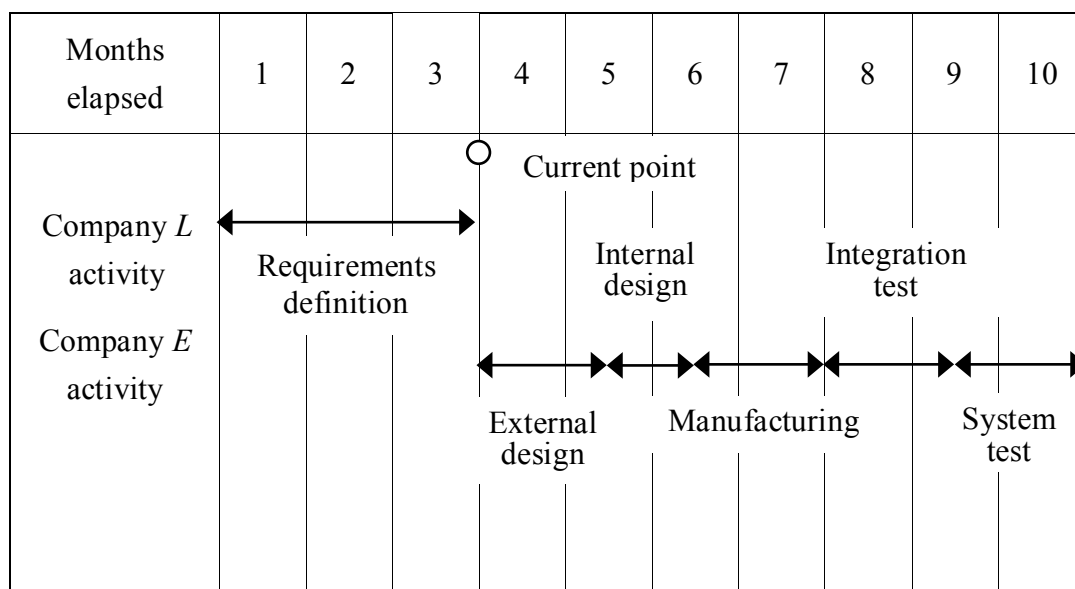


Fig. 1 Schedule

[Creation of procedure for risk management]

In order to start this project, Mr. *O* develops the procedure for risk management shown below.

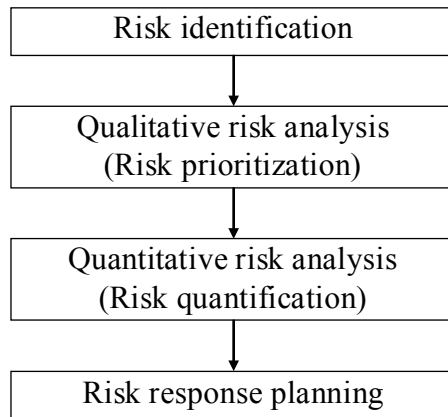


Fig. 2 Risk management procedure for the project in Company *E*

(1) Risk identification

Identify risks that exist in the project.

(2) Qualitative risk analysis

For each risk that is identified, calculate a risk value with the formula below and prioritize the risks.

$$\text{Risk value} = \boxed{A} \times \text{impact}$$

Here, risks are divided into risks that require measures and risks (i) that require no special measures.

(3) Quantitative risk analysis

Quantitatively evaluate and analyze identified risks that have an effect on the overall goal of the project.

(4) Risk response planning

For risks that require action, create a response plan that specifically states what kind of action is to be taken by when.

[Preconditions for the development of the sales management system]

For development of the sales management system, Mr. *O* sorts the preconditions for the project and compiles these preconditions as below:

- (1) For the phases after external design, Company *E* is to undertake work with a service contract.
- (2) Through the requirements definition performed by Company *L*, the data items are already fixed and identification of the necessary screens and forms is complete. However, the business priority of these things is not clear, and for some screens and forms it is not yet decided if they will be included in the development scope.
- (3) An estimate is complete for the scope that is currently set. Based on this estimate, Company *E* and Company *L* will reach an agreement concerning the cost and schedule.
- (4) Company *E* is to outsource some activities to its partner company, Company *I*.

[Risk identification]

At the start of the project, Mr. *O* decides to identify risks, and he discovers factors that may potentially lead to the risks below:

- (1) There is a high possibility that the number of screens and forms in the development scope will increase beyond that in the estimate.
- (2) In order to perform external design and a review of it, an understanding of Company *L*'s business is required. However, there is currently no one in Company *E*'s staff who sufficiently understands Company *L*'s business. No one in the staff of Company *I* sufficiently understands Company *L*'s business either.
- (3) In order to ensure simplicity in future changes, Company *L* would like to use SOA (Service Oriented Architecture). However, Company *E* does not have any know-how or experience concerning SOA.

Based on this situation, Mr. *O* considers that if risk response is not implemented urgently then this project will probably not succeed. Furthermore, as well as the identified risks, there are also concerns that new risks will appear as the project progresses. As such, Mr. *O* decides to consider D, a countermeasure for when a risk actually materializes.

Subquestion 1

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

A

in the description.

Answer group:

- a) Weighted average
- b) Mode value
- c) Probability of occurrence
- d) Standard deviation

Subquestion 2

From the answer group below, select the correct answer corresponding to underlined section (i).

Answer group:

- a) Risk transfer
- b) Risk avoidance
- c) Risk reduction
- d) Risk acceptance

Subquestion 3

Mr. O creates a plan for risk response. The table below is an excerpt from this plan.

Table Plan for risk response

Risk	Risk response
After the conclusion of the contract, the number of screens and forms that are included in the development scope increases.	<p>-(ii) <u>Before the conclusion of the contract, negotiate to finalize the number of screens and forms.</u></p> <p>-If the above is not achieved,</p> <p>B</p>
There are no members of staff who sufficiently understand the business of Company L.	<p>- C</p> <p>-Implement training concerning Company L's business.</p>
No know-how or experience concerning SOA.	<p>-(iii) <u>Secure staff familiar with SOA.</u></p>

- (1) From the answer group below, select the correct answer corresponding to underlined section (ii) in the Table.

Answer group:

- a) Risk transfer
- b) Risk avoidance
- c) Risk reduction
- d) Risk acceptance

(2) From the answer groups below, select the correct answer to be inserted in each blank in the Table.

Answer group for B:

- a) perform requirements definition again from the beginning on Company *E*'s own initiative.
- b) decide the specifications for screens and forms with prototyping with the cooperation of Company *L*'s end users.
- c) go ahead with the project within the development scope without an agreement.
- d) decide the maximum number of screens and forms as well as the deadline for the finalization of the specifications in advance. If the number of screens and forms exceeds the maximum, create a new estimate.

Answer group for C:

- a) Get support from representatives of Company *L*.
- b) Perform external design as far as possible even though Company *L*'s business is not understood.
- c) If a problem with the contract occurs, ensure that an escalation to superior managers at Company *L* is possible.
- d) Increase the number of staff members.

(3) If the risk response in the underlined section (iii) is adopted, a problem may occur where the cost of securing staff exceeds the assumed cost. From the answer group below, select the correct answer that represents this.

Answer group:

- a) Occurrence of secondary risks
- b) Identification of unknown risks
- c) Indication of the occurrence of a risk
- d) Materialization of risks

Subquestion 4

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

D

in the description.

Answer group:

- a) circumvention measures
- b) a contingency plan
- c) a business continuation plan
- d) a risk assessment

Q10-15 □□□

Read the following description of system development planning, and then answer Subquestions 1 and 2.

Company *X* is building a new business system. This business system requires new hardware installation and software development. In the software development, programs that are commonly used in multiple application programs (hereinafter “shared components”) will be developed separately from the main application programs by another team. Development tasks and the required number of days are shown in the table.

Table Tasks and required number of days

Task ID	Details	Number of Days
S1	System architectural design	6
G1	Definition of shared components of application programs	2
G2	Function design of application programs	4
G3	Detailed design of application programs	6
G4	Coding and unit testing for application programs	6
C1	Design of shared components (interface determination)	6
C2	Coding and unit testing for shared components	4
H1	Hardware procurement	15
H2	Building the hardware environment	6
S2	Integration test	6
S3	Production test	4

To plan the schedule for these tasks, the arrow diagram shown in the figure is created. The dotted line in the figure represents dummy work.

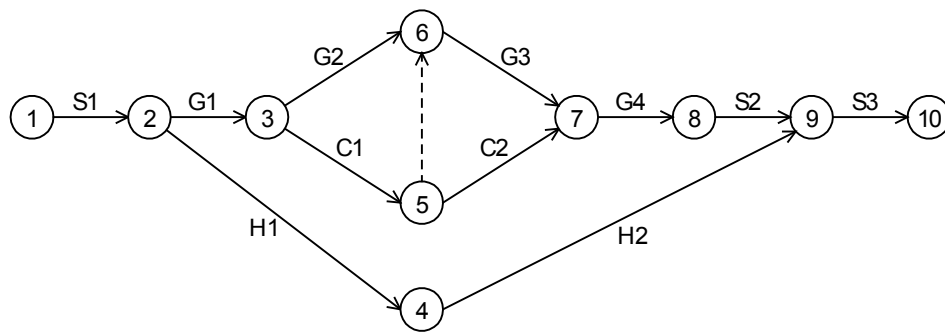


Fig. Arrow diagram for scheduling

Subquestion 1

Following the arrow diagram for task scheduling, select two answers from the answer group that correctly describe the relationship of dependency of tasks.

Answer group:

- Detailed design of application programs (G3) cannot be started until coding and unit testing for shared components (C2) is finished.
- Coding and unit testing for application programs (G4) cannot be started until coding and unit testing for shared components (C2) is finished.
- Detailed design of application programs (G3) can be started when function design of application programs (G2) is finished.
- Coding and unit testing for shared components (C2) can be started even without real computing environment, but coding and unit testing for application programs (G4) cannot be started without real computing environment.
- Hardware procurement (H1) is conducted after system architectural design (S1) is finished.

Subquestion 2

From the answer groups below, select the correct answers to insert in the blanks in the following description.

In this business system development, the critical path is A, and the least number of days required is B. Additionally, the overall development period can be shortened by shortening C.

Answer group for A:

- a) (1) → (2) → (3) → (5) → (6) → (7) → (8) → (9) → (10)
- b) (1) → (2) → (3) → (5) → (7) → (8) → (9) → (10)
- c) (1) → (2) → (3) → (6) → (7) → (8) → (9) → (10)
- d) (1) → (2) → (4) → (9) → (10)

Answer group for B:

- | | | |
|-------|-------|-------|
| a) 31 | b) 32 | c) 33 |
| d) 34 | e) 35 | f) 36 |

Answer group for C:

- a) Design of shared components (C1)
- b) Coding and unit testing for shared components (C2)
- c) Function design of application programs (G2)
- d) Hardware procurement (H1)

Q10-16 □□□

Read the following description concerning fault management in a project, and then answer Subquestions 1 and 2.

Company *A*, a consumer credit company, performs data entry for membership applications with an internal data entry staff of 100. To each member of the data entry staff, one PC for data entry is assigned. Each PC for data entry is connected to a business server via an internal LAN. If the business server stops, the PCs for data entry cannot be used.

The system configuration of the data entry system is shown in the figure.

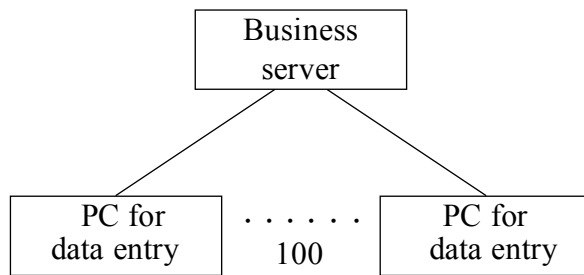


Fig. System configuration diagram

Recently, a backlog of data entry due to hardware faults is causing problems. As such, Company *A*'s operation manager, Mr. *T*, decides to review the data entry system.

[Investigation into the situation of fault occurrences]

Mr. *T* decides to evaluate the hardware fault situation in the data entry system. As a reference for the evaluation, Mr. *T* converts the stoppage time of data entry into a lost cash amount. Based on previous records, it is understood that if work on one PC for data entry stops for one hour then the lost cash amount is 10,000 yen. Based on the results of last year, the amount of stoppage time and lost cash amount that can be assumed over the course of a year is compiled in Table 1.

Table 1 Amount of stoppage time and lost cash amount that can be assumed over the course of a year

Hardware device	Number of failures (times/year)	Stoppage time (hours) for one fault	Extended stoppage time (hours) for PCs for data entry	Lost cash amount (k yen)
PC for data entry	10	10	100	1,000
Business server	2	4	A	B

[Proposals for countermeasures and evaluation of proposals]

As failure measures, Mr. *T* investigates the following two proposals for countermeasures.

Table 2 Proposals for countermeasures

Name of proposal for countermeasure	Details of countermeasure
Proposal <i>A</i> (countermeasures for PCs for data entry)	Install spare PCs for data entry at a ratio of 1 for every 20 PCs. With this countermeasure, stoppage time will be eliminated. The cost of the countermeasure is 20,000 yen per month for each spare PC. A switch to a spare PC will be performed by moving to different seat, but the cost of this can be ignored here because this takes only a relatively short period of time.
Proposal <i>B</i> (countermeasures for the business server)	Purchase one spare business server and create a redundant configuration. If a failure occurs with the business server, processing is continued on the spare business server. However, the switch to the spare business server will take 1 hour and during that time business will be stopped. For this countermeasure, a cost of 2,000,000 yen is required annually.

Next, Mr. *T* compiles the lost cash amount that can be avoided with the two proposals and the cost of countermeasures in Table 3.

Table 3 Lost cash amount that can be avoided and the cost of countermeasures

Proposal for countermeasure	Avoidable extended stoppage time (hours) for PCs for data entry	Avoidable lost cash amount (k yen)	Annual cost of countermeasures (k yen)
Proposal <i>A</i>	100	1,000	C
Proposal <i>B</i>	D	E	2,000

Subquestion 1

From the answer group below, select the correct answer to be inserted in each blank in the description below concerning the amount of stoppage time and lost cash amount that can be assumed over the course of a year shown in Table 1. Here, the answers for blanks A and B in the description below are also inserted into the same blanks in Table 1.

Based on the number of failures of PCs for data entry and the stoppage time for each failure, the total stoppage time is 100 hours. Because the lost cash amount if a PC for data entry stops for 1 hour is 10,000 yen, the lost cash amount is 1,000,000 yen.

However, if the business server stops, none of the PCs for data entry can be used, so for the business server the total stoppage time for data entry is A hours, and the lost cash amount is B k yen.

Answer group for A and B:

- | | | | |
|-----------|----------|----------|-----------|
| a) 8 | b) 10 | c) 80 | d) 100 |
| e) 800 | f) 1,000 | g) 8,000 | h) 10,000 |
| i) 80,000 | | | |

Subquestion 2

From the answer groups below, select the correct answer to be inserted in each blank in the description below about the proposals for countermeasures shown in Table 2. Here, blanks C through E in the description below are inserted into the same blanks in Table 3.

In consideration of proposal A, based on Table 1, the avoidable total stoppage time is 100 hours, and the avoidable lost cash amount is 1,000k yen. However, the annual cost of countermeasures is C k yen.

In consideration of proposal B, the time for the switch to the spare server is 1 hour, and in that time business is stopped, so in Table 1, the stoppage time for each failure of the business server changes from 4 hours to 1 hour. Thus, the avoidable total stoppage time for PCs for data entry is D hours, and the avoidable lost cash amount is E k yen.

The cash amount after the deduction of the cost of countermeasures from the avoidable lost cash amount is considered to be the effect of the countermeasures. If the proposal that has a positive effect of countermeasures is chosen then the answer is F. As such, the activity to find and eliminate the root cause of the failure applies to G of ITIL service support.

Answer group for C:

- | | | | |
|----------|----------|----------|----------|
| a) 20 | b) 100 | c) 200 | d) 240 |
| e) 1,000 | f) 1,200 | g) 2,000 | h) 2,400 |

Answer group for D:

- | | | | |
|--------|--------|--------|--------|
| a) 3 | b) 6 | c) 100 | d) 200 |
| e) 300 | f) 600 | | |

Answer group for E:

- | | | | |
|----------|----------|----------|----------|
| a) 1,000 | b) 2,000 | c) 3,000 | d) 6,000 |
| e) 8,000 | | | |

Answer group for F:

- a) proposal *A*
- b) both proposal *A* and proposal *B*
- c) neither proposal *A* nor proposal *B*
- d) proposal *B*

Answer group for G:

- | | |
|------------------------|-----------------------------|
| a) incident management | b) configuration management |
| c) change management | d) problem management |
| e) release management | |

Q10-17 □□□

Read the following description concerning incident and problem management, and then answer the Subquestion.

In Company *F* engaged in logistics business, the systems department operates the order reception system. This system is used by Company *F* and its affiliate companies.

One day, the order reception system becomes unavailable from morning. When an employee of an affiliate company who has learned of this incident asks the contact person of Company *F*, it is found that an application fault has occurred in the order reception system and that the affiliate company has not been notified of it.

After the recovery of the service, the systems department investigates the cause of this notification mistake and finds that the list of contacts in case of a fault is old and does not include the affiliate company. The systems department recognizes that the incident and problem management processes are not always functioned successfully. Therefore, the systems department decides to review whole processes with the cooperation of the auditor from the risk management department.

The auditor summarizes the findings identified in the review and the recommendations on those findings, as shown in Table 1, and submits a report to the manager of the systems department.

Company *F* controls the faults from the occurrence of an incident to the analysis and resolution of problems by using a fault management database (hereinafter the DB). The items of the DB are as follows:

- (1) Fault control number (sequential number)
- (2) Fault occurrence date and time
- (3) System name
- (4) Component name
- (5) Status of the fault (description)
- (6) Resolution method (description)
- (7) Name of the person in charge of resolution
- (8) Resolution date and time

Table 1 Findings identified in the review and the recommendations on those findings

No.	Finding	Recommendation
1	The process of notification to the related departments in case of a fault does not function effectively.	Review the processes and operations with regard to the notification and follow-up in case of a fault.
2	The DB has many records whose resolution date and time fields are blank; a blank resolution date and time field indicates that the incident process was completed but the problem has not been resolved.	Establish a confirmation process of the problem resolution.
3	The current items of the DB are insufficient, and the DB is not fully utilized.	Review the items of the DB and add lacking items. Also, ensure that the DB is fully utilized.
⋮	⋮	⋮

While there are many findings, the systems department decides to immediately make improvements on the findings of Nos. 1 through 3 that are considered important.

Subquestion

From the answer groups below, select the correct answer to be inserted in each blank in the following description.

- (1) As for the notification and follow-up processes, the systems department decides to make improvements as mentioned in Table 2.

Table 2 Improvements on the notification and follow-up processes

No.	Recommendation	Improvement (outline)
1	Review the processes and operations with regard to the notification and follow-up in case of a fault.	<p>The person in charge of the operation decides on <input type="text"/> A <input type="text"/>.</p> <ul style="list-style-type: none"> - Level 3 or higher: The board members and affiliate companies are notified, and the current service status is posted for users on the internal Web site. (At the time of occurrence and every hour after that) - Level 2: The manager of the systems department decides which party is to be notified. (At the time of occurrence and as needed after that) - Level 1: Notification is not given to any party outside the systems department.

Two items are added to the DB. First, the item A is created. This is the item to be determined first at the time of a fault, and the levels for this item are defined in advance. If a fault occurs, notification corresponding to the level is given. Also, the item B is created, and information about the recovery action and recovery status, which were formerly recorded on a whiteboard at the time of a critical fault, is recorded in the DB so that the current status can be shared by the staff of the systems department.

- (2) As for the problems whose resolution date and time fields are blank, the systems department decides to make improvements as mentioned in Table 3.

Table 3 Improvements on the problems whose resolution date and time fields are blank

No.	Recommendation	Improvement (outline)
2	Establish a confirmation process of the problem resolution.	(i) The problem management committee checks weekly whether the problems to be resolved in that week have been resolved. (ii) The closure of the problems remaining unresolved for a long time is reviewed once a month.

As a result of an investigation into problems whose resolution date and time fields are blank, it is found that some of them are not resolved yet, but on the other hand, the rest of them have actually been resolved but their resolution dates and times are simply not registered. Therefore, the item is created in the DB, and the problem management committee follows up on the status of problem resolution on a weekly basis by using this item as a criterion. The problem management committee, consists of the technical staff, reports its decisions to the manager of the systems department after the meeting.

As for those problems that remain unresolved for a long time, such as , the problem management committee decides whether to close the problems on a monthly basis.

Also, the following is found to be the reason for failing to register their resolution dates and times. Once the resolution process is determined for a problem, the task of problem resolution is separated from problem management and performed as the process of . This makes the staff forget to update the resolution date and time in the DB inadvertently. Therefore, the procedure for the task of problem resolution is changed so that the corresponding fault control number is passed to to link both management controls.

- (3) As for the items and usability of the DB, the systems department decides to make improvements as mentioned in Table 4.

Table 4 Improvements on the items and usability of the DB

No.	Recommendation	Improvement (outline)
3	Review the items of the DB and add lacking items. Also, ensure that the DB is fully utilized.	(i) This time, only those items needed for the improvements of Nos. 1 and 2 are added. (ii) The display order of the DB is changed for the system administrator.

Among the lacking items, only those items needed for the improvements of Nos. 1 and 2 are added this time.

Next, since the DB data is currently displayed in the descending order of fault control numbers, it is difficult to identify critical problems. Therefore, the display order, considering those added items this time, is reviewed, and a function is added that displays the problems whose field is blank in the descending order of so that unresolved problems are displayed in order of importance.

Answer group for A through C, and F:

- a) Resolution date and time
- b) Details of resolution process (descriptive type)
- c) Planned resolution date and time
- d) Details of recovery action (append type)
- e) Impact of the fault
- f) Fault occurrence date and time

Answer group for D:

- a) problems whose cause cannot be identified and which have not recurred
- b) problems that cannot be resolved because there are not sufficiently skilled staff in the systems department
- c) problems that do not greatly impact on business operations even if they are left unresolved
- d) problems for which the system cannot be changed because of an insufficient budget

Answer group for E:

- a) Capacity management
- b) Configuration management
- c) Service level management
- d) Change management

10.5

Multiple-choice Questions (Strategy)**Q10-18** □□□

Read the following description concerning sales analysis, and then answer Subquestions 1 through 3.

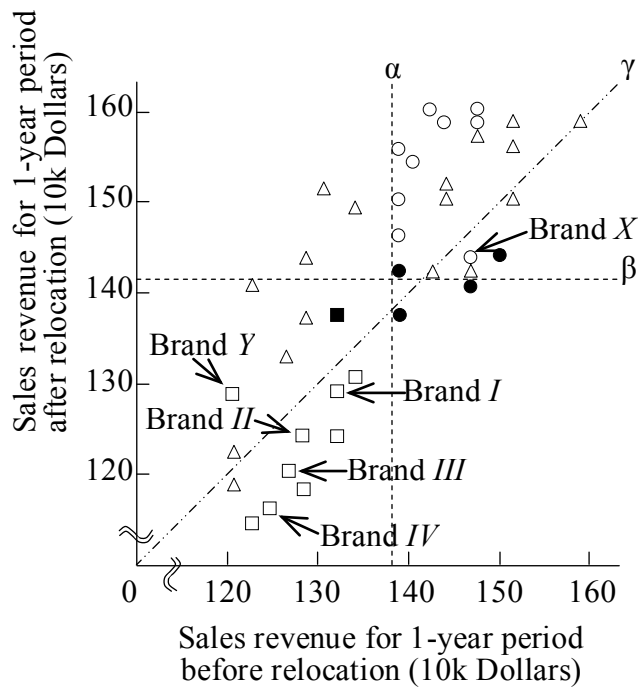
On the casual fashion floor (hereinafter called the floor) of Department Store *A*, the layout of shops for each brand is changed every 3 years. At the end of March last year, the layout of the floor was changed. However, there were no new brands that opened a shop and no existing brands closed a shop at that time.

All brands prefer to be located in shops near escalators where many people pass by (hereinafter called preferred shops). The criteria for allocation of a preferred shop are that sales revenue must grow for a certain period and sales revenue for 1-year period must exceed the average sales of the floor. On the other hand, the criteria for allocation of shops in the interior area where fewer people pass by (hereinafter called non-preferred shops) are that sales revenue declines for a certain period and the average sales revenue for 1 year is below the average sales revenue of the floor. In the case that none of these criteria are satisfied, shops are not relocated. However, even when the criteria for relocation are satisfied, a shop is sometimes not actually relocated.

In order to understand the effect of the relocation performed in March last year, the Department Store *A* decides to analyze the sales revenue of each brand. Fig. 1 shows a comparison graph of sales revenue for the 1 year before and after the relocation for each brand. Table 1 shows the meaning of symbols used in Fig. 1.

Table 1 Meaning of symbols used in Fig. 1

Symbol	Whether satisfied the criteria for relocation in previous year, and whether actually relocated or not
○	Brands that satisfied the criteria for relocation to preferred shops, and they were actually relocated
●	Brands that satisfied the criteria for relocation to preferred shops, however, they were not actually relocated
□	Brands that satisfied the criteria for relocation to non-preferred shops, and they were actually relocated
■	Brands that satisfied the criteria for relocation to non-preferred shops, however, they were not actually relocated
△	Brands that didn't satisfy the criteria for relocation



Note: Auxiliary lines α and β in the figure indicate average sales revenue for the 1 year before and after the relocation respectively.

Auxiliary line γ indicates the case where sales revenue is same before and after the relocation.

Fig. 1 Comparison of sales revenue for the 1 year before and after the relocation for the respective brands

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank in the following description about Fig. 1.

A comparison of the sales revenue of the entire floor for the 1 year before and after the relocation shows that sales revenue for the 1-year period after the relocation has grown. Furthermore, a comparison of the number of brands that experienced an increase in sales revenue after the shuffle relocation and the number of brands that experience a decline in sales revenue shows that .

Of the brands that satisfied the criteria for relocation to preferred shops, a comparison of the brands that were actually relocated and the brands that were not relocated with regard to the sales revenue of each brand for the 1-year period before and after the relocation shows that . Of the brands that were relocated to preferred shops, Brand X .

Out of all brands that met satisfied the conditions criteria of for reshuffling relocation to non-preferred shops, with regard to sales revenue for the 1-year period before and after the relocation, the number of brands experiencing growth in sales revenue was . It can be inferred that the decline in sales revenue stopped for these brands. Of all brands that were relocated to non-preferred shops, Brand Y .

Answer group for A:

- a) there are more brands that experienced a decline in sales revenue
- b) there are more brands that experienced an increase in sales revenue
- c) both are same

Answer group for B:

- a) most of brands that were relocated experienced an increase in sales revenue
- b) sales revenue didn't change even if relocated
- c) most of brands that were not relocated experienced an increase in sales revenue

Answer group for C:

- a) experienced the highest increase in sales revenue after relocation
- b) has the lowest sales revenue for the 1-year period before and after the relocation
- c) has the highest sales revenue for the 1-year period before the relocation
- d) was the only brand whose sales revenue fell below the average sales revenue of the floor after the relocation
- e) was the only brand whose sales revenue fell below the sales revenue before the relocation

Answer group for D:

- | | | | |
|------|------|------|------|
| a) 0 | b) 1 | c) 2 | d) 3 |
| e) 4 | f) 5 | g) 6 | h) 7 |

Answer group for E:

- a) recorded the highest sales revenue in the 1-year period after relocation
- b) recorded the lowest sales revenue in the 1-year period after relocation
- c) has a higher sales revenue than that before the relocation, and it exceeded the average sales revenue of the floor after the relocation
- d) experienced a decline in sales revenue after the relocation like other brands did
- e) was the only brand with a higher sales revenue than that before the relocation

Subquestion 2

From the answer groups below, select the correct answer to be inserted into each blank in the following description about changes in sales revenue for the 1-year period before and after the relocation for Brand *X*.

In order to analyze the sales revenue of Brand *X* in detail, a graph indicating the trend of monthly sales revenue and the number of customers who make a purchase at the Brand *X* shop is created as shown in Fig. 2.

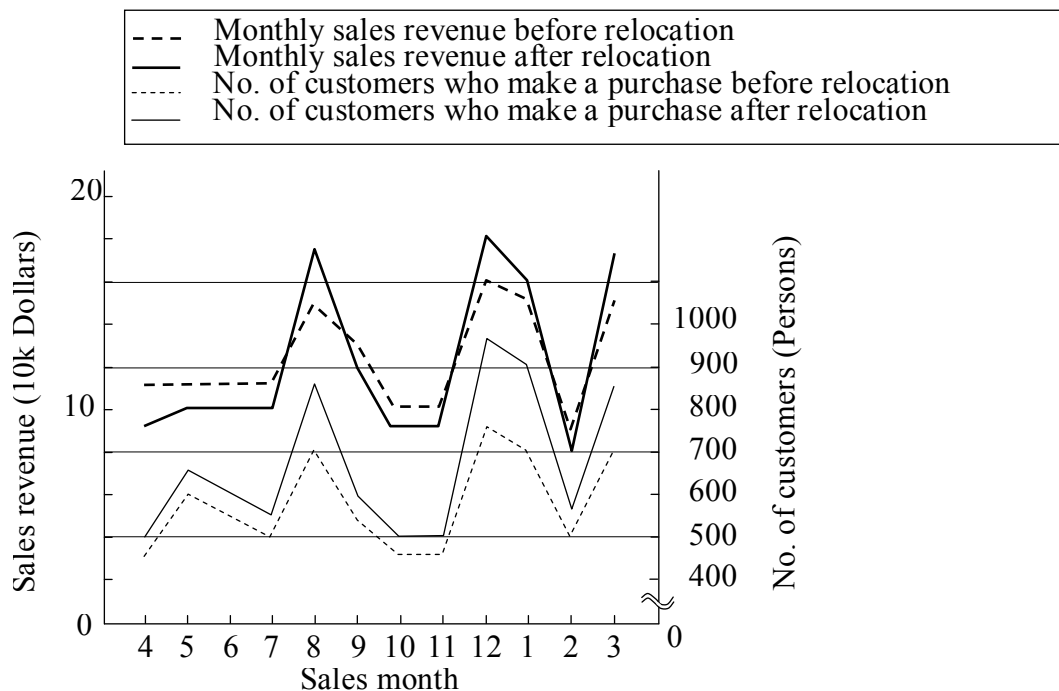


Fig. 2 Trend of monthly sales revenue and the number of customers who make a purchase at Brand *X*

Based on the sales revenue and the number of customers who make a purchase shown in Fig. 2, the monthly average purchase amount per customer (hereinafter called average customer spending) for the 1-year period before and after the relocation is compared and summarized as shown in Table 2.

Table 2 Comparison of monthly average purchase amount per customer for the 1-year period before and after the relocation

Month	4	5	6	7	8	9	10	11	12	1	2	3	Annual
Comparison results					↓	↓			F				↓

Note: The shaded part is not shown.

The increase in average customer spending after relocation is shown with a ↑, while a decline is shown with a ↓.

The three reasons below are possible reasons why sales revenue for the 1 year after the relocation is lower than that before the relocation.

- (1) Average customer spending is higher than that before the relocation, however, the number of customers who make a purchase is lower than that before the relocation.
- (2) The number of customers who make a purchase is higher than that before the relocation, however, the average customer spending is lower than that before the relocation.
- (3) The number of customers who make a purchase and the average customer spending are lower than their respective values before the relocation.

One of the possible reasons for change in sales revenue for the 1-year period before and after the relocation for Brand *X* is G. However, on a monthly basis, there are months where sales revenue after the relocation is higher than the sales revenue before the relocation. For these months, the number of customers who make a purchase has significantly increased over the number of customers who make a purchase before the relocation.

Answer group for F:

a)

↑

↑

b)

↑

↓

c)

↓

↑

d)

↓

↓

Answer group for G:

a) (1)

b) (2)

c) (3)

Subquestion 3

From the answer groups below, select the correct answer to be inserted into each blank in the following description about brands that were relocated to non-preferred shops.

In order to compare the sales revenue of Brand *Y* in Fig. 1, and Brands *I* through *IV* that were relocated to non-preferred shops, a graph comparing the average customer spending for each brand in the 1-year period before and after the relocation was created as shown in Fig. 3.

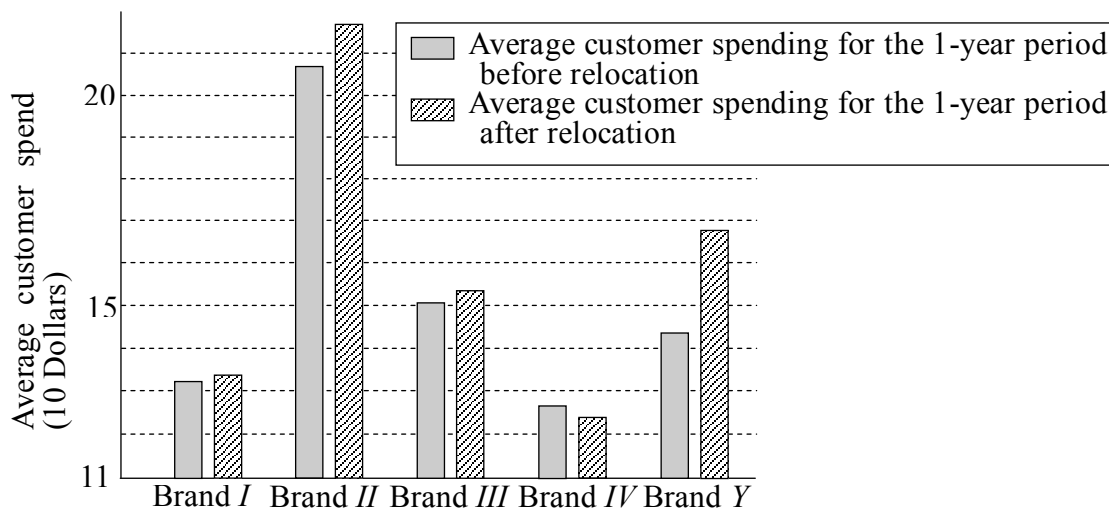


Fig. 3 Comparison of average customer spending for each brand in the 1-year period before and after the relocation

Next, Table 3 shows the average number of articles purchased by one customer who makes a purchase for each of the brands considered in Fig. 3, and the average number of customers who make a purchase per month.

Table 3 Average number of articles purchased by one customer who makes a purchase and the average number of customers who make a purchase per month

		Brand I	Brand II	Brand III	Brand IV	Brand Y
The 1-year period before the relocation	Average number of articles purchased per person (number of clothes)	1.3	2.1	1.3	1.1	1.2
	Average number of customers who make a purchase (Persons/month)	841	522	701	820	700
The 1-year period after the relocation	Average number of articles purchased per person (number of clothes)	1.3	1.8	1.4	1.2	1.8
	Average number of customers who make a purchase (Persons/month)	800	481	662	788	640

In Table 3, although the average number of customers who make a purchase per month is lower for each brand, for Brand I, Brand II, Brand III, and Brand Y, is higher. This is most likely because these brands were not relocated to non-preferred shops, and therefore instead of trying to increase the number of customers who make a purchase compared to before the relocation, these brands changed their sales approach so that the purchase amount for each customer increases.

From Fig. 3 and Table 3, it is clear that in the case of Brand , growth in the number of articles purchased by customers contributed to the sales revenue.

Brand *Y*'s sales revenue for the 1-year period after the relocation was almost the same as Brand ; however, the average number of articles purchased per customer who makes a purchase was higher. Furthermore, the sales revenue of Brand for the 1-year period after the relocation was in comparison to the sales revenue before the relocation. The unit price of articles sold in the case of Brand *Y* the unit price of articles sold for Brand . However, as the average number of articles purchased per customer who makes a purchase significantly exceeds that before the relocation, the sales revenue of Brand *Y* for the 1-year period after the relocation increased.

Answer group for H:

- a) sales revenue
- b) the number of sales
- c) average customer spending
- d) the number of customers who make a purchase

Answer group for I and J:

- a) *I*
- b) *II*
- c) *III*
- d) *IV*
- e) *Y*

Answer group for K and L

- a) exceeds
- b) is the same as
- c) is below

Q10-19 □□□

Read the following description about sorting customer information, and then answer Subquestions 1 through 3.

Company F has three corporate sales management systems, named α , β and γ , which were developed for each department. As each of these systems manages customer information and sales information independently, it is not possible to refer to all the sales information for a given customer at the same time. Therefore, Mr. G of the Sales Planning Department decides to collect the sales information by extracting customer information from each sales management system, and then consolidate the information for each customer. In the process of sorting the customer information, Mr. G decides to use a tool that consolidates the information for a given customer that is stored in multiple sales management systems into a single location (hereinafter called the reference tool). Table 1 shows functions of the reference tool, and a brief outline of the functions.

Table 1 Functions of the reference tools and a brief outline of the functions

Function	Outline
Cleaning	Unifies the way company names and addresses are noted so that customer information can be easily compared and evaluated.
Matching	<p>Compares the fields of customer information, quantifies the results as a score, generates a score list, and creates a correspondence table that manages linking to the customer code. The fields to be compared, the score to be assigned if the compared fields match, and Threshold I and II described below are predefined (Threshold $I > \text{Threshold } II$).</p> <p>(1)Threshold value I: Total value of scores when the customer is automatically determined to be the same.</p> <p>(2)Threshold value II: Total value of scores when the customer is manually determined to be the same.</p> <p>Customer information where the total value of the scores is equal to or greater than Threshold I is automatically registered in the correspondence table as the same customer. For customer information where the total value of the scores is equal to or greater than Threshold II but less than Threshold I, if it is found to be the same customer after a manual decision, it is registered as the same customer in the correspondence table.</p>

By using the cleaning and the matching function of the reference tool in sequence, Mr. G sorts the customer information of each sales management system and calculates the sales revenue for March.

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank in the following description about cleaning of information.

The cleaning of company names and addresses is performed as follows:

[Cleaning]

(1) Unification of the notation of company names

Delete the notation of corporate status such as “Company”, “Co. Ltd.”, and “LLC”.

(2) Unification of the notation of addresses

Change the “street number”, “of”, and “block number” that show the address after the street number to “-“, and change all doubly-byte numbers to single-byte numbers. Delete spaces.

Table 3 shows the results of cleaning the customer information provided in Table 2.

Table 2 Customer information

Company	Address
Japan ABCD Co. Ltd.	Tokyo Minato-ku Higashi Shimbashi 5-47-8
Company Japan ABCD	Tokyo Minato-ku Higashi Shimbashi 5-47-8
Company abcd	Chiba Inzai-shi Oguradai 5-chome 3-2
IPA Co. Ltd.	Tokyo Shinagawa-ku Shimoosaki 3 chome 2-3
(Co. Ltd.) IPA	Tokyo Shingawa-ku Shimoosaki 3-2-3
IPA LLC	Tokyo Shinagawa-ku Shimoosaki 3-chome Block no. 2 5
LLC HAMAYA	Saitama Ageo-shi Komon 2-chome Block no. 3 6
HAMAYA	Saitama Ageo-shi Komon 2-3-6
HAMAYA Co. Ltd.	Saitama Ageo-shi Kaminakajima 5-chome No. 3 6
Senbei (Co. Ltd.)	Niigata Kashiwazaki-shi Nishiyasuda 3-chome 2-3
Company Senbei	Niigata Kashiwazaki-shi Nishiyasuda 3-2-4
Senbei Co. Ltd.	Niigata Kashiwazaki-shi Nishiyasuda 3-chome Block no. 2 3
SENBEI Co. Ltd.	Tokyo Taito-ku Kamiasakusa 2-chome 3-4

Table 3 Results of cleaning the customer information in Table 2

Company	Address
<input type="text" value="A"/>	Tokyo, Minato-ku, Higashi Shimbashi 5-47-8
Japan ABCD	Tokyo, Minato-ku, Higashi Shimbashi 5-47-8
abcd	<input type="text" value="B"/>
IPA	Tokyo, Shinagawa-ku, Shimoosaki 3-2-3
IPA	Tokyo, Shinagawa-ku, Shimoosaki 3-2-3
IPA	Tokyo, Shinagawa-ku, Shimoosaki 3-2-5
HAMAYA	Saitama, Ageo-shi, Komon 2-3-6
HAMAYA	Saitama, Ageo-shi, Komon 2-3-6
HAMAYA	Saitama, Ageo-shi, Kaminakajima 5-3-6
Senbei	Niigata, Kashiwazaki-shi, Nishiyasuda 3-2-3
Senbei	Niigata, Kashiwazaki-shi, Nishiyasuda 3-2-4
Senbei	Niigata, Kashiwazaki-shi, Nishiyasuda 3-2-3
SENBEI	Tokyo, Taito-ku, Asakusa 2-3-4

As a result of cleaning, if records with an identical company name and address are considered as the same customer, there are records of customer information in Table 2.

Answer group for A:

- a) (Co. Ltd.) Japan ABCD
- b) Company Japan ABCD
- c) Japan ABCD
- d) Japan abcd
- e) Japan abcd Co. Ltd.

Answer group for B:

- a) Inzai-shi, Oguradai 5-3-2
- b) Chiba, Inzai-shi, Oguradai 5-3-2
- c) Chiba, Inzai-shi, Oguradai 5-Chome No. 3, 2

Answer group for C:

- a) 4
- b) 5
- c) 6
- d) 7
- e) 8
- f) 9
- g) 10
- h) 11
- i) 12

Subquestion 2

From the answer groups below, select the correct answer to be inserted in each blank in the following description about the comparison of fields of customer information in matching, and the generation of a score list.

This time, after the cleaning of the records, a combination of customers with identical company names, addresses, and telephone numbers is automatically considered to be the same customer. Records with matching company names and either a matching address or telephone number are treated as the records where a manual decision is required.

If 50 points is the score assigned when company names match, 25 points is the score assigned when addresses match, and 25 points is the score assigned when telephone numbers match, Threshold *II* can be set to D points.

Table 4 shows the cleaned customer information after the telephone number and sales revenue of March are added, and Table 5 shows the score list obtained by performing matching based on Table 4.

In addition to the combination of a data number for customer information and a total value of the scores, the score list also contains a rating column where “O” is printed if the total value of the scores is equal to or greater than Threshold *I*, “Δ” is printed if the total value of the scores is equal to or greater than Threshold *II* but less than Threshold *I*, and “×” is printed if the total value of the scores is less than Threshold *II*. Customer information records with matching company names are compared in sequence, and when there are no matching company names, “-” is printed in the comparison data number, score, and rating in the score list.

Table 4 Cleaned customer information after adding telephone number and sales revenue of March

Data number	System	Customer code	Company name	Address	Telephone number	March sales (10k Dollars)
1	α	1111	IPA	Tokyo, Shinagawa-ku, Shimoosaki 3-2-3	03-3080-2222	2
2	β	CD2311	IPA	Tokyo, Shinagawa-ku, Shimoosaki 3-2-3	03-3080-2222	3
3	γ	G-1123	IPA	Tokyo, Shinagawa-ku, Shimoosaki 3-2-3	03-3080-4444	5
4	α	1256	HAMAY A	Saitama, Ageo-shi, Komon 2-3-6	048-455-2222	4
5	β	ER3256	HAMAY A	Saitama, Ageo-shi, Komon 2-3-6	048-455-3333	8
6	γ	H-3321	HAMAY A	Saitama, Ageo-shi, Kaminakajima 5-3-6	048-245-4444	2
7	α	3233	Senbei	Niigata, Kashiwazaki-shi, Nishiyasuda 3-2-3	0257-40-2222	4
8	β	GH1324	Senbei	Niigata, Kashiwazaki-shi, Nishiyasuda 3-2-4	0257-40-2222	3
9	γ	J-4231	Senbei	Niigata, Kashiwazaki-shi, Nishiyasuda 3-2-3	0257-40-2222	5
10	γ	I-2234	SENBEI	Tokyo, Taito-ku, Kamiasakusa 2-3-4	03-6815-0232	7

Table 5 Score list of matching results based on Table 4

Original data number	Comparison data number	Score	Rating
1	2	100	○
1	3	50	
2	3	50	
4	5		E
4	6	50	
F			
7	8	75	
7	9	100	
8	9	75	
10	—	—	—

Note: The shaded parts are not shown.

Answer group for D:

- a) 25 b) 50 c) 75 d) 100

Answer group for E:

- a) b) c) d)
- e) f) g) h)

Answer group for F:

- a) b) c) d)
- e) f) g)

Subquestion 3

From the answer group below, select the correct answer to be inserted in each blank in the following description about sorting the referenced customer information.

Based on the score list generated through matching, it is decided to assign a new customer code (hereinafter called new customer code), and calculate the sales revenue for March for every new customer code.

Records with “Δ” in the rating column of the score list are considered to be the same customer, and new customer codes starting from M00001 are assigned in the sequence in Table 5. Table 6 shows the correspondence table generated as a result of this process. Customer codes corresponding to the new customer code M00003 in the respective systems and total sales revenue for March are G , and for M00005 it is H .

Table 6 Correspondence table of new customer codes

New customer code	Customer code in System α	Customer code in System β	Customer code in System γ	Calculated sales revenue of March (10k Dollars)
M00001	1111	CD2311		5
M00002			G-1123	5
M00003				
M00004				
M00005				
M00006				

Note: The shaded parts are not shown.

Answer group:

- a) 1256 of α , and 40k Dollars
- b) 1256 of α , ER3256 of β , and 120k Dollars
- c) 1256 of α , ER3256 of β , and H-3321 of γ , and 140k Dollars
- d) 3233 of α , and 40k Dollars
- e) 3233 of α , GH1324 of β , and 70k Dollars
- f) 3233 of α , GH1324 of β , J-4231 of γ , and 120k Dollars
- g) H-3321 of γ , and 20k Dollars
- h) I-2234 of γ , and 70k Dollars

Q10-20 □□□

Read the following description concerning product portfolio management analysis, and then answer Subquestions 1 through 3.

Product portfolio management analysis (hereinafter called PPM analysis) is a technique for analyzing the competitiveness of products in the market, and it is used for evaluating how much investment should be made in which product. In PPM analysis, the market growth rate (it is an indicator of the extent of overall market growth by product) and the percentage of market share (it is an indicator of relative strength in the market against competition) make the position of the respective product in the market clear, and analysis is conducted to determine what kind of investment allocation will maximize the sales revenue and profits under various risks.

[Portfolio chart]

In PPM analysis, analysis is conducted by creating a portfolio chart. In a portfolio chart, market growth rate is plotted on the vertical axis, and the percentage of market share is plotted on the horizontal axis. The positioning of a product is categorized into the 4 areas shown in the following figure.

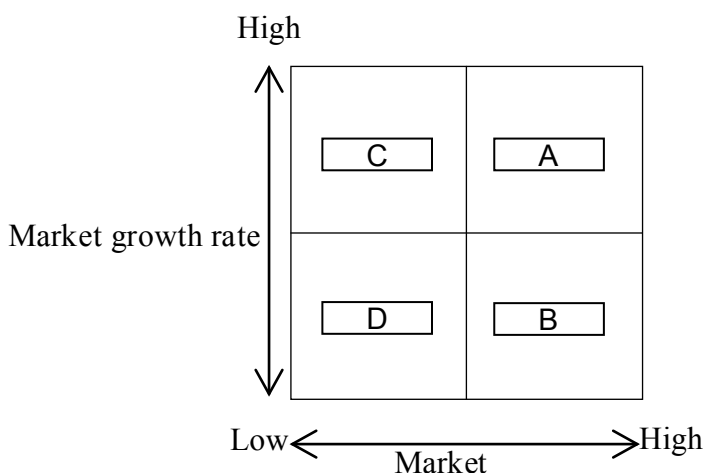


Fig. Portfolio chart

Product 1: A are the products having with a high market growth rate and a high percentage of market share. These products play fulfill the role of leading the overall market overall, and they can be expected to become a source of profits in the medium to long term.

Product 2: are the products with a low market growth rate but a high percentage of market share. These products have large sales revenue and are in a stable phase. Although they are not a target for aggressive investment, because they form the core of a company's income, it is appropriate that profits earned through these products are invested in or .

Product 3: are the products having with a high market growth rate but a low percentage of market share. In many cases, these products are just launched very recently new on the market. Due to future growth expectations, growth is accelerated by making large investments. They are potential candidates for ; however, when the percentage of market share cannot be secured, they may end up becoming .

Product 4: are the products with a low market growth rate as well as a low percentage of market share. Due to poor competitiveness in the market and poor attractiveness of the product itself, it is necessary to consider pulling out from of the market.

[Case study of analysis conducted at Company *M*]

Company *M* has 3 product groups, namely product group *X*, product group *Y*, and product group *Z*. Table 1 shows the last year's market size, current year's market size, current year market share, current year's manufacturing cost percentage, and current year's customer satisfaction.

Table 1 Status of Company *M*'s product groups

	Last year's market size	Current year's market size	Current year's market share	Current year's manufacturing cost percentage	Current year's customer satisfaction
Product group <i>X</i>	12,000M Dollars	10,800M Dollars	61%	38%	3.3 points
Product group <i>Y</i>	200M Dollars	900M Dollars	6%	27%	4.1 points
Product group <i>Z</i>	7,500M Dollars	4,000M Dollars	8%	56%	3.7 points

The current status of the product groups of Company *M* is analyzed and applied to the portfolio chart. The boundary value for determining whether the market growth rate is high or low is taken as "0%", and the boundary value for determining whether the percentage of market share is high or low is taken as "50%".

Calculation of the market growth rate and the percentage of market share for each product group of Company *M* gives the results shown in Table 2.

Table 2 Positioning of Company *M*'s product groups

	Market growth rate	Market share
Product group <i>X</i>	<input type="text" value="E"/> %	61%
Product group <i>Y</i>	<input type="text" value="F"/> %	6%
Product group <i>Z</i>	−47%	8%

From Table 2, it is clear that product group *X* corresponds to category in the portfolio chart, product group *Y* corresponds to category , while product group *Z* corresponds to category .

[Issues with Company *M*'s products]

Company *M* is investing most of its current profits in product group *X*. PPM analysis shows that securing future sources of profits is a major challenge faced by Company *M*. However, Company *M* has no plans to develop a new product group as of now. As such, Company *M*'s management plans to review their investments in the current product groups so that they can secure the future profit sources.

Subquestion 1

From the answer group below, select the correct answer to be inserted into each blank through in the figure.

Answer group for A through D:

- | | |
|-----------------------|---------------------------------|
| a) Competing products | b) Harvest products (cash cows) |
| c) Star products | d) Maintenance products |
| e) Dog products | f) Problem child products |

Subquestion 2

Answer (1) and (2) below about the portfolio chart.

- (1) From the answer group below, select the appropriate value to be inserted into each blank and in Table 2.

Answer group for E and F:

- | | | | |
|---------|---------|---------|---------|
| a) -450 | b) -350 | c) -20 | d) -10 |
| e) +10 | f) +20 | g) +350 | h) +450 |

- (2) From the answer group below, select the appropriate category to be inserted into each blank through in the description.

Answer group for G through I:

- | | | | |
|--------------|--------------|--------------|--------------|
| a) Product 1 | b) Product 2 | c) Product 3 | d) Product 4 |
|--------------|--------------|--------------|--------------|

Subquestion 3

From the answer group below, select the appropriate reason for arriving at the underlined conclusion concerning the outcome of Company *M*'s PPM analysis.

Answer group:

- Because there is no product that corresponds to Product 1, a medium-to-long term profit source is absent.
- Because no product corresponds to Product 2, there is no product in which aggressive investments should be made.
- Because all products correspond to Product 3, large investments are required.
- Because all products correspond to Product 4, it is necessary to considering pulling out from the market.

Q10-21 □□□

Read the following description concerning a Balance Score Card, and then answer Subquestions 1 and 2.

[Description of Company *A*]

Company *A* is a specialized trading company engaged in the field of electrical materials. Company *A* sources materials from chemical manufactures, and supplies them to electronics manufacturers. Recently, an increasing number of manufacturers are shifting their manufacturing bases to China and South East Asia in order to reduce labor cost. Company *A* also has offices in twelve locations throughout Asia. Meanwhile, in Japan, Company *A* is engaged in trading activities centering on large electronics manufacturers that manufacture high value-added electronic components such as liquid crystals and clocks.

Generally, in order to survive business competition, specialized trading companies must deliver added value to their customers who are electronics manufacturers, and their suppliers who are chemical manufacturers so that it is better to go through trading company.

As such, Company *A* concludes that the following management policies are important.

- It is necessary to provide real-time information about appropriate materials to customers in Japan who are electronics manufacturers. For example, providing an appropriate response to queries such as “which is the best chemical manufacturer that can supply clock materials that can withstand a wide range of temperatures?”
- For overseas vendors, Company *A* is expected to have the excellent function for the provision of information that only a trading company can provide such as the introduction of new customers. Furthermore, Company *A* is expected to promptly respond to unexpected requests such as “we immediately require 2 tons of Material *A*” from customers who are electronics manufacturers.
- Company *A* is expected to provide added value through distribution processing. For example, vinyl tapes are supplied by chemical manufacturers in the form of rolls. However, electronics manufacturers require these to be delivered in the form of tapes with a width of 5 millimeters. Thus, Company *A*, even though it is a trading company, performs distribution processing by cutting the tapes.
- Large electronics manufacturers expect that Company *A* to be a part of SCM (Supply Chain Management).

In order to implement these management policies, it is necessary for Company *A* to improve employees' knowledge of electrical materials and their understanding of the type of material required by different electronics manufacturers. Furthermore, Company *A* is required to appropriately manage this information as well as knowledge about overseas markets. In addition, Company *A* must manage very detailed information about suppliers, and create an internal mechanism to enable a prompt response to unexpected requests from customers. Also, by working in close collaboration with customers, Company *A* needs to pursue and realize their potential for distribution processing as a trading company. Therefore, it is necessary to improve technical and creative capabilities of employees concerning distribution processing.

With regard to becoming a part of SCM as desired by large electronics manufacturers, in addition to modifying their own systems so that they interface with customer's SCM, Company *A* is also required to develop features that can provide new value-added data to customers.

[Description of Balance Score Card]

A Balance Score Card (BSC) is a performance evaluation technique for “creating a strategy management system to achieve growth and competitiveness by turning a strategy into real action”. To realize the strategy, it is necessary to set goals from 4 different viewpoints in the Balance Score Card.

Table 1 Balance Score Card

Viewpoint	Goal
Finance	In order to meet the expectations of interested parties such as shareholders and employees, aim to achieve goals from a financial viewpoint.
Customer	In order to realize the financial viewpoint, aim to achieve goals from the customer's viewpoint.
Business process	In order to achieve financial goals and improve customer satisfaction, analyze what kind of processes are important, and what improvements are required, and aim to achieve goals from both the customer and financial viewpoint.
Learning and growth	In order to ensure that company has better business processes than competitors, attains customer satisfaction, and achieves its financial goals, it aims to achieve goals concerning the development of employee capability and the enhancement of intellectual properties.

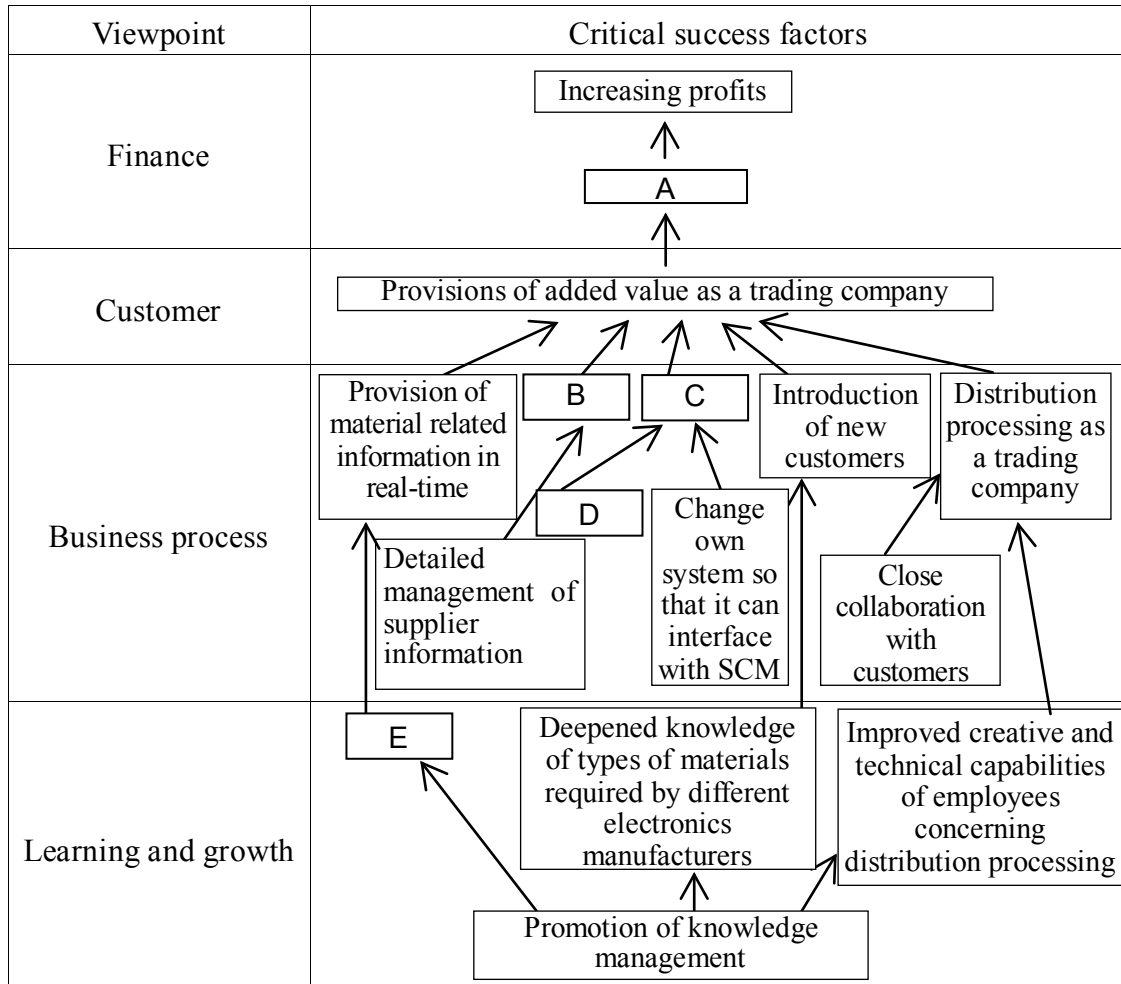
In order to achieve the goals listed in Table 1, a highly important management policy is created. This management policy is called Critical Success Factors (CSF). A means-end relationship must exist between these critical success factors. For example, a management policy from the viewpoint of the customer is the improvement of customer satisfaction, and a management policy from the viewpoint of business processes that achieves this must be the means for improvement of customer satisfaction. For example, goals such as “adherence to deadline” are set.

Furthermore, it is necessary to define indicators to evaluate whether management policies for the realization of goals are implemented appropriately. It is desirable that these indicators be described quantitatively. One of the indicators for improving the customer satisfaction might be “increasing the number of visiting customers”.

Subquestion 1

Table 2 shows the critical success factors for Company A drafted from 4 viewpoints based on the Balance Score Card. From the answer groups below, select the appropriate terms and phrases to be inserted in each blank .

Table 2 Critical success factors for Company A based on the Balance Score Card



Answer group for A:

- a) Increased sales revenue
- b) Enhanced technology
- c) Increased the number of employees
- d) Improved quality

Answer group for B through E:

- a) Incorporation of Company A's system in SCM
- b) Development of features for provision of new value-added data
- c) Prompt response to sudden requests
- d) Increased number of employees who have passed a certification exam
- e) Improved employees' knowledge of electrical materials
- f) Increased number of manufacturing bases

Subquestion 2

Table 3 shows the indicators for achieving critical success factors. From the answer group below, select the appropriate terms and phases to be inserted into each blank

in Table 3.

Table 3 Indicators for achieving of critical success factors

Critical success factors	Indicators
Provision of real-time information about materials	<input type="text" value="F"/>
Prompt response to sudden requests	<input type="text" value="G"/>
Promotion of knowledge management	<input type="text" value="H"/>
Introduction of new customers	<input type="text" value="I"/>
Achievement of distribution processing as a trading company	<input type="text" value="J"/>

Answer group:

- a) Frequency of capital movements between overseas offices
- b) Number of cases of handling unexpected requests
- c) Number of entertainment sessions with partners (suppliers and customers)
- d) Number of instances of provisions of information concerning materials
- e) Number of instances where a new customer is introduced
- f) Number of knowledge items registered
- g) Actual number of instances of incorporation of Company A's system into customer's SCM
- h) Number of instances of proposals for distribution processing

Afternoon Exam

Section 11

Mandatory Questions (Data Structures and Algorithms)

Learning Objectives

1. Be able to understand processing details by reading [Program description].
2. Be able to map [Program description] with algorithms of the program.
3. Be able to trace processing details in a simple example program.
4. From [Program description], be able to identify the processing detail to be inserted in the blanks in a program.
5. Based on the program, be able to determine the results of executing the data provided.
6. Be able to understand how to modify a program when a process is added or modified.

(Frequently-appearing points)

Array processing, character string processing, sorting, searching, graphics, etc.

11

Mandatory Questions (Data structures and Algorithms)**Q11-1** □□□

Read the following program description and the program itself, and then answer the subquestion.

[Program description]

The sub-program **Aggregate** tabulates the questionnaire responses stored in a response file, and prints a tabulation results table.

- (1) A questionnaire is performed on males between the age groups of 20s and 60s. The questionnaire is comprised of N ($1 \leq N \leq 50$) questions for surveying age and gender, and satisfaction level of respondents. Respondents are required to fill in his or her age in the age column, “M” if the respondent is a male and “F” if the respondent is a female in the gender column, and one of the following numbers in the response columns of the questions that inquires about satisfaction level.

5: Highly satisfied 4: Satisfied 3: Neutral 2: Somewhat unsatisfied 1: Unsatisfied

- (2) In the Response file, responses provided by the respondents for age and gender (“M” or “F”) are stored as numerical strings (character strings) for the selection numbers of Question 1 to Question N . Assume that there are no errors in the response file, and the total number of entries is 1,000 or less.

The format of a record in the response file is as follows:

Age (Integer type)	Gender (Character type)	Numerical string of response (Character type)
-----------------------	----------------------------	--

- (3) Three (3) items are printed in the tabulation results table, namely, number of people for each selection choice for each question in the questionnaire (hereinafter called response results), number of respondents by age group who selected “Highly satisfied” or “Satisfied” for the relevant question (hereinafter called satisfaction level by age group), and number of males and females by age group (hereinafter called number of males and females by age group).

Print format of tabulation results table is as follows:

Tabulation results table					
Response results:					
	Highly satisfied	Satisfied	Neutral	Somewhat unsatisfied	Satisfied
Q1	175	224	70	15	9
Q2	153	179	108	38	15
⋮			⋮		
QN	97	133	128	85	50
Satisfaction level by age group:					
	20s	30s	40s	50s	60s
Q1	123	97	77	59	43
Q2	92	75	63	56	46
⋮			⋮		
QN	31	42	53	55	49
Number of males and females by age group:					
	Males	Females			
20s	49	52			
30s	44	58			
40s	52	47			
50s	47	51			
60s	43	50			

(4) The following external functions are used in `Aggregate`.

- (i) External function `SubStr` for extracting a part of the character string.
- (ii) External function `CtoI` that converts a single character digit (between “0” and “9”) into its integer value.

(5) The following table shows the specifications of the arguments of `Aggregate`.

Table Specifications of the arguments of `Aggregate`

Variable	Data type	Input/Output	Meaning
<i>N</i>	Integer type	Input	Number of questions in the questionnaire

- (6) The index of all arrays in the program starts with one (1), and the two-dimensional array is as shown below:

DAT	1	2
1	<i>A</i>	<i>B</i>
2	<i>C</i>	<i>D</i>
3	<i>E</i>	<i>F</i>

Defined such as DAT[3, 2].

For example, DAT[1, 2]
indicates *B*.

- (7) Line feed process is performed by specifying “\n” as an argument in the procedure PRINT.

[Program]

- Aggregate (integer_type: N)
- integer_type: i, j, A, K, Cnt
- integer_type: Age[1000], QCnt[50,5], MCnt[50,5], SCnt[5,2]
- character_type: Gender[1000], Response[1000]
- File: AFile
- Procedure: File input(AFile, Age, Gender, Response, Cnt)
 - /* Procedure for reading the contents of the file AFile in the integer_type array Age, character_type arrays Gender and Response
 - The number of records read is stored in Cnt (1 ≤ Cnt ≤ 1000) */
- Procedure: PRINT(Argument 1, Argument 2, ...)
 - /* Procedure for printing data of Argument 1, Argument 2, ...
 - PRINT("\n") performs the line feed operation */

(Line number)

```

1  /* Reading file */
2  ·File input(AFile, Age, Gender, Response, Cnt)
3  /* Initialization of arrays */
4  ■ i : 1, i ≤ N, 1
5      ■ j : 1, j ≤ 5, 1
6          ·QCnt[i, j] ← 0    /* Array for response results */
7          ·MCnt[i, j] ← 0    /* Array for satisfaction level by age group */
8      ■
9  ■
10 ■ i : 1, i ≤ 5, 1
11     ■ j : 1, j ≤ 2, 1
12         SCnt[i, j] ← 0    /* Array for the number of males and females by age
group */
13     ■
14 ■
15 /* Tabulation process */
16 ■ i : 1, i ≤ Cnt, 1
17     · A
18     ■ j : 1, j ≤ N, 1
19         ·K ← CtoI(SubStr(Response[i], j, 1))
           /* SubStr fetches one (1) character on j-th location from the of Response[i]
           CtoI converts the digit character into an integer */
20         · B
21         ↑ K = 5 or K = 4
22         · C
23         ↓
24     ■
25     ↑ if(Gender[i] = "M")
26         ·SCnt[A, 1] ← SCnt[A, 1] + 1
27     ───
28         ·SCnt[A, 2] ← SCnt[A, 2] + 1
29     ↓
30 ■

```

```

31  /* Printing tabulation results table */
32  PRINT("          Tabulation results table","\n")
          /* Prints "          Tabulation results table", line feed */
33  PRINT("Response results", "\n")
34  PRINT("Highly satisfied Satisfied Neutral Somewhat unsatisfied Unsatisfied", "\n");
35  ■ i:1, i ≤ N, 1
36      ·PRINT("Q ", i) /* After "Q " is printed, prints the value of variable i */
37      ■ D
38      ·PRINT(QCnt[i, j], "persons ")
39      ■
40      ·PRINT("\n")
41  ■
42  ·PRINT("\n", "Satisfaction level by age group", "\n")
43  ·PRINT("  20s  30s  40s  50s  60s", "\n")
44  ■ i:1, i ≤ N, 1
45      ·PRINT("Q", i)
46      ■ j:1, j ≤ 5, 1
47      ·PRINT(MCnt[i, j], " persons ")
48      ■
49      ·PRINT("\n")
50  ■
51  ·PRINT("\n", "Number of males and females by age group ", "\n")
52  ·PRINT("      Males  Females", "\n")
53  ■ i:1, i ≤ 5, 1
54      ·PRINT(E, "s ")
55      ■ j:1, j ≤ 2, 1
56      ·PRINT(SCnt[i, j], " persons")
57      ■
58      ·PRINT("\n")
59  ■

```

Subquestion

From the answer groups below, select the correct answers to be inserted in each blank

in the [Program].

Answer group for A:

- a) $A \leftarrow A + 1$
- b) $A \leftarrow \text{Age}[i] - (\text{Age}[i] \div 10) \times 10$
- c) $A \leftarrow \text{Age}[i] \div 10 - 1$
- d) $A \leftarrow \text{Age}[i] \div 10 \times 10$

Answer group for B and C:

- a) $\text{MCnt}[A, i] \leftarrow \text{MCnt}[A, i] + 1$
- b) $\text{MCnt}[A, j] \leftarrow \text{MCnt}[A, j] + 1$
- c) $\text{MCnt}[i, A] \leftarrow \text{MCnt}[i, A] + 1$
- d) $\text{MCnt}[j, A] \leftarrow \text{MCnt}[j, A] + 1$
- e) $\text{QCnt}[A, j] \leftarrow \text{QCnt}[A, j] + 1$
- f) $\text{QCnt}[j, A] \leftarrow \text{QCnt}[j, A] + 1$
- g) $\text{QCnt}[j, K] \leftarrow \text{QCnt}[j, K] + 1$
- h) $\text{QCnt}[K, j] \leftarrow \text{QCnt}[K, j] + 1$

Answer group for D:

- a) $j:1, j < 5, 1$
- b) $j:1, j \leq 5, 1$
- c) $j:5, j > 0, -1$
- d) $j:5, j \geq 0, -1$

Answer group for E:

- a) i
- b) $i \times 10$
- c) $(i + 1) \times 10$
- d) $(i \times 2) \times 10$

Q11-2 □□□

Read the following program description and the program itself, and then answer Subquestions 1 through 3.

[Program description]

The subprogram `Merge` sorts the contents of array A in ascending order. The number of elements in array A is N (N must be the power of two (2)) and the value of each element is less than 9999. No two (2) or more elements have the same value. Moreover, this array A and the number of elements N are passed to `Merge` as arguments. In `Merge`, array X and array Y are used for processing. In merging, at the end of array X and array Y , a sentinel with a value greater than any of the element values of array A is placed (in the program, the value of the sentinel is 9999). The sorting process is as follows:

Example: Assume that array A has eight (8) elements with the values (4, 3, 8, 6, 0, 9, 1, 5).

- (1) Consider that array A is comprised of sorted subarrays (indicated with underline) where the number of elements is one (1).

Array A : (4, 3, 8, 6, 0, 9, 1, 5)

- (i) Operation 1 Fetch subarray 4 and subarray 3 from array A , and insert them in array X and array Y respectively.

Operation 2 The merge elements of array X and array Y are in ascending order, and update array A as shown below. As a result, array A is partially sorted, the number of elements in this sorted subarray becomes two (2).

Array A : (3, 4, 8, 6, 0, 9, 1, 5)

Continue on the following steps (ii) to (iv) with the similar operations with Operation 1 and 2.

- (ii) Fetch subarray 8 and subarray 6 from array A , and insert them in array X and array Y respectively.

Merge array X and array Y , and update array A .

Array A : (3, 4, 6, 8, 0, 9, 1, 5)

- (iii) Fetch subarray 0 and subarray 9 from array A , and insert them in array X and array Y respectively.

Merge array X and array Y , and update array A .

Array A : (3, 4, 6, 8, 0, 9, 1, 5)

- (iv) Fetch subarray 1 and subarray 5 from array A , and insert them in array X and array Y .

Merge array X and array Y , and update array A .

Array A : (3, 4, 6, 8, 0, 9, 1, 5)

(2) Consider that array A is comprised of subarrays each of which has two (2) sorted elements, and perform Operation 1 and 2.

(i) Fetch subarray 3, 4 and subarray 6, 8 from array A , and insert them in array X and array Y respectively.

Merge array X and array Y , and update array A .

Array A : (3, 4, 6, 8, 0, 9, 1, 5)

(ii) Fetch subarray 0, 9 and subarray 1, 5 from array A , and insert them in array X and array Y respectively.

Merge array X and array Y , and update array A .

Array A : (3, 4, 6, 8, 0, 1, 5, 9)

(3) Consider that array A is comprised of subarrays each of which has four (4) sorted elements, and perform Operation 1 and 2.

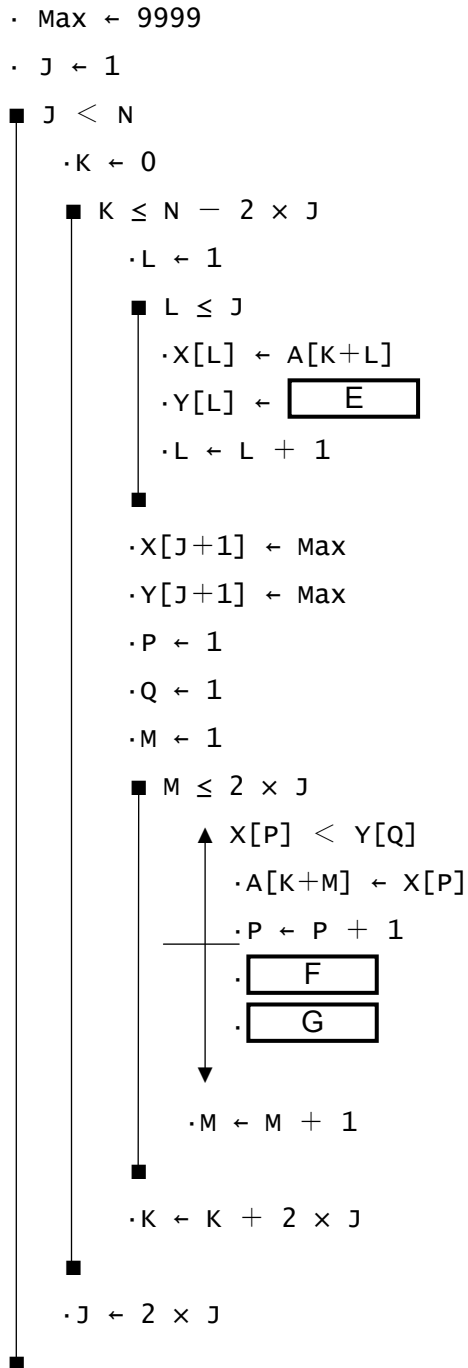
Fetch subarray 3, 4, 6, 8 and subarray 0, 1, 5, 9 from array A , and insert them in array X and array Y respectively.

Merge array X and array Y , and update array A . With this, sorting is completed.

Array A : (0, 1, 3, 4, 5, 6, 8, 9)

[Program]

- Subprogram: Merge(A[], N)
- integer_type: X[], Y[], Max, J, K, L, M, P, Q



Subquestion 1

The element values of array B are (8, 1, 7, 2, 6, 3, 5, 4). When the subprogram Merge is executed for sorting array B in ascending order; after step (ii) in paragraph (2) of [Program description] is completed and number of elements in the sorted subarray becomes four (4), what are the contents of array B ? From the answer groups below, select the correct answers to be inserted in each blank below.

(1, 2, A, B, C, D, 5, 6)

Answer groups for A though D:

- a) 3 b) 4 c) 7 d) 8

Subquestion 2

From the answer group below, select the correct answers to be inserted into the in the program.

Answer group for E through G:

- | | |
|-------------------------------|-------------------------------|
| a) $A[K + L]$ | b) $A[K + L + 1]$ |
| c) $A[K + L + J]$ | d) $A[K + M]$ |
| e) $A[K + M] \leftarrow X[Q]$ | f) $A[K + M] \leftarrow Y[P]$ |
| g) $A[K + M] \leftarrow Y[Q]$ | h) $P \leftarrow P + 1$ |
| i) $Q \leftarrow Q + 1$ | |

Subquestion 3

From the answer group below, select the correct answer to be inserted in each blank in the description below.

The reason for using a sentinel in the subprogram Merge is because when elements remain in either array X or Y only when merging is being performed, by comparing with a large value that actually does not exist as data, the remaining portion of the array X or Y can be copied to the array A .

For example, in (2)(ii) under [Program description], prior to the merging process, 9999 is assigned to H and I that are used sentinels. Proceeding with merging in the sequence of $X[1](=0)$, $Y[1](=1)$, and $Y[2](=5)$; $X[2](=9)$ remains in the end. Here, comparing $X[2]$ with the sentinel element J gives $X[2] < 9999$, and $X[2]$ is copied to the array A , which completes the merging process for this subarray.

Answer group for H through J:

- | | | |
|-----------|-----------|-----------|
| a) $x[1]$ | b) $x[2]$ | c) $x[3]$ |
| d) $y[1]$ | e) $y[2]$ | f) $y[3]$ |

Q11-3 □□□

Read the following description of an algorithm, and then answer the Subquestions 1 and 2.

[Description of the Algorithm]

The algorithm `ShortestLength` finds the shortest distance from the starting point to other points in a graph containing N points ($N > 1$).

- (1) The description of `ShortestLength` is given below using the graph ($N = 6$) shown in Fig. 1 as an example. In Fig. 1, a circle shows a point, the direction of an arrow shows the direction of movement, and the number attached to the arrow shows the distance between the points.

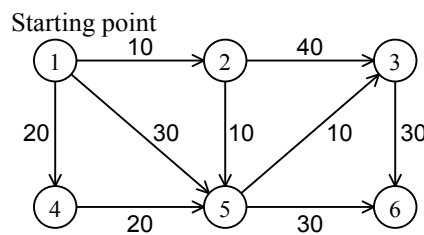


Fig. 1 Example graph ($N = 6$)

- (2) `ShortestLength` uses the following arrays. Element numbers 1, 2, ..., N correspond with the points. The index of each array starts at 1.

$Dt[i][j]$: The array with $N \times N$ elements storing the distance from Point i to Point j . When there is no direct path from Point i to Point j , when the direction of movement is opposite, or in the case of $Dt[i][i]$, ∞ (constant indicating the maximum value) is stored. In Fig. 1, part of $Dt[i][j]$ is as follows.

$$Dt[1][1] = \infty, Dt[1][2] = 10,$$

$$Dt[1][3] = \infty, Dt[2][1] = \infty$$

$Sd[i]$: The array that stores the temporary shortest distance from the starting point, Point 1, to Point i . Initially, each element is set to ∞ .

$Pe[i]$: The array for identifying the points that have been processed while the shortest distance is calculated. Initially, each element is set to `false`. When $Pe[i]$ is `true`, $Sd[i]$ stores the shortest distance from Point 1 to Point i . When all the elements are `true`, the process will be finished.

- (3) The following describes the procedure of calculating the shortest distance using the example of Fig. 1.

- (i) Because the starting point is Point 1, set $Pe[1]$ to $true$. Next, find the points that are connected directly from Point 1. Those are Points 2, 4 and 5. Then store those distances $Dt[1][2]$, $Dt[1][4]$ and $Dt[1][5]$ into $Sd[2]$, $Sd[4]$ and $Sd[5]$, respectively. As a result, $Sd[2] = 10$, $Sd[4] = 20$, and $Sd[5] = 30$. The result is shown in Fig. 2. The value in $[]$ above or below Point i shows the temporary shortest distance $Sd[i]$ from Point 1 to Point i . The marked point by shade indicates that it is processed ($Pe[i] = true$).

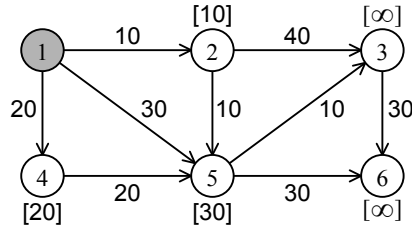


Fig. 2 The result of step (i)

- (ii) Among unprocessed points, select the point whose temporary shortest distance from Point 1 is the shortest. That is Point 2, and set $Pe[2]$ to $true$ (2 is the value of index k where $Pe[k] = false$ and $Sd[k]$ is the smallest). At this point, $Sd[2] = 10$ is determined as the shortest distance between Point 1 and Point 2.

Next, temporary shortest distances $Sd[i]$ to Points 3 and 5, which are connected directly from Point 2, are updated. However, when the value of $Sd[i]$ is not become smaller, it is not replaced.

(Before update)	(After update)
$Sd[3] = \infty$	$\rightarrow Sd[3] = Sd[2] + Dt[2][3] = 50$
$Sd[5] = 30$	$\rightarrow Sd[5] = Sd[2] + Dt[2][5] = 20$

At this time, the assignment statement in a pseudo-language for updating temporary shortest distance $Sd[i]$ to point i ($i = 3, 5$) via point k ($k = 2$) is as shown in [Part of the program] below. Here, the system function \min returns the smaller value within two arguments.

[Part of the program]

$Sd[i] \leftarrow \min(Sd[i], \boxed{A})$

The result is shown in Fig. 3.

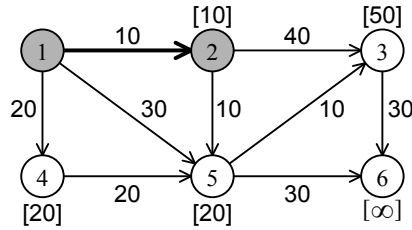


Fig. 3 The result of step (ii)

- (iii) Among unprocessed points, Points 4 and 5 are the points whose temporary shortest distance is the shortest. When multiple points have the same value, a point with a smaller element number, Point 4, is selected and marked as processed. At this point, $Sd[4]$ is determined as the shortest distance between Point 1 and Point 4.

Next, the temporary shortest distance to the point connected directly from Point 4 is updated.

$Sd[4] + Dt[4][5] = 40$. This is larger than the current value of $Sd[5]$. Therefore, it is not updated. The result is shown in Fig. 4.

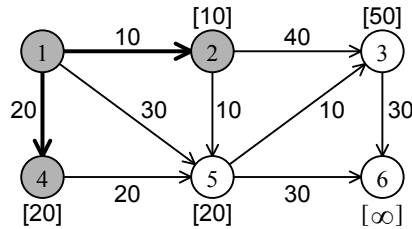


Fig. 4 The result of step (iii)

- (iv) Among unprocessed points, Point 5 is the point whose temporary shortest distance is the shortest. Select Point 5 and mark it as processed. At this point, $Sd[5]$ is determined as the shortest distance between Point 1 and Point 5.

Next, the temporary shortest distances of points that are connected directly from Point 5 are updated.

$$Sd[3] = 50 \quad \rightarrow Sd[3] = Sd[5] + Dt[5][3] = 30$$

$$Sd[6] = \infty \quad \rightarrow Sd[6] = Sd[5] + Dt[5][6] = 50$$

The result is shown in Fig. 5.

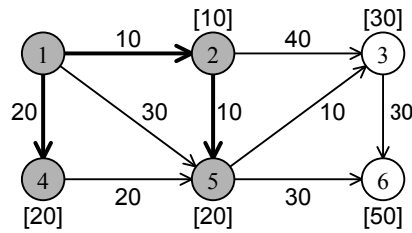


Fig. 5 The result of step (iv)

- (v) Among unprocessed points, Point 3 is the point whose temporary shortest distance is the shortest. Select it and mark it as processed. At this point, $Sd[3]$ is determined as the shortest distance between Point 1 and Point 3.

Next, the temporary shortest distance to Point 6, which is connected directly from Point 3, is updated.

Calculated as the same way in step (iii), the temporary shortest distance of Point 6, $Sd[6]$ becomes B.

The result is shown in Fig. 6.

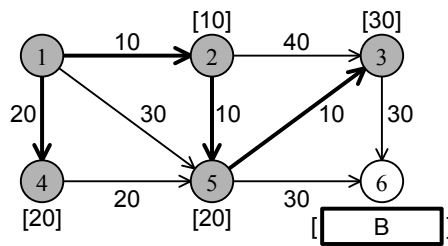


Fig. 6 The result of step (v)

- (vi) Among unprocessed points, Point 6 is the point whose temporary shortest distance is the shortest. Select it and mark it as processed. At this point, $Sd[6]$ is determined as the shortest distance between Point 1 and Point 6.

All the points have been processed, bringing the procedure completed. The result is shown in Fig. 7.

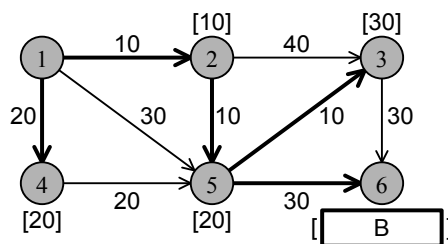


Fig. 7 The result of step (vi)

Subquestion 1

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

in the description of the algorithm ShortestLength.

Answer group for A:

- | | |
|-----------------------|-----------------------|
| a) $Sd[i] + Dt[i][k]$ | b) $Sd[i] + Dt[k][i]$ |
| c) $Sd[k] + Dt[i][k]$ | d) $Sd[k] + Dt[k][i]$ |

Answer group for B:

- | | | | |
|-------|-------|-------|-------|
| a) 30 | b) 40 | c) 50 | d) 60 |
|-------|-------|-------|-------|

Q11-4 □□□

Read the following program description and the program itself, and then answer Subquestions 1 and 2.

[Description of Program 1]

The subprogram **Compress** is a program for compressing a character string.

- (1) The character type array **Dat** is searched from the start. When the same character appears four (4) or more times consecutively, those characters are substituted with the character string described below that starts with '@', and the substitute character string is stored in the character type array **Cmp** instead of the substituted characters.

Character string after substitution

"@Xn"

X shows the character that appears continuously.

n shows the number of times for which the same character is appearing consecutively ($4 \leq n \leq 9$).

Fig.1 Character string after substitution

- (2) In the respective element of the character type array, one (1) character at a time is stored in sequence. In the element after the last character, the system constant **EOS** is stored. Array **Dat** does not contain '@', and the number of times for which the same character appears consecutively is nine (9) or less. The index of all arrays used in the program starts with zero (0).

- (3) An execution example is shown below.

Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dat	A	A	B	B	B	B	C	D	E	E	E	E	E	F	EOS
Cmp	A	A	@	B	4	C	D	@	E	5	F	EOS			

- (4) The specifications of arguments of the subprogram **Compress** are as shown below

Argument	Data type	Input/Output	Meaning
Dat[]	Character type	Input	Character type array to be compressed
Cmp[]	Character type	Output	Character type array after compression

[Program 1]

- Subprogram: Compress(character_type: Dat[], character_type :Cmp[])
- integer_type: Didx, Cidx, Cnt
- character_type: CmpChar

(Line number)

```

1 Didx ← 0
2 Cidx ← 0
3 ■ Dat[Didx] ≠ EOS
4   · CmpChar ← Dat[Didx]
5   · Cnt ← 1
6   ■ A
7   · Cnt ← Cnt + 1
8   ■
9   · B
10  ▲ Cnt ≥ 4
11  · Cmp[Cidx] ← '@'
12  · Cmp[Cidx + 1] ← CmpChar
13  · Cmp[Cidx + 2] ← IntToChar(Cnt)
14  · C
15  ───────────
16  ■ Cnt > 0
17  · Cmp[Cidx] ← CmpChar
18  · Cidx ← Cidx + 1
19  · Cnt ← Cnt - 1
20  ■
21  ▼
22  ■
23  · Cmp[Cidx] ← EOS
  
```

(5) For changing the number of times for which the same character appears consecutively, function `IntToChar` is used. Specifications of the function `IntToChar` are as follows:

Function	Specifications
Character_type: <code>IntToChar(integer_type :Num)</code>	Converts the integer number specified by the argument <code>Num</code> into character, and returns it. Example) $6 \rightarrow '6'$

- character_type: `IntToChar(integer_type:Num)`
- character_type: `Cnum[0:10] = {'0', '1', '2', '3', '4', '5', '6', '7', '8', '9', EOS}`
 /* Initialization of the character type array Cnum */
 /* In the respective element of Cnum, value inside { } is stored. Index start from zero (0) */
 - Return `Cnum[Num]`

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank

in Program 1.

Answer group for A:

- a) `CmpChar = Dat[Didx + 1]` b) `CmpChar = Dat[Didx + Cnt]`
- c) `CmpChar ≠ Dat[Didx + 1]` d) `CmpChar ≠ Dat[Didx + Cnt]`

Answer group for B and C:

- a) `Cidx ← Cidx + 1` b) `Cidx ← Cidx + 2`
- c) `Cidx ← Cidx + 3` d) `Cidx ← Cidx + Cnt`
- e) `Didx ← Didx + 1` f) `Didx ← Didx + 3`
- g) `Didx ← Didx + Cnt`

Subquestion 2

The subprogram Expand is a program for decompressing a compressed character string. From the answer group below, select the correct answers to be inserted in the blanks in the following [Program 2]. Specification of arguments of the subprogram Expand are as follows:

Argument	Data type	Input/Output	Meaning
Cmp[]	Character type	Input	Compressed character type array
Exp[]	Character type	Output	Character type array after decompression

[Program 2]

- Subprogram: Expand(character_type:Cmp[], character_type:Exp[])
- integer_type: Cidx, Eidx, i, Cnt

(Line number)

```

1 Cidx ← 0
2 Eidx ← 0
3 ■ Cmp[Cidx] ≠ EOS
4   ▲ Cmp[Cidx] = '@'
5   · Cnt ← CharToInt(Cmp[Cidx + 2])
6   ■ i : 1, i ≤ Cnt, 1
7   ·  D
8   · Eidx ← Eidx + 1
9   ■
10  ·  E
11  ───────────
12  · Exp[Eidx] ← Cmp[Cidx]
13  · Eidx ← Eidx + 1
14  · Cidx ← Cidx + 1
15  ▼
16 ■
17 · Exp[Eidx] ← EOS

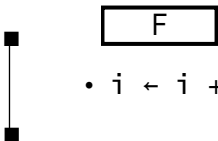
```

Moreover, for converting the number of times for which the same character appears consecutively, from character to integer, the subprogram Expand uses the function CharToInt. Specifications of the function CharToInt are as follows:

Function	Specifications
integer_type: CharToInt(character_type: Chr)	Converts the character specified with the argument Chr into integer, and returns the converted value. Example) '6' → 6

```

○ integer_type: CharToInt(character_type: Chr)
○ character_type: Cnum[0:10] = {'0', '1', '2', '3', '4',
                                '5', '6', '7', '8', '9', EOS}

/* Initialization of the character string Cnum */
/* Value inside { } is stored in the respective elements of Cnum. Index starts with zero (0).
*/
○ integer_type: i
  .. i ← 4
  
  • i ← i + 1
• Return i

```

Answer group for D:

- | | |
|------------------------------|--------------------------------|
| a) Exp[Eidx] ← Cmp[Cidx] | b) Exp[Eidx] ← Cmp[Cidx + 1] |
| c) Exp[Eidx] ← Cmp[Cidx + 2] | d) Exp[Eidx] ← Cmp[Cidx + Cnt] |

Answer group for E:

- | | |
|----------------------|-----------------------|
| a) Cidx ← Cidx + 1 | b) Cidx ← Cidx + 3 |
| c) Cidx ← Cidx + Cnt | d) Cidx ← Cidx + Eidx |

Answer group for F:

- | | |
|----------------------|----------------------|
| a) Chr = Cnum[i] | b) Chr = Cnum[i - 1] |
| c) Chr = EOS | d) Chr ≠ Cnum[i] |
| e) Chr ≠ Cnum[i - 1] | |

Q11-5 □□□

Read the following description of a program and the program itself, and then answer Subquestions 1 and 2.

[Program Description]

Subprogram mergeSort performs sorting 2^n pieces of integer data (n is an integer and $n > 0$) stored contiguously in a one-dimensional array, by repeatedly merging them n times.

- (1) Sort elements of array input[] in ascending order and then store them in array output[].
- (2) The subscript (index) of each array begins with 0.
- (3) The argument specifications of subprogram mergeSort are shown in the following table.

Table Argument Specifications of mergeSort

Variable	Type	Input/Output	Meaning
input[]	integer	input	Data to be sorted
output[]	integer	output	Area for storing sorted result
size	integer	input	Number of elements in array

The figure below shows an example in which 8 pieces of data stored in the one-dimensional array are sorted by repeating merging 3 times.

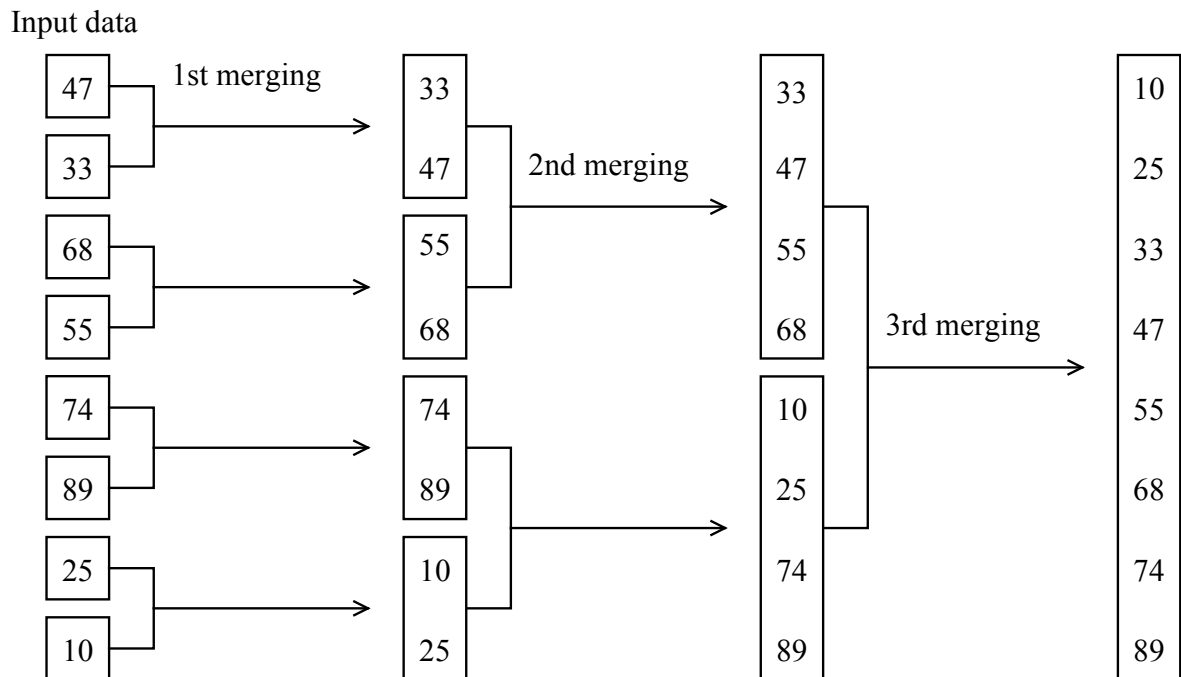


Fig. Example of Merge/Sort

[Program]

```

○ mergeSort (integer: input[], integer: output[], integer: size)
○ integer: span_size, temp[size / 2], span_idx, write_idx, a_idx, b_idx
○ logical: a_yet, b_yet
  • span_size ← 2                /* size of areas to be merged */
  • output[] ← input[]           /* copy of array */
  ■ span_size ≤ size
    ■ span_idx ← 0                /* initialization of index in input area */
    ■ write_idx ← 0               /* initialization of index in output area */
    ■ span_idx < size              ← α
      ■ a_idx ← span_idx
      ■ b_idx ← span_idx + span_size / 2
      ■ i: a_idx - span_idx, i < b_idx - a_idx, 1
        ■ temp[i] ← output[i + span_idx]
      ■ a_yet ← true
      ■ b_yet ← true
      ■ A
        b_yet = false or (a_yet = true
          and b_yet = true and
            temp[a_idx - span_idx] ≤ output[b_idx])
        ■ output[write_idx] ← temp[a_idx - span_idx]
        ■ a_idx ← a_idx + 1
        ■ a_idx ≥ span_idx + span_size / 2
          ■ a_yet ← false
        ■ output[write_idx] ← output[b_idx]
        ■ b_idx ← b_idx + 1
        ■ b_idx ≥ span_idx + span_size
          ■ b_yet ← false
      ■ B              ← β
      ■ span_idx ← span_idx + span_size
    ■ span_size ← span_size × 2    ← γ
  
```

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank in the above program.

Answer group for A:

- a) `a_yet = false` and `b_yet = false`
- b) `a_yet = false` or `b_yet = false`
- c) `a_yet = true` and `b_yet = true`
- d) `a_yet = true` or `b_yet = true`

Answer group for B:

- a) `b_idx ← span_idx`
- b) `b_idx ← span_idx + span_size`
- c) `b_idx ← span_idx + span_size ÷ 2`
- d) `b_idx ← span_idx + span_size × 2`
- e) `write_idx ← 1`
- f) `write_idx ← a_idx + 1`
- g) `write_idx ← b_idx + 1`
- h) `write_idx ← write_idx + 1`

Subquestion 2

From the answer groups below, select the correct answer to be inserted in each blank in the following description.

If the subprogram `mergeSort` is executed using the following data as input data, the merging process is carried out times. Actually, however, data is sorted in ascending order at the time merging has been completed times.

The following changes 1 through 3 can be added to terminate the subprogram `mergeSort` at the time data has been sorted in ascending order. Here, the variable `ordered` in the program after the change is assumed to have been declared as logical type.

Input data

2 1 4 3 8 7 6 5

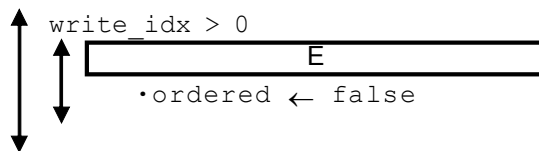
Change 1

Add the following process just before α :

•ordered \leftarrow true

Change 2

Add the following process just before β :



Change 3

Add the following process just before γ :

ordered = true
•span_size \leftarrow size

Answer group for C and D:

- a) 1 b) 2 c) 3 d) 4 e) 5

Answer group for E:

- a) output[write_idx - 1] \leq output[write_idx]
- b) output[write_idx] \leq output[write_idx + 1]
- c) output[write_idx - 1] $>$ output[write_idx]
- d) output[write_idx] $>$ output[write_idx + 1]
- e) temp[write_idx] \leq output[write_idx]
- f) temp[write_idx - 1] \leq temp[write_idx + 1]
- g) temp[write_idx] $>$ output[write_idx]
- h) temp[write_idx - 1] $>$ temp[write_idx + 1]

Q11-6 □□□

Read the following program description and the program itself, and then answer Subquestion.

[Program Description]

There is a display area of 64 (8×8) pixels. When coordinates of a pixel (VS, HS) and a new-color (NC) are given, the program repaints the pixel and its same-colored neighboring pixels with the new-color. As a result, a same-colored area is repainted.

For a given pixel, if its upper, lower, left, or right adjacent pixels have the same color, those pixels are determined to be within the same-colored area. This test is executed repeatedly for each adjacent pixel that is determined to be within the same-colored area. Thus, the same-colored area is searched thoroughly, and is repainted with the new-color.

- (1) Prepare a two-dimensional array `Image` with a size of 10×10 (the range of each index is 0 to 9). A part of the array `Image` (the range of each index is 1 to 8) contains the color of each pixel.
- (2) Three colors, black (■), gray (▣), and white (□) are used. These colors are represented by values 1, 2, and 3, respectively.
- (3) The pixel that indicates the starting point in the area to be repainted is specified with variables VS and HS. VS and HS are vertical and horizontal indices of the element in array `Image` which corresponds to the pixel.
- (4) The new-color with which the area is repainted is specified by a variable NC.
- (5) The program obtains the current-color of the pixel from `Image[VS, HS]`, and repaints the area (the pixel and its same-colored neighboring pixels) with the new-color NC.
- (6) Correct values have already been set to the global variables `Image`, VS, HS, and NC.
- (7) Indices for arrays `VPos` and `HPos` start at 1.
- (8) Fig. 1 shows an example of running the program with VS=5, HS=3 to indicate that `Image[5, 3]` is the starting point of the area to be repainted, and NC=1 to use black (■) as the new-color.

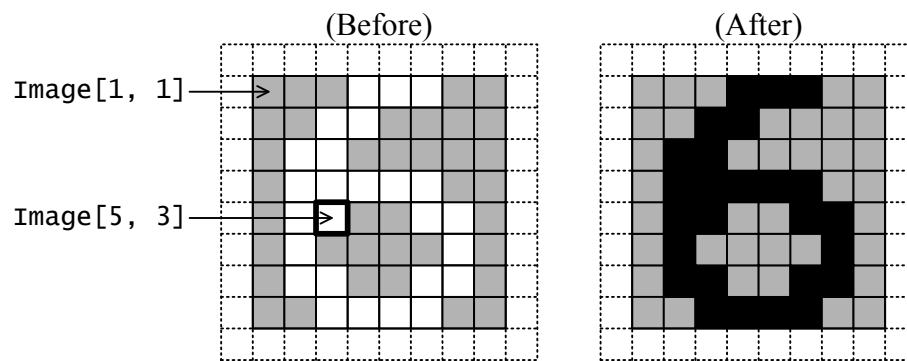


Fig. 1 Example of running the program (with NC=1, VS=5, HS=3)

[Program]

(Line number)

```

1  o Unsigned 8-bit integer: Image[10, 10]          /* Color of pixels */
2  o Integer: VS, HS                                /* Starting point is Image[VS, HS] */
3  o Unsigned 8-bit integer: CC, NC                /* Repaint area with color CC using color NC */
4  o Integer: More                                  /* Number of pixels waiting for process */
5  o Integer: VPos[64], HPos[64]                  /* Positions of pixels waiting for process */
6
7  o Program: Main
8  o Integer: V, H                                /* Indices for vertical (V) and horizontal (H) directions */
9  o Unsigned 8-bit integer: wall
10                                     /* Value to be stored in the periphery of display area */
11 • CC ← Image[VS, HS]                          /* Get current-color of starting point */
12 ▲ CC = NC
13 │   • Return                                    /* End of processing */
14 ▼
15 • wall ← 0
16 ■ V: 1, V ≤ 8, 1                                /* Set value for periphery (V=1, 2, ..., 8) */
17 │   • Image[V, 0] ← wall
18 │   • Image[V, 9] ← wall
19 ■
20 ■ H: 1, H ≤ 8, 1                                /* Set value for periphery (H=1, 2, ..., 8) */
21 │   • Image[0, H] ← wall
22 │   • Image[9, H] ← wall
23 ■
24 • More ← 0
25 • CheckAndStack(VS, HS) /* Register starting point as the pixel waiting for process */
26 ■ More > 0                                       /* Repeat the following steps while More>0 */
27 │   • V ← VPos[More]
28 │   • H ← HPos[More]
29 │   • More ← More - 1
30 │   • CheckAndStack(V - 1, H)
31 │   • CheckAndStack(V, H - 1)
32 │   • CheckAndStack(V + 1, H)
33 │   • CheckAndStack(V, H + 1)
34 ■
35 • Return                                       /* End of processing */
36
37 o Subprogram: CheckAndStack(Integer: Vt, Integer: Ht)
38 ▲ Image[Vt, Ht] = CC                          /* Within the area of same color? */
39 │   • Image[Vt, Ht] ← NC
40 │   • More ← More + 1
41 │   • VPos[More] ← Vt
42 │   • HPos[More] ← Ht
43 ▼
44 • Return                                       /* Return to the caller */

```

Subquestion

From the answer groups below, select the correct answer to be inserted into each blank in the following description.

The following is a conversation between a senior engineer (hereinafter called SE) and a fundamental engineer (hereinafter called FE) about this program.

SE: To understand the behavior of a program, it's important to trace the flow of the processes. First, using numbers 1 through 5, show me the order of how the first 5 pixels are repainted for the data shown in Fig. 1.

FE: Okay. I'll try tracing the program. The result is A .

SE: That's right. Now, let's examine the program. First, the size of the display area is 8×8 , but the size of array `Image` is 10×10 , and 0's are set in the array elements for the periphery by lines 15 through 23. What is the purpose of this process?

FE: B . But setting values for 32 array elements among 64 elements in the display area seems like a lot of unnecessary work.

SE: Then, when the size of a display area is $m \times n$, what is the expression for the number of elements for which values are set by lines 15 through 23?

FE: Well, it would be C . I see, this number of elements becomes relatively small as the number of pixels $m \times n$ in the display area becomes larger.

SE: Next, let's think about the value to be set in the periphery array elements. By line 15, value 0 is assigned to the variable `wall`. In the given specification, the color of a pixel is represented by a value in the range of 1 to 3, so this is not a problem, but if all unsigned 8-bit values from 0 to 255 are used to specify a color, how should line 15 be modified? Give an example.

FE: One example is to change line 15 to D .

SE: Next, let's take a look at lines 12 through 14. What are these lines for?

FE: If the program is going to repaint the area with the same color as the current-color, it returns to the caller without executing the subsequent steps. This is because repainting with the same color makes no difference and is meaningless.

SE: That is certainly one reason. Let's see what happens if lines 12 through 14 are removed from the program. Now, trace the program when it is trying to repaint a white-colored area with the same white color. We'll try 3 cases; for a white-colored area consisting of 1, 2, and 3 pixels as shown in (1) through (3) in Fig. 2. Here, variables `VS` and `HS` are set to point the pixel with the thick border.

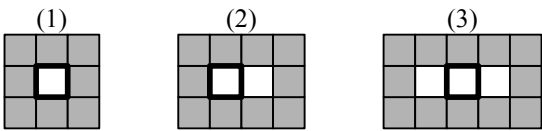


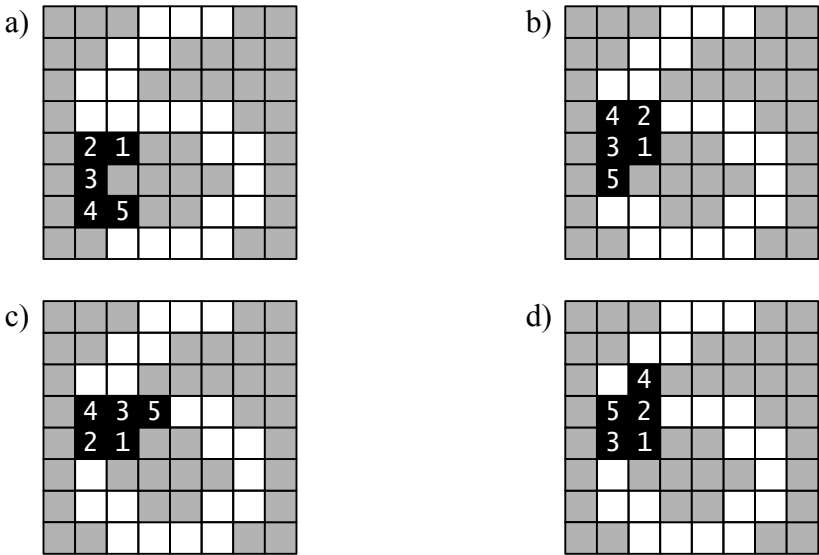
Fig. 2 Areas consisting of 1, 2, and 3 pixels

FE: Let me see. The results would be as shown in the following table. From these results, I see that lines 12 through 14 are important steps that cannot be omitted.

Table Results of tracing

Test case	Behavior of the program
(1) in Fig. 2 (area with 1 pixel)	<div>E</div>
(2) in Fig. 2 (area with 2 pixels)	<div>F</div>
(3) in Fig. 2 (area with 3 pixels)	Value of variable <code>more</code> increases and exceeds the maximum index value of the array

Answer group for A



Answer group for B

- a) Even though these elements are not referenced, their index values can be used to determine whether they are within the display area
- b) It simplifies the processing by setting these elements repaintable with color NC
- c) It allows the range check for each index of array `Image` to be omitted
- d) It allows the range check for each index of arrays `VPos` and `HPos` to be omitted

Answer group for C

- a) $2(m+1)(n+1)$
- b) $2(m+n)$
- c) $2(m+n+2)$
- d) $2(m+n-2)$

Answer group for D

- a) • `wall ← CC`
- b) • `wall ← NC`
- c) • `wall ← 256 - CC`
- d) • `wall ← 255 - NC`

Answer group for E and F

- a) Repaints the area with the same color according to the specification and exits normally.
- b) Exits without repainting the area.
- c) Repaints surrounding pixels excessively that are not included in the area to be repainted, and then exits.
- d) Value of variable `More` increases and exceeds the maximum index value of the array.
- e) Value of variable `More` remains less than a certain value, but the processes loop infinitely.

Q11-7 □□□

Read the following program description and the program itself, and then answer Subquestion.

[Program Description]

Function `RadixConv` is a program that converts a base M digit string ($2 \leq M \leq 16$) to a base N digit string ($2 \leq N \leq 16$).

- (1) A base M digit string consists of base M digits alone without space characters. For digits greater than 10 in bases (base 11 through 16), the alphabetic characters A through F are used.
- (2) `RadixConv` first converts a base M digit string to an integer and then converts it to a base N digit string. Function `MtoInt` converts a base M digit string to an integer, and function `IntToN` converts the integer to a base N digit string.
- (3) Function `MtoInt` and function `IntToN` use the following functions:
 - (i) Function `ToInt` that converts a one-digit character P ("0", "1", ..., or "F") to an integer
 - (ii) Function `ToStr` that converts an integer Q ($0 \leq Q \leq 15$) to a one-digit character ("0", "1", ..., or "F")
 - (iii) Predefined function `Length` that returns the length of the string
 - (iv) Predefined function `Substr` that extracts part of the string
- (4) Tables 1 through 5 list the specification of arguments and return values of functions.

Table 1 RadixConv

Argument/ Return value	Data type	Meaning
<code>Frdx</code>	Integer type	Radix of source digit string ($2 \leq Frdx \leq 16$)
<code>Fnum</code>	Character type	Source digit string
<code>Trdx</code>	Integer type	Radix of converted digit string ($2 \leq Trdx \leq 16$)
Return value	Character type	Converted base <code>Trdx</code> digit string

Table 2 MToInt

Argument/ Return value	Data type	Meaning
Rdx	Integer type	Radix of source digit string ($2 \leq \text{Rdx} \leq 16$)
Num	Character type	Source digit string
Return value	Integer type	Converted integer

Table 3 IntToN

Argument/ Return value	Data type	Meaning
Val	Integer type	Converted integer
Rdx	Integer type	Radix of converted digit string ($2 \leq \text{Rdx} \leq 16$)
Return value	Character type	Converted base Rdx digit string

Table 4 ToInt

Argument/ Return value	Data type	Meaning
P	Character type	Source one-digit character ("0", "1", ..., or "F")
Return value	Integer type	Converted integer

Table 5 ToStr

Argument/ Return value	Data type	Meaning
Q	Integer type	Source integer ($0 \leq Q \leq 15$)
Return value	Character type	Converted one-digit character

[Program]

○ character_type: RadixConv (integer_type: Frdx, character_type: Fnum, integer_type: Trdx)

• return IntToN(MToInt(Frdx, Fnum), Trdx)
/* Takes IntToN value as return value of function */

○ integer_type: MToInt (integer_type: Rdx, character_type: Num)

○ integer_type: Idx, Val

• Val ← 0

■ Idx: 1, Idx ≤ Length(Num), 1 /* Length returns string length of Num */

• Val ← + ToInt(Substr(Num, Idx, 1))

■ /* Substr fetches the Idxth(≥ 1) character from the beginning of Num */

• return Val /* Takes Val as the return value of function */

○ character_type: IntToN(integer_type: Val, integer_type: Rdx)

○ integer_type: Quo /* Quotient */

○ integer_type: Rem /* Remainder */

○ character_type: Tmp

•

• Tmp ← ""

■ Quo ≥ Rdx

• Rem ← Quo % Rdx

• Tmp ← ToString(Rem) + Tmp /* + is an operator to concatenate strings */

•

■

•

• return Tmp /* Takes Tmp as return value of function */

○ integer_type: ToInt(character type: P)

○ integer_type: Idx

○ character_type: Code[16] /* Subscript begins at 0 */

/* Code stores initial values "0", "1", "2", "3", "4", "5", "6", "7", /*

/* "8", "9", "A", "B", "C", "D", "E", "F" in this order */

/* Character values are incremented in this order */

• Idx ← 0

■ /* Compare the character */

• Idx ← Idx + 1

■

• return Idx /* Takes Idx as the return value of function */

○ character_type: ToString(integer_type: Q)

○ character_type: Code[16] /* Subscript begins at 0 */

/* Code stores initial values "0", "1", "2", "3", "4", "5", "6", "7", /*

/* "8", "9", "A", "B", "C", "D", "E", "F" in this order */

/* Character values are incremented in this order */

• return Code[Q] /* Takes Code[Q] as the return value of the function */

Subquestion

From the answer groups below, select the correct answer to insert in each blank

in the above program.

Answer group for A:

- | | |
|---------------------|-------------------|
| a) Rdx | b) Val |
| c) $Val \times Rdx$ | d) $Val \div Rdx$ |

Answer group for B, C, and D:

- | | |
|---|---|
| a) $Quo \leftarrow Quo \div Rdx$ | b) $Quo \leftarrow Quo \div Rem$ |
| c) $Quo \leftarrow Rdx$ | d) $Quo \leftarrow Rem \div Rdx$ |
| e) $Quo \leftarrow Val$ | f) $Rem \leftarrow Rdx$ |
| g) $Rem \leftarrow Val$ | h) $Tmp \leftarrow ToString(Quo) + Tmp$ |
| i) $Tmp \leftarrow ToString(Rem) + Tmp$ | |

Answer group for E:

- | | |
|-----------------------|-----------------------|
| a) $P < Code[Idx]$ | b) $P > Code[Idx]$ |
| c) $P \leq Code[Idx]$ | d) $P \geq Code[Idx]$ |

Afternoon Exam

Section 12

Software Development (Five Languages, One Mandatory Question)

Learning Objectives

1. Read the "Description of Program" and understand the content of the processing. Be able to perform mapping of code.
2. Be able to follow (i.e., trace) the processing of the program using simple examples.
3. Based on the Description of Program, be able to identify the processing that goes into blanks in the program.
4. Be able to calculate the execution outcome for given data, based on the program algorithms.
5. Be able to locate mistakes in the program.
6. Understand how the program should be modified to accommodate additions and changes to the processing.
7. Understand the functions of spreadsheet software and the use of functions.

12.1

Software Development (C)**Q12-1** □□□

Read the following description of a C program and the program itself, and then answer the Subquestion.

[Program Description]

Function `execute` draws lines when the marker displayed on the screen is moved.

- 1) A bitmap screen has 800 pixels in the horizontal direction and 600 pixels in the vertical direction. Fig. 1 shows the screen's coordinate system. A marker (• in Fig. 1) with positional and directional information is shown on the screen. The marker moves in four directions: up, down, left, or right. The locus of the marker is drawn when it is moved.

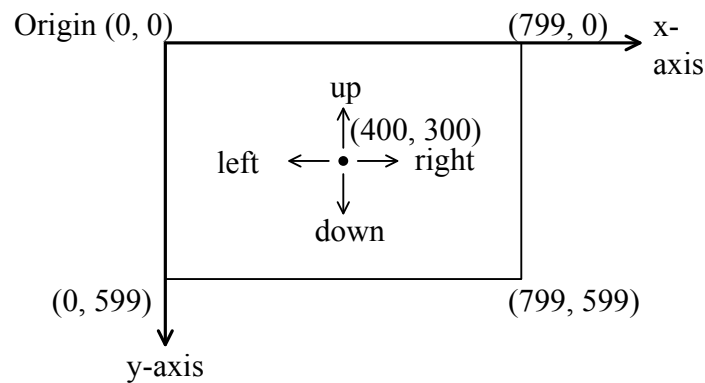


Fig. 1 Screen coordinate system and initial marker status

- 2) The marker is represented by `MARKER` type structure `mark`. When the program starts, the marker position is set to (400, 300) and its direction of movement is upward.

```
typedef struct {
    int x;    /* x coordinate of marker */
    int y;    /* y coordinate of marker */
    int dir;  /* Marker direction 0:right 1:up 2:left 3:down
*/
} MARKER;

MARKER mark = {400, /* Initial x coordinate of marker */
               300, /* Initial y coordinate of marker */
               1    /* Initial direction of marker (up) */
               };
```

- 3) Instructions for operating the marker are defined. Each instruction consists of an instruction code and a value, and is expressed by the structure `INST`.

```
typedef struct {
    char code; /* Instruction code */
    int val;   /* value */
} INST;
```

The instructions are stored in the order of execution from the beginning of `insts`, which is an array of the structure `INST`.

- 4) The table below lists instruction codes and descriptions.

Instruction code	Description
{	Repeat executing <code>val</code> times from the next instruction to the last one before the code <code>'}'</code> that forms a pair. <code>val</code> is an integer greater than 1.
t	Change the direction of movement of the marker by $90^\circ \times \text{val}$ in the counterclockwise direction. <code>val</code> is a nonnegative integer.

f	Move the marker in the current direction by val pixels to draw a line from the source to the destination. val is any integer.
}	Indicates the end of a series of instructions to be repeated. val is not referenced.
\0	Indicates the end of the instruction array. val is not referenced.

- 5) Fig. 3 shows the output of function `execute` executed with the instructions stored in the structure array `insts`, as shown in Fig. 2. Note, however, that the coordinate values in Fig. 3 are added for the sake of explanation and are not actually outputted.

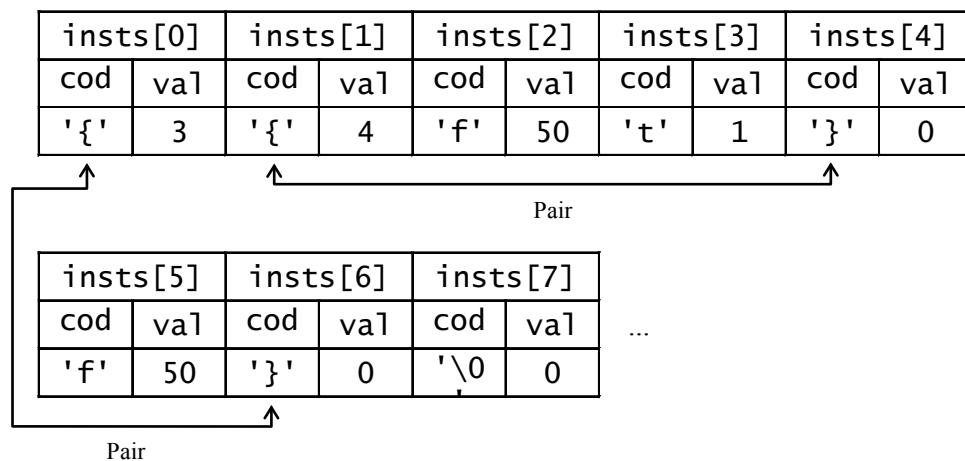


Fig. 2 Example of instructions stored in the structure array `insts`

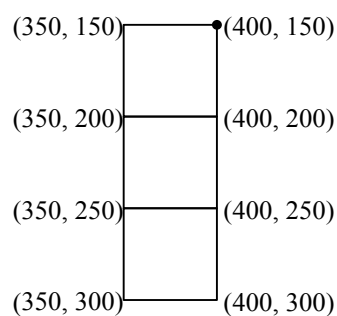


Fig. 3 Results of executing the example in Fig. 2

- 6) The following functions are available for drawing lines:

```
void drawLine( int x1, int y1, int x2, int y2 );
```

Features: Draws part of the line segment connecting coordinate (x1, y1) and coordinate (x2, y2) that is included in the screen area.

- 7) The following functions related to the marker are available:

```
void eraseMarker( MARKER mark );
```

Feature: Erases the indication of the marker when it is in the screen area.

```
void paintMarker( MARKER mark );
```

Feature: Draws the marker when it is in the screen area.

- 8) Even if the marker has moved out of the screen area and is no longer visible, its position coordinates and direction of movement are retained.

[Program]

```
#define INSTSIZE 100 /* Upper limit of number of instructions */
```

```
#define STACKSIZE 50 /* Upper limit of nesting */
```

```
typedef struct {
```

```
    int x;      /* x coordinate of marker */
```

```
    int y;      /* y coordinate of marker */
```

```
    int dir; /* Marker direction 0:right 1:up 2:left 3:down */
```

```
} MARKER;
```

```
typedef struct {
```

```
    char code; /* Instruction code */
```

```
    int val;   /* value */
```

```
} INST;
```

```
typedef struct {
```

```
    int opno; /* Element No. of array insts at which the start of loop is
defined */
```

```
    int rest; /* Remaining loop count */
```

```
} STACK;
```

```
void drawLine( int, int, int, int );
```

```
void eraseMarker( MARKER );
```

```
void paintMarker( MARKER );
```



```

INST insts[INSTSIZE];    /* Structure array for storing instructions */
MARKER mark = {400, /* Initial x coordinate of marker */
               300, /* Initial y coordinate of marker */
               1    /* Initial direction of marker (up) */
               };

void execute(){

    STACK stack[STACKSIZE];
    int opno = 0;    /* Element No. of array insts which contains the instruction
to be executed */
    int spt = -1;    /* Stack pointer */
    int dx, dy;

    paintMarker( mark );

    while( insts[opno].code != '\0' ){
        switch( insts[opno].code ){
            case '{':
                stack[  ].opno = opno;
                stack[spt].rest = insts[opno].val;
                break;
            case 't':
                mark.dir = ;
                break;
            case 'f':
                eraseMarker( mark );
                dx = ( mark.dir % 2 == 0 ) ? ;
                dy = ( mark.dir % 2 == 0 ) ? ;
                drawLine( mark.x, mark.y,
                           mark.x + dx, mark.y + dy );
                mark.x += dx;
                mark.y += dy;
                paintMarker( mark );
                break;
            case '}':
                if ( stack[spt].rest  ){
                    opno = stack[spt].opno;

```

```

        stack[spt].rest--;
    } else {
        ;
    }
    break;
}
;
}
}

```

Subquestion

From the answer groups below, select the correct answers to be inserted in the blanks in the above program.

Answer group for A:

- a) ++spt b) --spt c) spt
d) spt++ e) spt--

Answer group for B:

- a) (mark.dir + insts[opno].val) % 2
b) (mark.dir + insts[opno].val) % 3
c) (mark.dir + insts[opno].val) % 4
d) mark.dir + insts[opno].val
e) mark.dir + insts[opno].val % 2
f) mark.dir + insts[opno].val % 3
g) mark.dir + insts[opno].val % 4

Answer group for C and D:

- a) `(1 - mark.dir) * insts[opno].val : 0`
- b) `(2 - mark.dir) * insts[opno].val : 0`
- c) `(mark.dir - 1) * insts[opno].val : 0`
- d) `(mark.dir - 2) * insts[opno].val : 0`
- e) `0 : (1 - mark.dir) * insts[opno].val`
- f) `0 : (2 - mark.dir) * insts[opno].val`
- g) `0 : (mark.dir - 1) * insts[opno].val`
- h) `0 : (mark.dir - 2) * insts[opno].val`
- i) `0 : mark.dir * insts[opno].val`
- j) `mark.dir * insts[opno].val : 0`

Answer group for E:

- a) `< 0`
- b) `< 1`
- c) `== 0`
- d) `> 0`
- e) `> 1`

Answer group for F and G:

- a) `mark.dir++`
- b) `mark.dir--`
- c) `opno++`
- d) `opno--`
- e) `spt++`
- f) `spt--`

Q12-2 □□□

Read the following description of a C program and the program itself, and then answer Subquestions 1 through 3.

[Description of Program 1]

This program writes customer information and total card usage amounts for a credit card company.

- (1) At the end of the fiscal year, the credit card company writes a file containing a list of customers' card usage amounts, in the data format shown in Fig. 1. Assume that the number of cardholders is at most 30,000, and that a cardholder's total usage amount does not exceed ¥100 million.

	Cardholder ID	Cardholder name	Prefecture	Total usage amount
(example)	4741	Rokuro_KIHON	Tokyo	3,500,000

Fig. 1 Data format for usage amount list

- (2) The data required for output is described in the two (2) types of files shown in Fig. 2. Data items are separated by spaces while underscore is used between a cardholder's family name and given name. In addition, both the cardholders file and the card usage file are sorted in ascending order of cardholder ID, and cardholder IDs are not duplicated in the data in the cardholders file.

Cardholder ID	Cardholder name	Prefecture	Cardholder ID	Usage amount
1	Taro_JOHO	Hokkaido	1	1,000
2	Hanako_JOHO	Aomori	1	50,000
3	Toriko_KODO	Miyagi	1	3,000
...
4740	Goro_KIHON	Chiba	4740	1,500
4741	Rokuro_KIHON	Tokyo	4741	10,000
...	4741	250,000
25760	Yoshiko_KEIEI	Kagoshima	4741	3,000,000
25761	Narumi_KEIEI	Okinawa

Cardholders file
member.txt

Card usage file
shopping.txt

Fig. 2 Example of import file

- (3) The program first calls the function `init`, and, as shown in Fig. 3, constructs a binary search tree structure in memory from the two (2) types of files shown in Fig. 2. For data in the cardholder ID `memNo` (in the cardholder file) that matches data in the cardholder ID `shopNo` (in the card usage file), the usage amount `shopAmount` is totaled for each cardholder ID, and the total usage amount `memAmount` is calculated. After this, the data is registered in the binary search tree using the function `regist`.

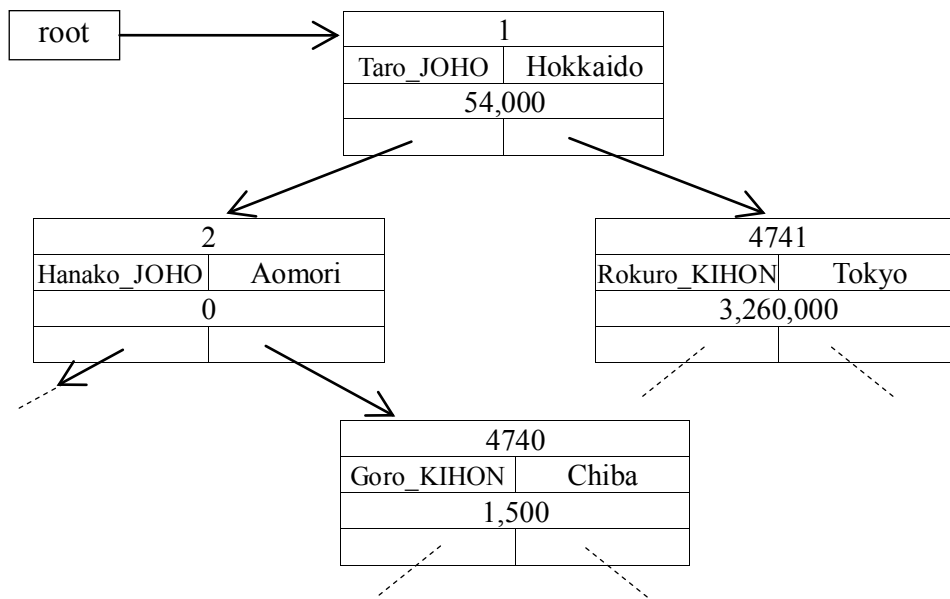


Fig. 3 Example of binary search tree data structure

- (4) Descriptions of the functions defined in the program are as follows.

`void init()`

Function: Reads in the two (2) types of file shown in Fig. 2, and constructs a binary search tree.

`void regist(int, char *, char *, long)`

Function: Registers data that was passed as arguments, into the corresponding sections of the binary search tree.

`void writeTree()`

Function: Writes data to an output file.

`void writeMember(struct MEMBER *, FILE *)`

Function: A recursive function that reads in the binary search tree in order, and writes it to an output file.

- (5) The program uses the following library function.

`void *malloc(size_t size)`

Function: Allocates an area in memory of size bytes, and returns a pointer to the allocated area. NULL is returned when memory allocation fails.

[Program 1]

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#define MAX_MEMBER 30000 /* Number of cardholders */
#define MAX_NAME_LENGTH 20
#define MAX_AREA_LENGTH 10

struct MEMBER {
    int no;
    char name[MAX_NAME_LENGTH];    /* cardholder name */
    char area[MAX_AREA_LENGTH];    /* Prefecture */
    long amount;
    struct MEMBER *left;
    struct MEMBER *right;
};

struct MEMBER *root = NULL;

void init();
void regist(int, char *, char *, long);
void writeTree();
void writeMember(struct MEMBER *, FILE *);

void init() {
    int memNo, shopNo;
    long memAmount, shopAmount;
    char tmpName[MAX_NAME_LENGTH];
    char tmpArea[MAX_AREA_LENGTH];
    int memEnd, shopEnd;

    FILE *fMember = fopen("member.txt", "r");
    FILE *fShopping = fopen("shopping.txt", "r");
    memEnd = fscanf(fMember, "%d", &memNo);
    shopEnd = fscanf(fShopping, "%d", &shopNo);

    while( memEnd != EOF ) {
```

```

    fscanf(fMember, "%s", tmpName);
    fscanf(fMember, "%s", tmpArea);
    memAmount = 0;
    while(( shopEnd != EOF) && (shopNo == memNo)) {
        fscanf(fShopping, "%d", &shopAmount);
        memAmount += shopAmount;
        shopEnd = fscanf(fShopping, "%d", &shopNo);
    }
    regist(memNo, tmpName, tmpArea, memAmount);
    memEnd = fscanf(fMember, "%d", &memNo);
}
}

void regist(int no, char *name, char *area, long amount) {
    struct MEMBER *p, *ptr, *pre;
    if ((p = (struct MEMBER *)malloc(sizeof(struct MEMBER))) == NULL ) {
        printf("Memory error\n");
        exit(-1);
    }
    p->no = no;
    strcpy(p->name, name);
    strcpy(p->area, area);
    p->amount = amount;
    p->left = p->right = NULL;

    /*Registers data in an appropriate location in binary search tree */
    if ( root == NULL ) {
        root = p;
    } else {
        ptr = root;
        while ( ptr != NULL ) {
            pre = ptr;
            if ( amount < ptr->amount ) ptr = ptr->left;
            else ptr = ptr->right;
        }
        if ( amount < pre->amount ) A ;

        else B ;
    }
}

```



```

    }
}

void writeTree() {
    FILE *fOutput = fopen("output.txt", "w");
    writeMember(root, fOutput);
    fclose(fOutput);
}

void writeMember(struct MEMBER *p, FILE *fp) {
    if( p == NULL )return;
    writeMember(p->left, fp);
    fprintf(fp, "%5d %-20s %-10s %8d\n",  C );
    writeMember(p->right, fp);
}

```

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank

in the above program.

Answer group for A and B

- | | |
|------------------|-------------------|
| a) p = pre->left | b) p = pre->right |
| c) p = ptr->left | d) p = ptr->right |
| e) pre->left = p | f) pre->right = p |
| g) ptr->left = p | h) ptr->right = p |

Answer group for C

- &p->no, &p->name, &p->area, &p->amount
- &p->no, p->name, p->area, &p->amount
- *p->no, *p->name, *p->area, *p->amount
- *p->no, p->name, p->area, *p->amount
- p->no, &p->name, &p->area, p->amount
- p->no, *p->name, *p->area, p->amount
- p->no, p->name, p->area, p->amount

Subquestion 2

For Program 1, from the answer group, select the answer that shows the correct order of output for the usage amount list, and insert into answer column D in the answer sheet.

- a) Data with larger cardholder ID values is written first.
- b) Data with smaller cardholder ID values is written first.
- c) Data with larger total usage amount values is written first. If the total usage amounts are equal, the data with the larger cardholder ID value is written first.
- d) Data with larger total usage amount values is written first. If the total usage amounts are equal, the data with the smaller cardholder ID value is written first.
- e) Data with smaller total usage amount values is written first. If the total usage amounts are equal, the data with the larger cardholder ID value is written first.
- f) Data with smaller total usage amount values is written first. If the total usage amounts are equal, the data with the smaller cardholder ID value is written first.

Subquestion 3

The function `writeMember` in Program 1 has been modified per Program 2. This time, output is to be performed so that larger total usage amounts are written first. From the answer group below, select the correct answer to be inserted in each blank in Program 2. However, the same item from Subquestion 1 goes into blank C.

[Program 2]

```
void writeMember(struct MEMBER *p, FILE *fp) {
    if( p == NULL ) return;
     E  ;
    fprintf(fp, "%5d %-20s %-10s %8ld\n",  C  );
     F  ;
}
```

Answer group:

- a) `writeMember(p->left, fp)`
- b) `writeMember(p->left, fp);`
`writeMember(p->right, fp)`
- c) `writeMember(p->right, fp)`
- d) `writeMember(p->right, fp);`
`writeMember(p->left, fp)`
- e) None

Q12-3 □□□

Read the following description of a C program and the program itself, and then answer Subquestions 1 through 3.

[Program Description]

This is a program for outputting students' performance in a certain university.

- (1) In this university, a list of students' course grades is outputted at the end of each semester, to a file which has the record format shown in Fig. 1. The number of students is 15,000, the number of courses is 2,000, and the scores are integers in the 0 – 100 range.

	Student key	Student name	Course name	Score	Course name	Score		Course name	Score
[Example]	02498	Goro KIHON	Information Processing 2	25	Chemistry Lab	50	...	Basic English Conversation 1	67

Fig. 1 Record format of list of course grades

(2) Data required for outputting is entered in three types of files as shown in Fig. 2.

Course key	Course name	Student file	Student name	Course key	Student key	Score
0000	Information Processing 1	00000	Hanako SEKKEI	1932	00472	34
0001	Information Processing 2	00001	Taro JOHO	1932	09755	79
0002	Numerical Analysis	00002	Jiro KAIHATSU	0357	10253	41
	:		:		:	
0752	Chemistry Lab	02498	Goro KIHON	0752	02498	50
	:		:		:	
1997	Basic English Conversation 3	14997	Mamoru SHIKEN	0173	13712	13
1998	Basic English Conversation 4	14998	Saburo TANGEN	0173	00638	78
1999	Advanced English	14999	Daisuke GENGO	0173	03581	61

Course file course.txt	Student file student.txt	Score record file recrd.txt
---------------------------	-----------------------------	--------------------------------

Fig. 2 Read-in files (sample)

(3) By first calling function `init`, this program creates the list structures as shown in Fig. 3 in the memory from the three types of files shown in Fig. 2. A course name corresponding to a course key `courseKey` is stored in a `char` type array `courseName [courseKey]`. Moreover, student information corresponding to student key `studentKey` is expressed by a `STUDENT` type structure `student [studentKey]`. A student name is stored in member `studentName`. A pointer to the top of a list denoting the score record of this student is stored in member `rFirstCourse`. The score record regarding each course completed by a student is expressed by a `RECORD` type structure. A score is stored in member `score`. A pointer to a course name is stored in member `courseName`. A pointer to the score record of another completed course is stored in member `rNextCourse`.

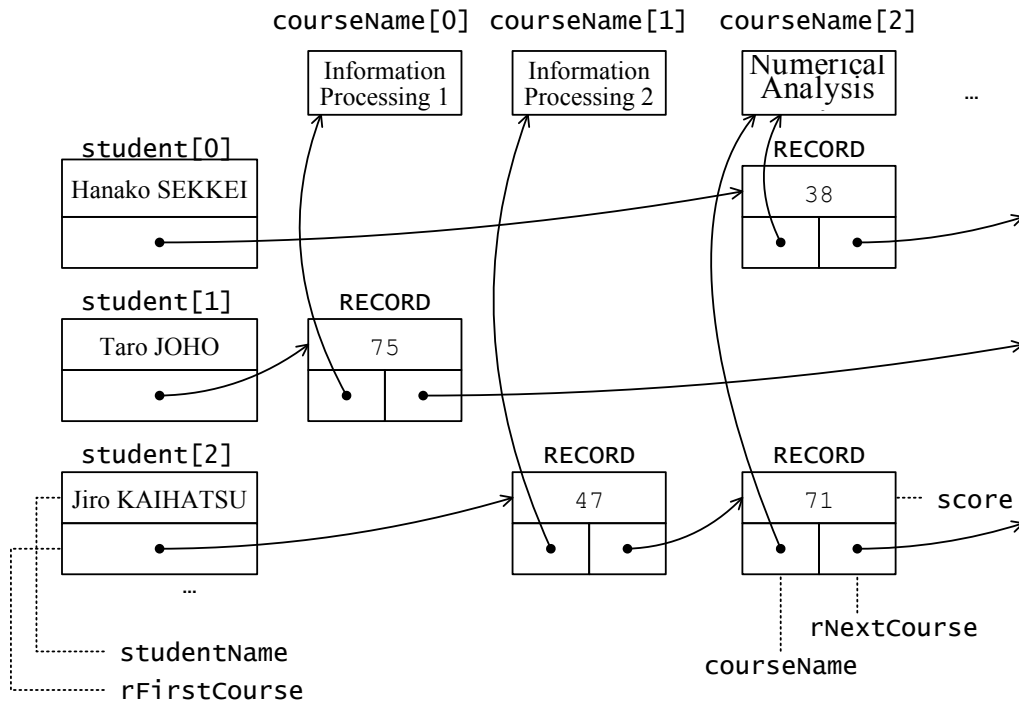


Fig. 3 Example of data structures

- (4) Descriptions of other functions defined in the program are as follows.

```
void regist (int coursekey, int studentkey, short s);
```

Function: A `RECORD` type structure is newly created, and score `s` is assigned to member `score`. Moreover, information is set to specify that this is accessed by using course key `coursekey` which is accessed by using student key `studentkey`,

```
void writeCourses();
```

Function: A list of course grades of all students is outputted to a file.

- (5) The following library function is used in this program.

```
void *malloc (size_t size);
```

Function: A domain of `size` bytes is allocated in the memory, and a pointer to the allocated domain is returned. If the memory allocation fails, `NULL` is returned.

[Program]

```
#include <stdio.h>
#include <stdlib.h>
#define NUM_STUDENT 15000 /* Number of student */
#define NUM_COURSE 2000 /* Number of courses */
#define MAX_WORD_LENGTH 21

struct RECORD {
    /* Course grade */
    char *courseName; /* Pointer to course name */
    short score; /* Score */
    struct RECORD *pNextCourse;
    /* Pointer to the next course grade */
};

struct STUDENT {
    /* Student information */
    char studentName[MAX_WORD_LENGTH];
    /* Student name */
    struct RECORD *pFirstCourse;
    /* Pointer to the first course grade */
} student[NUM_STUDENT];

char courseName[NUM_COURSE][MAX_WORD_LENGTH];
/* Array of course names */

void init();
void regist(int, int, short);
void writeCourses();

void init(){
    FILE *fStudent = fopen("student.txt", "r");
    FILE *fCourse = fopen("course.txt", "r");
    FILE *fRecord = fopen("record.txt", "r");
    int studentKey, courseKey, score;
    while(fscanf(fCourse, "%d", &courseKey) != EOF){
        fscanf(fCourse, "%s", courseName[courseKey]);
    }
    while(fscanf(fStudent, "%d", &studentKey) != EOF){
        fscanf(fStudent, "%s", student[studentKey].studentName);
    }
}
```

```

        student[studentKey].rFirstCourse = NULL;
    }
    while(fscanf(fRecord, "%d %d %d", &courseKey, &studentKey,
                                   &score) != EOF){
        regist(courseKey, studentKey, (short)score);
    }
    fclose(fStudent);
    fclose(fCourse);
    fclose(fRecord);
}

```

```

void regist(int courseKey, int studentKey, short s){
    struct RECORD *p;
    if ((p = (struct RECORD *)malloc(sizeof(struct RECORD)))
        == NULL){
        printf("A memory error occurred\n");
        exit(-1);
    }
    p->rNextCourse = student[studentKey].rFirstCourse;
    student[studentKey].rFirstCourse = a;
    p->courseName = b;
    p->score = s;
}

```

$\leftarrow \alpha$

$\leftarrow \beta$

```

void writeCourses(){
    FILE *fOutput = fopen("output.txt", "w");
    struct RECORD *p;
    int i;
    for (i = 0; i < NUM_STUDENT; i++){
        fprintf(fOutput, "%05d %-24s ", i,
                student[i].studentName);
        p = student[i].rFirstCourse;
        while(p != NULL){
            fprintf(fOutput, "%-24s %3d ", c );
            p = p->rNextCourse;
        }
        fprintf(fOutput, "\n");
    }
}

```



```

    fclose(foutput);
}

```

Subquestion 1

From the answer groups below, select the correct answers to be inserted into the blanks in the above program.

Answer group for a:

- a) &p b) &p++ c) NULL d) p e) p++

Answer group for b:

- a) &courseName b) *courseName[courseKey]
 c) courseNamed)
 courseName[courseKey]
 e) p->rNextCourse->courseName

Answer group for c:

- a) &p->courseName, &p->score b) &p->courseName, p->score
 c) *p->courseName, *p->score d) *p->courseName, p->score
 e) p->courseName, &p->score f) p->courseName, *p->score
 g) p->courseName, p->score

Subquestion 2

From the answer group below, select the correct answer in terms of the order in which course names are outputted in the list of course grades illustrated in Fig. 1.

Answer group:

- a) The smaller the value of a course key, the earlier the course name is outputted.
- b) The smaller the value of a course key, the later the course name is outputted.
- c) The earlier a course was registered by function `regist`, the earlier the course name is outputted.
- d) The earlier a course was registered by function `regist`, the later the course name is outputted.
- e) Course names are outputted in ascending order of the numbers of course attendees.
- f) Course names are outputted in descending order of the numbers of course attendees.

Subquestion 3

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

in the following description.

α and β in function `regist` were changed as follows, in order that course names will be outputted in descending order of scores in the list of course grades illustrated in Fig. 1.

In this regard, it is assumed that the correct answer is already inserted into **a** .

Action	Description of changes to program
α is replaced by.	<pre>struct RECORD *p; struct RECORD *q;</pre>
β is replaced by.	<pre>q = student[studentKey].rFirstCourse; if (<input type="text"/> d <input type="text"/>) { p->rNextCourse = q; student[studentKey].rFirstCourse = <input type="text"/> a <input type="text"/>; } else { while(<input type="text"/> e <input type="text"/>){ q = q->rNextCourse; } p->rNextCourse = q->rNextCourse; q->rNextCourse = <input type="text"/> a <input type="text"/>; }</pre>

Answer group:

- a) `q != NULL && q->score < s`
- b) `q != NULL && q->score > s`
- c) `q == NULL || q->score < s`
- d) `q == NULL || q->score > s`
- e) `q->rNextCourse != NULL && q->rNextCourse->score < s`
- f) `q->rNextCourse != NULL && q->rNextCourse->score > s`
- g) `q->rNextCourse == NULL || q->rNextCourse->score < s`
- h) `q->rNextCourse == NULL || q->rNextCourse->score > s`

12.2

Software Development (COBOL)**Q12-4** □□□

Read the following description of a COBOL program and the program itself, and then answer Subquestions 1 and 2.

[Description of Program]

The program reads a grade file in which grade data for practice exams in three main school courses is stored, and creates a grade-ranking file that appends a ranking for each course.

(1) The record format for the grade file is as follows.

Examinee ID	Japanese score	Math score	English score
----------------	-------------------	------------	------------------

- (i) Examinee ID is a 5-digit number, and the number of examinees is less than 1000.
- (ii) Scores for Japanese, Math, and English are recorded as 3-digit numbers, with 100 the highest score.

(2) The record format for the grade-ranking file is as follows.

Examinee ID	(1)		(2)		(3)	
	Japanese score	Japanese ranking	Math score	Math ranking	English score	English ranking

- (i) For each course, ranking is calculated in the order of highest score. In the case of equal scores, equal ranking is applied.

Example: Score Ranking

100	1
98	2
98	2
97	4
:	:

- (ii) Records are written in ascending order of examinee ID.

[Program]

(Line number)

```

1  DATA                                DIVISION.
2  FILE                                SECTION.
3  FD IN-FILE.
4  01 IN-REC.
5      03 IN-NO                        PIC X(05).
6      03 IN-TEN                       PIC 9(03) OCCURS 3.
7  FD OUT-FILE.
8  01 OUT-REC.
9      03 OUT-NO                        PIC X(05).
10     03 OUT-ARIA                      OCCURS 3.
11         05 O-TEN                     PIC 9(03).
12         05 O-JUNI                     PIC 9(03).
13  FD TEMP-FILE.
14  01 TEMP-REC.
15     03 TEMP-KBN                      PIC 9(01).
16     03 TEMP-NO                       PIC X(05).
17     03 TEMP-TEN                      PIC 9(03).
18     03 TEMP-JUNI                     PIC 9(03).
19  SD SORT-FILE.
20  01 SORT-REC.
21     03 SD-KBN                        PIC 9(01).
22     03 SD-NO                         PIC 9(05).
23     03 SD-TEN                        PIC 9(03).
24     03 SD-JUNI                       PIC 9(03).
25  WORKING-STORAGE SECTION.
26  01 END-FLG                          PIC X(03) VALUE "ON".
27     88 END-FLG-EOF VALUE "OFF".
28     88 END-FLG-SOF VALUE "ON".
29  01 I                                PIC 9(01).
30  01 WK-KBN                           PIC 9(01).
31  01 WK-TEN                           PIC 9(03).
32  01 WK-JUNI                           PIC 9(03).
33  01 WK-CNT                           PIC 9(03).
34  PROCEDURE DIVISION.
35  PRG-SYORI.
36      SORT          SORT-FILE          A
37          INPUT     PROCEDURE          IN1-SYORI
38          GIVING     TEMP-FILE
39      SORT          SORT-FILE          B
40          INPUT     PROCEDURE          IN2-SYORI
41          OUTPUT    PROCEDURE          OUT-SYORI
42  STOP RUN.
43  IN1-SYORI.

```

```

44      OPEN          INPUT    IN-FILE OUTPUT  TEMP-FILE.
45      PERFORM UNTIL  END-FLG-EOF
46          READ      IN-FILE AT  END SET END-FLG-EOF TO  TRUE
47          NOT AT  END
48          MOVE      IN-NO    TO  SD-NO
49          PERFORM VARYING I FROM 1 BY 1 UNTIL I > 3
50              MOVE      I    TO  SD-KBN
51              MOVE      IN-TEN(I)  TO  SD-TEN
52              RELEASE SORT-REC
53          END-PERFORM
54      END-READ
55      END-PERFORM.
56      CLOSE IN-FILE  TEMP-FILE.
57  IN2-SYORI.
58      OPEN      INPUT    TEMP-FILE.
59      SET END-FLG-SOF TO  TRUE.
60      PERFORM TEMP-READ.
61      PERFORM UNTIL  END-FLG-EOF
62          MOVE      TEMP-KBN    TO  WK-KBN
63          MOVE      TEMP-TEN    TO  WK-TEN
64          C
65          PERFORM UNTIL  TEMP-KBN NOT = WK-KBN OR  END-FLG-EOF
66              MOVE      TEMP-KBN    TO  SD-KBN
67              MOVE      TEMP-NO     TO  SD-NO
68              MOVE      TEMP-TEN    TO  SD-TEN
69          IF      TEMP-TEN < WK-TEN
70              D
71              MOVE      TEMP-TEN TO  WK-TEN
72              END-IF
73              MOVE      WK-JUNI TO  SD-JUNI
74              RELEASE SORT-REC
75              PERFORM TEMP-READ
76              ADD 1    TO  WK-CNT
77          END-PERFORM
78      END-PERFORM.
79      CLOSE  TEMP-FILE.
80  OUT-SYORI.
81      OPEN      OUTPUT  OUT-FILE.
82      SET END-FLG-SOF TO  TRUE.
83      PERFORM SORT-READ.
84      PERFORM UNTIL  END-FLG-EOF
85          MOVE      SD-NO    TO  OUT-NO
86          PERFORM VARYING I FROM 1 BY 1 UNTIL I > 3 OR END-FLG-EOF
87              MOVE      SD-TEN TO  O-TEN(E)
88              MOVE      SD-JUNI TO  O-JUNI(E)

```

```

89          PERFORM SORT-READ
90          END-PERFORM
91          WRITE  OUT-REC
92          END-PERFORM.
93          CLOSE  OUT-FILE.
94  TEMP-READ.
95          READ   TEMP-FILE  AT  END SET END-FLG-EOF TO  TRUE.
96  SORT-READ.
97          RETURN SORT-FILE  AT  END SET END-FLG-EOF TO  TRUE.

```

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank

in the above program.

Answer group for A and B

- a) ASCENDING KEY SD-KBN
- b) ASCENDING KEY SD-NO
- c) ASCENDING KEY SD-KBN SD-TEN
- d) ASCENDING KEY SD-KBN DESCENDING KEY SD-TEN
- e) DESCENDING KEY SD-KBN
- f) DESCENDING KEY SD-NO
- g) DESCENDING KEY SD-TEN ASCENDING KEY SD-KBN

Answer group for C and D

- a) ADD 1 TO WK-JUNI
- b) COMPUTE WK-JUNI = WK-JUNI + WK-CNT
- c) INITIALIZE WK-CNT WK-JUNI
- d) MOVE 1 TO WK-CNT
- e) MOVE 1 TO WK-CNT WK-JUNI
- f) MOVE 1 TO WK-JUNI
- g) MOVE WK-CNT TO WK-JUNI

Answer group for E

- a) I b) I + 1 c) I - 1 d) SD-KBN

Subquestion 2

The program is to be modified to enable output of the total scores for the three courses, and the rankings of the total scores. From the answer group below, select the correct answer to be inserted in the blank in the following description.

Table Contents of modifications to the program

Modification	Contents of modifications to the program
Replace Line 10	03 OUT-ARIA OCCURS 4.
Insert between Lines <input type="text"/> F	MOVE 4 TO SD-KBN COMPUTE SD-TEN = IN-TEN(1) + IN-TEN(2) + IN-TEN(3) RELEASE SORT-REC
Replace Line 86	PERFORM VARYING I FROM 1 BY 1 UNTIL I > 4 OR EOF

Answer group for F

- | | |
|---------------|---------------|
| (a) 45 and 46 | (b) 47 and 48 |
| (c) 52 and 53 | (d) 53 and 54 |
| (e) 55 and 56 | |

Q12-5 □□□

Read the following description of a COBOL program and the program itself, and then answer Subquestions 1 and 2.

[Explanation on the Program]

This is a program used by a railroad with 10 stations named A through J. The program reads a passenger file which records, for a day, the train stations where the passengers got on, got off, and what time the passengers got on the trains; the program then counts how many people used the trains between two adjacent train stations and prints out the results.

- (1) The passenger file (IN-FILE) is a sequential file of the following record format. For each use by each passenger, a record is created.

Starting Station	Ending Station	Starting Time
2 digits	2 digits	4 digits

- (i) Passengers in both directions are recorded, unsorted.
(ii) The starting time is recorded in the HHMM format. Here, the HH indicates the hour in the 24-hour convention, and the MM indicates the minute.

Each station opens at 6 A.M. and closes at midnight. Passengers cannot stay in the stations or on trains when the stations are closed.

- (iii) The starting and ending stations are recorded by numbers 01 through 10 assigned to the ten stations. The ending station must be different from the starting station. “01” is Station A, “02” is Station B, “03” is Station C, “04” is Station D, etc. and “10” is Station J.

(Example) The following record shows a passenger who got on a train at 6:55 at Station B and got off at Station D.

02	04	0655
----	----	------

- (2) The print format is as follows:

TIME		A-B	B-C	C-D	D-E	...	I-J
06:00	UP	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
	DOWN	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
07:00	UP	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
	DOWN	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
:							
23:00	UP	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
	DOWN	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9

- (i) TIME indicates the hour period in which the trains were used. For example, the line 07:00 represents ridership between 7 A.M. and 7:59 A.M.
- (ii) “A-B” to “I-J” show the segments of two adjacent train stations. For example, “A-B” indicates the segment between Station A and Station B.
- (iii) “UP” means inbound (direction from A to J), and “DOWN” means outbound (direction from J to A).
- (iv) The number of passengers is counted according to the lapsed time and the segment, based on the starting time. It is assumed that it takes 10 minutes between each pair of adjacent stations and that waiting time and transfer time are ignored. For example, consider the passenger who “got on a train at Station B at 6:55 and got off at D” in Example (1) (iii) above. That passenger is included and counted as one passenger in each of the two shaded cells below. Each number shall be 999,999 or less.

TIME		A-B	B-C	C-D	D-E	...	I-J
06:00	UP	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
	DOWN	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
07:00	UP	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
	DOWN	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
⋮							
23:00	UP	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9
	DOWN	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	ZZZ,ZZ9	...	ZZZ,ZZ9

[Program]

(Line Number)

```

1  DATA DIVISION.
2  FILE SECTION.
3  FD  IN-FILE.
4  01  IN-REC          PIC X(8).
5  FD  PR-FILE.
6  01  PR-REC          PIC X(100).
7  WORKING-STORAGE SECTION.
8  01  W-IN-REC.
9      02  IN-STATION  PIC 9(2).
10     02  OUT-STATION PIC 9(2).
11     02  IN-TIME.
12         03  IN-HH      PIC 9(2).
13         03  IN-MM      PIC 9(2).
14  01  COUNT-TABLE.
15     02  UP-TABLE      OCCURS 18.
16         03  UP-PASSENGER OCCURS 9 PIC 9(6) VALUE ZERO.
17     02  DOWN-TABLE    OCCURS 18.
18         03  DOWN-PASSENGER OCCURS 9 PIC 9(6) VALUE ZERO.

```

```

19 77 READ-SW      PIC X(1) VALUE SPACE.
20      88 AT-END  VALUE "E".
21 77 WAY          PIC S9(1).
22      88 UP-WAY  VALUE 1.
23      88 DOWN-WAY VALUE -1.
24 77 TIME-IDX     PIC S9(2).
25 77 TIME-CNT     PIC S9(2).
26 77 SECT-IDX     PIC S9(2).
27 01 W-PR-HEADER.
28      02          PIC X(15) VALUE "TIME".
29      02          PIC X(50) VALUE
30          "A-B      B-C      C-D      D-E      E-F".
31      02          PIC X(35) VALUE
32          "F-G      G-H      H-I      I-J".
33 01 W-PR-REC.
34      02 PR-TIME.
35          03 PR-HH      PIC 9(2).
36          03 PR-MM      PIC X(4).
37      02 PR-WAY      PIC X(4).
38      02              OCCURS 9.
39          03          PIC X(3) VALUE SPACE.
40          03 PR-PASSENGER PIC ZZZ,ZZ9.
41 PROCEDURE DIVISION.
42 MAIN-PROCEDURE.
43     OPEN INPUT IN-FILE OUTPUT PR-FILE.
44     PERFORM TEST BEFORE UNTIL AT-END
45         READ IN-FILE AT END SET AT-END TO TRUE
46         NOT AT END MOVE IN-REC TO W-IN-REC
47         PERFORM COUNT-PASSENGER
48     END-READ
49     END-PERFORM.
50     PERFORM PRINT-DATA.
51     CLOSE IN-FILE PR-FILE.
52     STOP RUN.
53 COUNT-PASSENGER.
54     IF A THEN
55         SET UP-WAY TO TRUE
56     ELSE
57         SET DOWN-WAY TO TRUE
58     END-IF.
59     COMPUTE TIME-IDX = IN-HH - 5.
60     MOVE IN-MM TO TIME-CNT.
61     PERFORM VARYING SECT-IDX FROM IN-STATION BY WAY
62         UNTIL SECT-IDX = OUT-STATION
63     IF UP-WAY THEN
64         ADD 1 TO UP-PASSENGER(TIME-IDX, SECT-IDX)

```

```

65      ELSE
66          ADD 1 TO DOWN-PASSENGER()
67      END-IF
68      COMPUTE TIME-CNT = TIME-CNT + 10
69      IF  THEN
70          COMPUTE TIME-IDX = TIME-IDX + 1
71          COMPUTE TIME-CNT = TIME-CNT - 60
72      END-IF
73  END-PERFORM.
74  PRINT-DATA.
75      WRITE PR-REC FROM W-PR-HEADER.
76      PERFORM VARYING TIME-IDX FROM 1 BY 1
77          UNTIL TIME-IDX > 18
78          COMPUTE PR-HH = TIME-IDX + 5
79          MOVE ":00" TO PR-MM
80          MOVE "UP" TO PR-WAY
81          PERFORM VARYING SECT-IDX FROM 1 BY 1
82              UNTIL SECT-IDX > 9
83              MOVE UP-PASSENGER(TIME-IDX, SECT-IDX)
84                  TO PR-PASSENGER()
85      END-PERFORM
86      WRITE PR-REC FROM W-PR-REC
87      MOVE SPACE TO PR-TIME
88      MOVE "DOWN" TO PR-WAY
89      PERFORM VARYING SECT-IDX FROM 1 BY 1
90          UNTIL SECT-IDX > 9
91          MOVE DOWN-PASSENGER(TIME-IDX, SECT-IDX)
92              TO PR-PASSENGER()
93      END-PERFORM
94      WRITE PR-REC FROM W-PR-REC
95  END-PERFORM.

```

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank

in the above program.

Answer group for A and C:

- | | |
|-------------------|-----------------------------|
| a) IN-STATION < 5 | b) IN-STATION < OUT-STATION |
| c) IN-STATION > 5 | d) IN-STATION > OUT-STATION |
| e) TIME-CNT = 60 | f) TIME-CNT >= 60 |
| g) TIME-IDX = 0 | h) TIME-IDX NOT = 0 |

Answer group for B and D:

- | | |
|---------------------------|---------------------------|
| a) SECT-IDX | b) SECT-IDX, TIME-IDX |
| c) TIME-IDX - 1, SECT-IDX | d) TIME-IDX + 1, SECT-IDX |
| e) TIME-IDX | f) TIME-IDX, SECT-IDX - 1 |
| g) TIME-IDX, SECT-IDX + 1 | h) TIME-IDX, SECT-IDX |

Subquestion 2

To count the number of passengers for each segment more accurately, a table that indicates how many minutes it takes to travel between each pair of adjacent stations is prepared, and modify the program so that the lapse time can be obtained from the table. From the answer group below, select the correct answer to be inserted in each blank in the following table.

Action	Contents of the Program Change
Adding between Lines 40 and 41	01 TIME-TABLE. 02 TIME-DATA PIC X(18) VALUE "080611071009081013". 02 SECT-MM REDEFINES TIME-DATA PIC 9(2) OCCURS 9.
Adding between Lines 64 and 65	COMPUTE TIME-CNT = <input type="text" value="E"/>
Adding between Lines 66 and 67	COMPUTE TIME-CNT = <input type="text" value="F"/>
Delete Line 68	

Answer group:

- 60 - SECT-MM(SECT-IDX)
- 60 - SECT-MM(TIME-IDX)
- TIME-CNT + SECT-MM(SECT-IDX)
- TIME-CNT + SECT-MM(SECT-IDX + 1)
- TIME-CNT + SECT-MM(SECT-IDX - 1)
- TIME-CNT + SECT-MM(TIME-IDX)
- TIME-CNT + SECT-MM(TIME-IDX + 1)
- TIME-CNT + SECT-MM(TIME-IDX - 1)

Q12-6 □□□

Read the following description of a COBOL program and the program itself, and then answer Subquestions 1 and 2.

[Program Description]

This is a program for creating a list of caregivers (such as parents) for students at an elementary school. The program outputs a caregiver list for the current year, using the caregiver list for last year and the caregiver list for new students (new first-year students) as input.

- (1) Caregiver lists for the current and last year are sequential files with records in the following format.

Caregiver Name 20 characters	Tel. No. 13 digits	Existing Student		Existing Student			
		Grade 1 digit	Student Name 20 characters	Grade 1 digit	Student Name 20 characters		

There are five student entries

- (i) Records are sorted in ascending order by the first 33 columns of data, representing the caregiver name and telephone number.
- (ii) The academic year (grade) and name of existing students are stored in the Existing Student section.
- (iii) If there are two or more existing students, they are sorted by grade in ascending order.
- (iv) If there are four or fewer existing students per caregiver, they are stored left-justified, with the remaining fields left blank.

Example: Information for a caregiver with existing students in 3rd and 5th grade is stored as follows.

Ken Smith	03-1234-5678	3	John Smith	5	Mike Smith	Blank
-----------	--------------	---	------------	---	------------	-------

- (2) Caregiver list for new students is sequential files with records in the following format.

Caregiver Name 20 characters	Tel. No. 13 digits	Student Name 20 characters	Student Name 20 characters		

There are five student entries

- (i) Records are sorted in ascending order by the first 33 columns of data, representing the caregiver name and telephone number.
 - (ii) The names of the new students are stored in the Student Name fields.
 - (iii) If there are four or fewer new students per caregiver, they are stored left-justified, with the remaining fields left blank.
- (3) Assume that one caregiver has no more than five students.
 - (4) Each student's grade is unconditionally increased by one. When 6th grade is completed, the student graduates.
 - (5) Need not take account of transfer students who enter or leave the school.
 - (6) A caregiver's record is removed when all of their students graduate and they have no new students.
 - (7) New records are created for unregistered caregivers of new students.

[Program]

(Line number)

```

1  DATA DIVISION.
2  FILE SECTION.
3  FD  OLD-FILE.
4  01  OLD-REC          PIC X(138).
5  FD  NEW-FILE.
6  01  NEW-REC          PIC X(138).
7  FD  ENT-FILE.
8  01  ENT-REC          PIC X(133).
9  WORKING-STORAGE SECTION.
10 01 W-OLD-REC.
11    02 OLD-ID          VALUE SPACE.
12      88 OLD-EOF      VALUE HIGH-VALUE.
13      03 OLD-PARENT    PIC X(20).
14      03 OLD-TEL       PIC X(13).
15    02 OLD-PUPIL       OCCURS 5 TIMES.
16      03 OLD-NUM       PIC 9(1).
17      03 OLD-NAME      PIC X(20).
18 01 W-NEW-REC.
19    02 NEW-ID.
20      03 NEW-PARENT    PIC X(20).
21      03 NEW-TEL       PIC X(13).
22    02 NEW-PUPIL       OCCURS 5 TIMES.
23      03 NEW-NUM       PIC 9(1).
24      03 NEW-NAME      PIC X(20).
25 01 W-ENT-REC.
26    02 ENT-ID          VALUE SPACE.
27      88 ENT-EOF      VALUE HIGH-VALUE.

```

```

28          03 ENT-PARENT      PIC X(20).
29          03 ENT-TEL         PIC X(13).
30      02 ENT-NAME             OCCURS 5 TIMES PIC X(20).
31  01 OLD-CNT                 PIC 9(1).
32  01 NEW-CNT                 PIC 9(1).
33  01 ENT-CNT                 PIC 9(1).
34  01 READ-FLAG               PIC X(1) VALUE "B".
35      88 READ-BOTH           VALUE "B".
36      88 READ-OLD-FILE       VALUE "O".
37      88 READ-ENT-FILE       VALUE "E".
38  PROCEDURE DIVISION.
39  MAIN-PROC.
40      OPEN INPUT OLD-FILE ENT-FILE OUTPUT NEW-FILE.
41      PERFORM UNTIL OLD-EOF AND ENT-EOF
42          IF READ-OLD-FILE OR READ-BOTH THEN
43              READ OLD-FILE INTO W-OLD-REC
44                  AT END SET OLD-EOF TO TRUE
45          END-READ
46      END-IF
47      IF READ-ENT-FILE OR READ-BOTH THEN
48          READ ENT-FILE INTO W-ENT-REC
49              AT END SET ENT-EOF TO TRUE
50      END-READ
51  END-IF
52  IF  A  THEN
53      PERFORM CREATE-PROC
54  END-IF
55  END-PERFORM.
56  CLOSE OLD-FILE ENT-FILE NEW-FILE.
57  STOP RUN.
58  CREATE-PROC.
59      MOVE SPACE TO W-NEW-REC.
60      EVALUATE TRUE
61      WHEN OLD-ID < ENT-ID
62          PERFORM NUM-UP-PROC
63           B 
64          SET READ-OLD-FILE TO TRUE
65      WHEN OLD-ID = ENT-ID
66          PERFORM NUM-UP-PROC
67          MOVE OLD-ID TO NEW-ID
68          PERFORM ENT-ADD-PROC
69          MOVE 1 TO OLD-CNT
70          PERFORM VARYING NEW-CNT FROM ENT-CNT BY 1
71              UNTIL NEW-CNT > 5
72           C 
73          ADD 1 TO OLD-CNT

```



```

74         END-PERFORM
75         SET READ-BOTH TO TRUE
76     WHEN OLD-ID > ENT-ID
77         MOVE ENT-ID TO NEW-ID
78         PERFORM ENT-ADD-PROC
79         SET READ-ENT-FILE TO TRUE
80     END-EVALUATE.
81     IF NEW-PUPIL(1) NOT = SPACE THEN
82         WRITE NEW-REC FROM W-NEW-REC
83     END-IF.
84 NUM-UP-PROC.
85     PERFORM VARYING OLD-CNT FROM 1 BY 1
86         UNTIL OLD-CNT > 5 OR OLD-PUPIL(OLD-CNT) = SPACE
87     IF OLD-NUM(OLD-CNT) < 6 THEN
88          D
89     ELSE
90         MOVE SPACE TO OLD-PUPIL(OLD-CNT)
91     END-IF
92     END-PERFORM.
93 ENT-ADD-PROC.
94     PERFORM VARYING ENT-CNT FROM 1 BY 1
95         UNTIL ENT-CNT > 5 OR ENT-NAME(ENT-CNT) = SPACE
96         MOVE 1 TO NEW-NUM(ENT-CNT)
97         MOVE ENT-NAME(ENT-CNT) TO NEW-NAME(ENT-CNT)
98     END-PERFORM.

```

Subquestion 1

From the answer groups below, select the correct answer to insert in each blank

in the above program.

Answer group for A:

- a) NOT (OLD-EOF AND ENT-EOF)
- b) NOT (OLD-EOF OR ENT-EOF)
- c) OLD-EOF AND ENT-EOF
- d) OLD-EOF OR ENT-EOF

Answer group for B, C, and D:

- a) ADD 1 TO OLD-NUM(OLD-CNT)
- b) MOVE OLD-ID TO NEW-ID
- c) MOVE OLD-PUPIL(ENT-CNT) TO NEW-PUPIL(NEW-CNT)
- d) MOVE OLD-PUPIL(OLD-CNT) TO NEW-PUPIL(NEW-CNT)
- e) MOVE W-OLD-REC TO W-NEW-REC
- f) PERFORM ENT-ADD-PROC

Subquestion 2

Modify the program to display the name and telephone number of caregivers who have been removed from the list—that is, caregivers who were registered on the list last year but not this year. Select the correct answer from the answer group.

Answer group:

a)

Action	New Program Contents
Add between lines 53 and 54	ELSE DISPLAY "REMOVED DATA = " OLD-ID

b)

Action	New Program Contents
Add between lines 82 and 83	ELSE DISPLAY "REMOVED DATA = " OLD-ID

c)

Action	New Program Contents
Add between lines 90 and 91	DISPLAY "REMOVED DATA = " OLD-ID

d)

Action	New Program Contents
Add between lines 92 and 93	DISPLAY "REMOVED DATA = " OLD-ID.

12.3

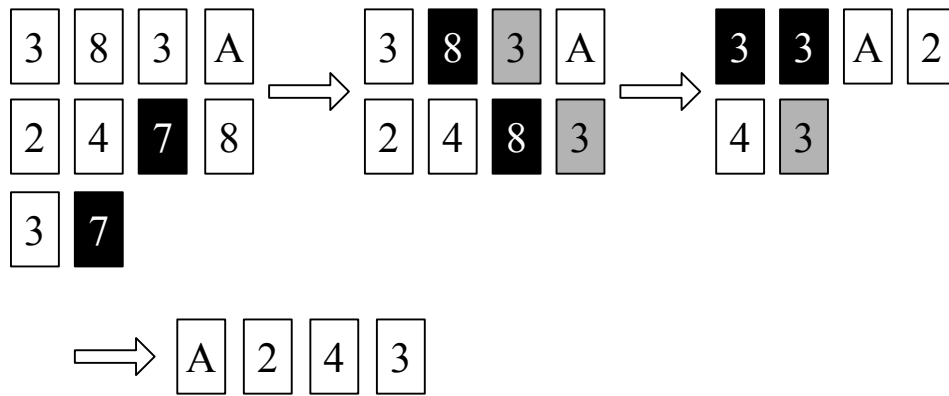
Software Development (Java)**Q12-7** □□□

Read the following description of a Java program and the program itself, and then, answer the Subquestion.

[Explanation on the Program]

This is a program that plays a one-person card game. The rules of the game are as follows:

- (1) The deck of cards contains the four suits: spades, hearts, diamonds, and clubs. Each suit has an A (ace), 2 through 10, a J (jack), a Q (queen), and a K (king), respectively with the ranks 1 through 13. The game uses a total of 52 cards, and the suits are irrelevant.
- (2) The 52 cards are flipped, one card at a time, and placed face up side by side. After four cards are placed, move down to another row below the first, again lining up the cards from the left. The area where the cards are placed is called the ground, and each line of cards is called a row.
- (3) As shown in the figure, every time a card is placed in Step (2), check to see if the card has the same rank as an adjacent card—above, below, side, or diagonal. If the new card makes a pair of cards with the same rank (referred to as a “pair”), the pair is removed (**7** in the figure), filling in the empty spaces. A card at the end of a row is not considered adjacent to the card that starts the next row. If more than one pair is formed (two each of **8** and **3**), remove the pair containing the card that has been on the ground the longest (**8**). If there is more than one such pair, remove the pair containing the card that has been on the ground the longest among those cards making pairs with the cards that have been there the longest (**3**).
- (4) Repeat Step (3) until all adjacent cards have different ranks.



- (5) Repeat Steps (2) through (4) until all the cards in the hand are gone.
- (6) The game is won if all the cards are removed from the ground when all the cards in the hand are gone.

The class `Card` represents the deck of cards. During its initialization, this class generates the `Card` instances corresponding to the 13 ranks from the ace to the king in all four suits and stores them in a `Card` array `cards`. These instances are immutable so that the same instance always corresponds to a particular card. For example, there is only one `Card` instance representing the ace of hearts. Class method `newDeck` shuffles the cards randomly and returns the array of `Cards` as a deck.

Class `Game` executes this game. The `List` instance `list` represents the ground where the cards are placed, and a card is taken, one at a time, from `deck` to be added to `list`. Each time this occurs, method `checkAndRemove` is called on to remove adjacent cards that make up “pairs.”

Class `java.util.Random` generates random numbers. Method `nextInt(int n)` returns the random numbers from the range 0 to $n - 1$ in the `int` type.

Interface `java.util.List` represents a list structure, and each element is designated by an index. The first element of the list is designated by the index number 0. Method `add(Object obj)` adds the given object `obj` at the end of the list. Method `get(int index)` returns the object of the element designated by `index`. Method `remove(int index)` removes the object of the element designated by `index`; if there are objects on and after “`index + 1`,” they are shifted to fill the empty position. Method `size()` returns the number of objects in the list in the `int` type.

Class `java.util.ArrayList` implements interface `List` using an array.

[Program 1]

```
import java.util.Random;
```

```
public class Card {
```

```
    public static final int SPADES = 0;
```

```
    public static final int HEARTS = 1;
```

```
    public static final int DIAMONDS = 2;
```

```
    public static final int CLUBS = 3;
```

```
    private static final Random rand = new Random();
```

```
    private static final Card[] cards = new Card[13 * 4];
```

```
    private final int suit;
```

```
    private final int rank;
```

```
        A
```

```
        for (int i = SPADES; i <= CLUBS; i++) {
```

```
            for (int j = 1; j <= 13; j++) {
```

```
                cards[B] = new Card(i, j);
```

```
            }
```

```
        }
```

```
    }
```

```
    private Card(int suit, int rank) {
```

```
        this.suit = suit;
```

```
        this.rank = rank;
```

```
    }
```

```
    public int getSuit() { return suit; }
```

```
    public int getRank() { return rank; }
```

```
    public static Card[] newDeck() {
```

```
        Card[] deck = new Card[cards.length];
```

```
        System.arraycopy(cards, 0, deck, 0, cards.length);
```

```
        for (int i = cards.length - 1; i > 0; i--) {
```

```
            int index = rand.nextInt(i + 1);
```

```
            Card tmp = deck[i];
```

```
            deck[i] = deck[index];
```

```
            deck[index] = tmp;
```

```

    }
    return deck;
}
}

```

[Program 2]

```

import java.util.ArrayList;
import java.util.List;

```

```

public class Game {
    // relative index from the card currently in focus
    private static final int[][] indexDiff = {
        { 1, 4, 5 },
        { 1, 3, 4, 5 },
        { 1, 3, 4, 5 },
        { 3, 4 }
    };

    private static void checkAndRemove(List list) {
        // Compare adjacent cards from the beginning of list
        // currentIndex is the index value of the card currently in focus
        for (int currentIndex = 0; currentIndex < list.size();
            currentIndex++) {
            // currentRank is the rank of the card currently in focus
            int currentRank =
                ((Card) list.get(currentIndex)).getRank();
            // Find the indices of cards adjacent to the card currently
            // in focus
            int[] diffList = indexDiff[currentIndex % 4];
            for (int i = 0; i < diffList.length; i++) {
                // adjacentIndex is the index value to adjacent card
                int adjacentIndex = C;
                if (D
                    && ((Card) list.get(adjacentIndex)).
                        getRank()
                        == currentRank) {
                    list.remove(adjacentIndex);
                }
            }
        }
    }
}

```

```

        list.remove();
        checkAndRemove(list);
        return;
    }
}
}
}

public static void main(String[] args) {
    Card[] deck = Card.newDeck();
    List list = new ArrayList();
    for (int i = 0; i < deck.length; i++) {
        list.add(deck[i]);
        checkAndRemove(list);
    }
    if (list.size() == 0) {
        System.out.println("You Have Won!");
    } else {
        System.out.println("Remaining" + list.size() + "cards");
    }
}
}

```

Subquestion

From the answer groups, select the correct answers to be placed in the blanks in the program.

Answer group for A:

- | | |
|--------------------------|---------------------------------|
| a) private Card() { | b) private static void init() { |
| c) private void init() { | d) static { |
| e) synchronized { | f) { |

Answer group for B:

- | | |
|-------------------|-------------------|
| a) i * 13 + j | b) i * 13 + j - 1 |
| c) i * 4 + j - 1 | d) j * 13 + i |
| e) j * 13 + i - 1 | f) j * 4 + i - 1 |

Answer group for C:

- a) `currentIndex * diffList[i]`
- b) `currentIndex + diffList[i]`
- c) `currentIndex - diffList[i]`
- d) `i * diffList[currentIndex]`
- e) `i + diffList[currentIndex]`
- f) `i - diffList[currentIndex]`

Answer group for D:

- a) `adjacentIndex != list.size()`
- b) `adjacentIndex < list.size()`
- c) `adjacentIndex <= list.size()`
- d) `adjacentIndex == list.size()`
- e) `adjacentIndex > list.size()`
- f) `adjacentIndex >= list.size()`

Answer group for E:

- | | |
|-----------------------------------|---------------------------------|
| a) <code>0</code> | b) <code>adjacentIndex</code> |
| c) <code>adjacentIndex - 1</code> | d) <code>currentIndex</code> |
| e) <code>currentIndex - 1</code> | f) <code>list.size() - 1</code> |

Q12-8 □□□

Read the following description of a Java program and the program itself, and then answer Subquestions 1 and 2.

At Company *A*, a system development company, a project team is composed of employees of Company *A* (hereinafter “main members”) and employees of partner Company *B* (hereinafter “sub members”). However, employee IDs follow code schemes unique to each company, which creates numerous inconveniences in the unified management of project members.

To ease the management of project members for a new project to be launched, the company has decided to issue unified project member IDs to the constituent members.

For Company *A* employees: Employee IDs consist of a 2-digit number and a 5-digit number, connected by a hyphen (e.g., 21-19436). Project member IDs will consist of “A00” placed before the employee ID without the hyphen, creating a 10-digit number.

For Company *B* employees: Employee IDs consist of the year the employee joined the company, followed by four (4) numbers, for an 8-digit ID. Project member IDs will consist of “B0” placed before the employee ID, creating a 10-digit number.

[Program Description]

- (1) In class `ProjectMember` of Program 1, an employee ID and a name are defined as data common to all project members. A method to return the employee ID and the name is also defined.
- (2) Interface `ProjectMemberId` of Program 2 is an interface for handling a 10-digit project member ID. A method for returning a project member ID and a method for comparing the magnitude of project member IDs are defined.
- (3) Class `MainMember` in Program 3 represents a Company *A* employee. It inherits class `ProjectMember` and also implements interface `ProjectMemberId`. It implements method `getProjectMemberId` of interface `ProjectMemberId` that returns a project member ID converted from a Company *A* employee ID.
- (4) Class `SubMember` in Program 4 represents a Company *B* employee. It inherits class `ProjectMember` and also implements interface `ProjectMemberId`. It implements method `getProjectMemberId` of interface `ProjectMemberId` that returns a project member ID converted from a Company *B* employee ID.

- (5) Class `PmApp` in Program 5 is a class for testing. It issues project member IDs to a total of five (5) project members (3 Company *A* employees and 2 Company *B* employees), sorts them in ascending order of project member ID, and lists project member IDs and names in order.

An example of program `PmApp` class execution is shown below.

```
>java PmApp
ProjectMember ID : A002119436
Member name: Yukimura Sanada
ProjectMember ID : A002220556
Member name: Ieyasu Tokugawa
ProjectMember ID : A006158910
Member name: Kenshin Uesugi
ProjectMember ID : B020051192
Member name: Nobunaga Oda
ProjectMember ID : B020071603
Member name: Shingen Takeda
>
```

[Program 1]

```
public class ProjectMember { // definition of project members
    String memberId; // employee ID
    String memberName; // name
    ProjectMember(String id, String name){
        memberId = id;
        memberName = name;
    }
    // method that returns employee ID
    public String getMemberId() {
        return memberId;
    }
    // method that returns name
    public String getMemberName() {
        return memberName;
    }
}
```

[Program 2]

```
// implementation of project member ID
interface ProjectMemberId {
    String getProjectMemberId(); // returns project member ID
    int biggerId(ProjectMemberId pi); // compares to size of project member ID
}
```

[Program 3]

```
// class that represents a Company A member
public class MainMember extends ProjectMember implements ProjectMemberId {
    MainMember(String id, String name){
        super(id, name);
    }
    // method that returns project member ID converted from Company A member ID
    [A] String getProjectMemberId() {
        StringBuffer sb = new StringBuffer("A00");
        [B] ;
        int i = [C] ;
        sb.deleteCharAt(i);
        return sb.toString();
    }
    // method that performs size comparison of project member IDs
    [A] int biggerId(ProjectMemberId pi) {
        return getProjectMemberId().compareTo(pi.getProjectMemberId());
    }
}
```

[Program 4]

```
// class that handles Company B members
public class SubMember extends ProjectMember implements ProjectMemberId{
    SubMember(String id, String name) {
        super(id, name);
    }
    // method that converts Company B member ID to project member ID, and returns
    it
    A String getProjectMemberId() {
        return "B0" + getMemberId();
    }
    // method that performs magnitude comparison of project member IDs
    A int biggerId(ProjectMemberId pi) {
        return getProjectMemberId().compareTo(pi.getProjectMemberId());
    }
}
```

[Program 5]

```
// class for testing
public class PmApp {
    public static void main(String[] args) {
        // creates members
        ProjectMemberId[] pi = new ProjectMemberId[5];
        pi[0] = new MainMember("22-20556", "Ieyasu Tokugawa");
        pi[1] = new SubMember("20071603", "Shingen Takeda");
        pi[2] = new MainMember("61-58910", "Kenshin Uesugi");
        pi[3] = new SubMember("20051192", "Nobunaga Oda");
        pi[4] = new MainMember("21-19436", "Yukimura Sanada");
        // sorts project member IDs in ascending order
        // α
        ProjectMemberId temp;
        for (int i = pi.length - 1; i > 0; i--) {
            for (int j = 0; j < i; j++) {
                if ( D ) {
                    temp = pi[j];
                    pi[j] = pi[j + 1];
                    pi[j + 1] = temp;
                }
            }
        }
    }
}
```

```

        }
    }
    // β
    // performs output
    for (int i = 0; i < pi.length; i++) {
        System.out.println
            ("ProjectMember ID : " + pi[i].getProjectMemberId());
        System.out.println("Member name : " +
            ((ProjectMember)pi[i]).getMemberName());
    }
}
}

```

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank

in the above program.

Answer group for A

- a) private
- b) protected
- c) public
- d) nothing inserted in the blank (i.e., leave blank)

Answer group for B

- a) sb.append(getMemberId())
- b) sb.append(getProjectMemberId())
- c) sb.insert(0, getMemberId())
- d) sb.insert(0, getProjectMemberId())

Answer group for C

- a) sb.append("-")
- b) sb.indexOf("-")
- c) sb.capacity()
- d) sb.length()

Answer group for D

- a) pi[j] < pi[j+1]
- b) pi[j] >= pi[j+1]
- c) pi[j].biggerId(pi[j+1]) < 0
- d) pi[j].biggerId(pi[j+1]) >= 0

Subquestion 2

The project is considerably large, with many members; as such, sorting needs to be performed efficiently. The testing-purpose class `PmApp` performs a *bubble sort* to sort project member IDs. The goal is to change this to *quick sort* to make sorting faster. The section of the program between α and β in the problem text was modified as follows to call method `qSort`, which performs *quick sort*.

```
qSort(pi, 0, pi.length-1);
```

Furthermore, method `qSort`, which performs *quick sort*, is implemented in `PmApp`. When method `qSort` is defined per the below, then from the answer group below, select the correct answer to be inserted in the in the following program.

```
public static void qSort(ProjectMemberId[] pi, int first, int last) {
    ProjectMemberId x = pi[(first + last) / 2];
    int i = first;
    int j = last;
    for (;;) {
        while (pi[i].biggerId(x) < 0) i++;
        while (x.biggerId(pi[j]) < 0) j--;
        if (i >= j) break;
        ProjectMemberId swap = pi[i];
        pi[i] = pi[j];
        pi[j] = swap;
        i++;
        j--;
    }
     E
}
```

Answer group

- a) `if (first < i-1) qSort(pi, first, i-1);`
 `if (j+1 < last) qSort(pi, j+1, last);`
- b) `if (first < i-1) qSort(pi, first, i-1);`
 `if (j+1 > last) qSort(pi, j+1, last);`
- c) `if (first > i-1) qSort(pi, first, i-1);`
 `if (j+1 < last) qSort(pi, j+1, last);`
- d) `if (first > i-1) qSort(pi, first, i-1);`
 `if (j+1 > last) qSort(pi, j+1, last);`

Q12-9 □□□

Read the following description of Java program and the program itself, and then answer the Subquestions 1 and 2. (Refer to the end of this booklet for the description of APIs used in the Java programs.)

[Program Description]

This program checks a given string with a pattern for checking string (hereinafter pattern). The pattern and the given string are strings that consist of zero or more characters. Patterns are composed of the characters which bear the special meanings for matching (hereinafter metacharacters) and other characters except metacharacters (hereinafter literal characters). Table 1 shows metacharacters and their meanings.

Table 1 Metacharacters and their meanings

Metacharacter	Meaning
^	Matches the beginning of the string
.	Matches any one character
\$	Matches the end of the string

Literal characters match the characters themselves. For example, a literal character “a” matches one character “a”.

If the entire pattern matches the whole or part of the given string, it is determined that the pattern matches the given string. When the number of characters in a pattern is zero, the pattern matches any string. Table 2 shows the examples of patterns, strings that the patterns match, and strings that the patterns do not match.

Table 2 Examples of patterns, strings that patterns match and strings that patterns do not match

Pattern	Sample strings that pattern matches	Sample strings that pattern does not match
"	"", "home"	None
"home"	"home", "tachometer"	"how", "hope", "me"
"^ho.e"	"home", "hope", "hotel"	"hot", "hook", "shore"
"ho.. \$"	"home", "hope", "shore"	"hop", "hotel", "hobby"

The program analyzes one character of the given pattern at a time and converts it into a format that facilitates checking. The processes of analysis and conversion are called compiling, and the converted unit for checking process is called a pattern element. A metacharacter is converted into a pattern element that indicates the meaning of the metacharacter, while a literal character is converted into a pattern element that indicates the literal character. The whole pattern is represented by a list of pattern elements. For example, the pattern `"^ho.e"` is divided into `'^'`, `'h'`, `'o'`, `'.'`, and `'e'` and each character is converted into the following pattern element:

- (i) Pattern element indicating the beginning of the string
- (ii) Pattern element indicating `'h'`
- (iii) Pattern element indicating `'o'`
- (iv) Pattern element indicating any one character
- (v) Pattern element indicating `'e'`

Next, the pattern and the given string are checked by evaluating the list of the pattern elements. The given string is checked sequentially from the first character with the pattern elements in the list (in the above example, (i) to (v)). If all the pattern elements are matched successively, it is determined that the pattern matches the given string.

Interface `PatternElement` represents a pattern element. Method `matches` checks whether this pattern element matches the string `str` given in the argument from position `index`. When they match, the method returns `true`; otherwise it returns `false`. The value of `index` is greater than or equal to zero. Method `length` returns the length of the string that matches this pattern element.

The following shows each class that implements interface `PatternElement`:

- (1) Class `OneChar` is a pattern element that indicates one literal character.
- (2) Class `AnyChar` is a pattern element that indicates any one character.
- (3) Classes `BeginningOfString` and `EndOfString` are pattern elements that indicate the beginning and the end of the string, respectively.

Class `Pattern` converts the given pattern in a constructor into a list of pattern elements. Method `matches` compares the given string with the list of pattern elements. When they match, it returns `true`; otherwise it returns `false`. Method `main` tests class `Pattern`. Method `main` produces the output result shown in Fig. 1.

```
"ho.e$" matches "home".
"ho.e$" matches "shore".
"ho.e$" doesn't match "hotel".
```

Fig. 1 Output result

In this program, it is assumed that one character can be represented as `char`. Supplementary characters in Unicode are not considered.

[Program 1]

```
public interface PatternElement {
    public boolean matches(String str, int index);
    public int length();
}
```

[Program 2]

```
class OneChar implements PatternElement {
    private final char ch;
    OneChar(char ch) { this.ch = ch; }
    // When the character at position index in the given string str
    // and one character represented by this pattern element match,
    // return true; otherwise return false.
    public boolean matches(String str, int index) {
        return str.length() > index && A;
    }
    public int length() { return 1; }
}
```

[Program 3]

```
class AnyChar implements PatternElement {
    // When there are one or more characters from position index in the given
    // string str, return true; otherwise return false.
    public boolean matches(String str, int index) {
        return B;
    }
    public int length() { return 1; }
}
```

[Program 4]

```
class BeginningOfString implements PatternElement {
    public boolean matches(String str, int index) {
        return index == 0;
    }
    public int length() { return 0; }
}
```

[Program 5]

```
class EndOfString implements PatternElement {
    public boolean matches(String str, int index) {
        return index == str.length();
    }
    public int length() { return 0; }
}
```

[Program 6]

```
import java.util.ArrayList;
import java.util.List;

public class Pattern {
    private List<PatternElement> expr;
    public Pattern(String pattern) {
        expr = compile(pattern);
    }

    public boolean matches(String str) {
        for (int i = 0; i <= str.length(); i++) {
```

```

        if (matches(str, i))
            return true;
    }
    return false;
}

private boolean matches(String str, int index) {
    for (PatternElement node : expr) {
        if (!node.matches(str, index))
            return false;
        index += node.length();
    }
    return true;
}

private List<PatternElement> compile(String pattern) {
    List<PatternElement> list = new ArrayList<PatternElement>();
    for (int i = 0; i < pattern.length(); i++) {
        char c = pattern.charAt(i);
        PatternElement node = null;
        if (c == '.') {
            node = new C;
        } else if (c == '^') {
            node = new BeginningOfString();
        } else if (c == '$') {
            node = new EndOfString();
        } else {
            node = new D;
        }
        list.add(node);
    }
    return list;
}

public static void main(String[] args) {
    String[] data = { "home", "shore", "hotel" };
    Pattern pattern = new Pattern("ho.e$");
    for (String str : data) {

```

← α

```

String result;
if (  ) {
    result = "matches";
} else {
    result = "doesn't match";
}
System.out.printf("\aho.e$\n" %s \"%s\".%n",
                  result, str);
}
}

```

Subquestion 1

From the answer groups below, select the correct answers to be inserted in the blanks in the above program.

Answer group for A:

- | | |
|---|---|
| a) <code>str.charAt(index) != ch</code> | b) <code>str.charAt(index) < ch</code> |
| c) <code>str.charAt(index) == ch</code> | d) <code>str.charAt(index) > ch</code> |

Answer group for B:

- | | |
|---|--|
| a) <code>str.length() < index</code> | b) <code>str.length() <= index</code> |
| c) <code>str.length() > index</code> | d) <code>str.length() >= index</code> |

Answer group for C and D:

- | | | |
|------------------------------|------------------------------|----------------------------|
| a) <code>AnyChar('.')</code> | b) <code>AnyChar()</code> | c) <code>AnyChar(c)</code> |
| d) <code>AnyChar(i)</code> | e) <code>OneChar('.')</code> | f) <code>OneChar()</code> |
| g) <code>OneChar(c)</code> | h) <code>OneChar(i)</code> | |

Answer group for E:

- | | |
|--------------------------------------|---------------------------------------|
| a) <code>!pattern.equals(str)</code> | b) <code>!pattern.matches(str)</code> |
| c) <code>pattern.equals(str)</code> | d) <code>pattern.matches(str)</code> |

Subquestion 2

Line α in program 6 is modified as in Fig. 2. From the answer group below, select the appropriate description about the behavior of the modified program.

```
} else if (c == '^' && i == 0) {
```

Fig. 2 Modified line α in program 6

Answer group:

- a) Character '^' is always treated as a literal character.
- b) Character '^' is treated as a metacharacter only at the beginning of argument pattern. Otherwise, it is treated as a literal character.
- c) Character '^' is treated as a metacharacter only at the beginning of argument pattern. Otherwise, it is ignored.
- d) Character '^' is treated as a metacharacter only at the beginning of argument pattern. Otherwise, an exception is thrown.

12.4

Software Development (Assembler)**Q12-10** □□□

Read the following description of an assembler program and the program itself, and then answer Subquestions 1 through 3.

[Program Description]

Subprogram 1 BCDADD receives, from the main program, the two (2) integers a , b ($a \geq 0$, $b \geq 0$) expressed in BCD encoding, and calculates the sum of a and b in BCD encoding.

- (1) BCD encoding expresses each digit of a decimal value in 4-bit binary format. For example, the decimal number 6935 is expressed in BCD encoding as follows.

thousands place	hundreds place	tens place	units place
6	9	3	5
↓	↓	↓	↓
0110	1001	0011	0101

- (2) Both a and b are 4-digit (16-bit) numbers, are stored in GR1 and GR2, respectively, and are passed by the main program.
- (3) An example of execution of Subprogram 1 BCDADD is shown below.

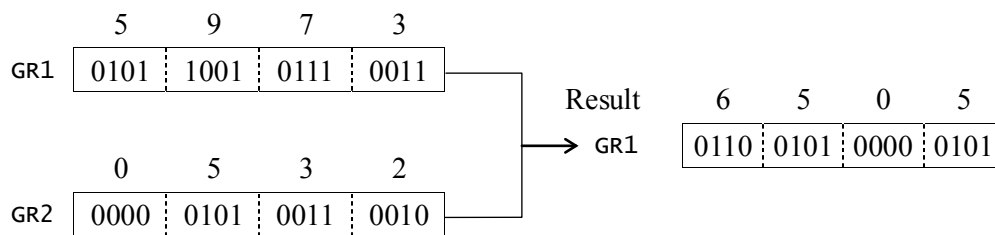


Fig. Example of execution of Subprogram 1 BCDADD

- (4) Upon return to the main program, the result is placed in GR1 and a is placed in GR3. The original contents of the general registers GR4 through GR7 are restored.

[Subprogram 1]

(Line number)

```

1  BCDADD      START
2          PUSH 0,GR4
3          PUSH 0,GR5
4          PUSH 0,GR6
5          PUSH 0,GR7
6          ST   GR1,A
7          ST   GR2,B
8          LD   GR3,=0      ; initializes shift count
9          LD   GR5,=0      ; initializes the result area
10 LOOP1 AND   GR1,=#000F ; identifies 4 bits from integer a
11        AND   GR2,=#000F ; identifies 4 bits from integer b
12        LD   GR0,=0      ; initializes carry
13        ADDA  GR1,GR2     ; 4-bit addition
14        CPA   GR1,=10    ; result ≥ 10?
15        

|   |
|---|
| A |
|---|


16        SUBA  GR1,=10    ; subtracts 10 from result
17        LD   GR0,=1      ; sets carry
18 NOTOVRSLL GR1,0,GR3 ; puts 4-bit addition result into original position
19        OR    GR1,GR5    ; merges into interim result
20        ADDA  GR3,=4
21        CPA   GR3,=16    ; all digits are completed?
22        JZE   FIN1
23 NEXT1 LD   GR5,GR1      ; stores interim result
24        LD   GR1,A       ; resets GR1 to integer a
25        SRL   GR1,0,GR3  ; moves next 4 bits of integer a to right end
26        LD   GR2,B       ; resets GR2 to integer b
27        SRL   GR2,0,GR3  ; moves next 4 bits of integer b to right end
28        ADDA  GR1,GR0    ; adds carry
29        JUMP  LOOP1
30 FIN1  LD   GR2,B
31        LD   GR3,A
32        POP   GR7
33        POP   GR6
34        POP   GR5
35        POP   GR4
36        RET

```



```

37  A      DS      1
38  B      DS      1
39                END

```

Subquestion 1

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

in Subprogram 1.

Answer group for a

- | | | | |
|--------|-------|--------|--------|
| a) JMI | NEXT1 | b) JMI | NOTOVR |
| c) JNZ | NEXT1 | d) JNZ | FIN1 |
| e) JPL | FIN1 | f) JPL | NOTOVR |

Subquestion 2

From the answer group below, select the correct answer to be inserted into each blank

in the following sentence.

When the contents of GR1 and GR2 passed by the main program are as follows, then after execution of BCDADD, GR0 is set to B and GR1 is set to C, and these are returned to the main program.

GR1 = 0101 0010 1001 1000

GR2 = 0100 1000 0101 0011

Answer group for B and C

- | | |
|------------------------|------------------------|
| a) 0000 0000 0000 0000 | b) 0000 0000 0000 0001 |
| c) 0000 0001 0101 0001 | d) 0100 1000 0101 0011 |
| e) 0101 0010 1001 1000 | f) 1001 1001 1001 1001 |
| g) 1010 0001 0101 0001 | h) 1111 1111 1111 1111 |

Subquestion 3

Subprogram 2 **BCDIN** has been created. This subprogram inputs two (2) strings m and n in the format of a 4-digit numeric strings as a decimal value and converts them in BCD encoding, then calls Subprogram 1 **BCDADD** to add the two (2) decimal values, converts the result to a 5-digit numeric string (string). From the answer groups below, select the correct answer to be inserted in each blank in Subprogram 2 below.

- (1) The input characters are the characters '0' through '9', and contain no input errors.
- (2) The relationship between input and output is as shown in the table below.

Table: Correspondence of output values to input values

m	n	Output string
'6052'	'4001'	'10053'
'5008'	'0007'	'05015'

- (3) Upon return to the main program, the original contents of the general registers GR4 through GR7 are restored.

[Subprogram 2]

(Line number)

```

51  BCDIN  START
52          RPUSH
53          IN    INBUF1,INLEN    ; inputs  $m$ 
54          IN    INBUF2,INLEN    ; inputs  $n$ 
55          LD    GR1,=0          ; initiates BCD encoding register
56          LD    GR2,=0          ; as above
57          LD    GR6,=0          ; initializes shift count
58          LD    GR7,=3          ; initializes loop counter
59  LOOP2  LD    GR4,INBUF1,GR7    ; retrieves 1 character from  $m$ 
60          AND    GR4,=#000F      ; converts to numeric value
61          SLL    GR4,0,GR6
62          OR     GR1,GR4          ; merges BCD encoding
63          LD    GR5,INBUF2,GR7    ; retrieves 1 character from  $n$ 
64          AND    GR5,=#000F      ; converts to numeric value
65          SLL    GR5,0,GR6
66          OR     GR2,GR5          ; merges BCD encoding
67          D

```

```

68      SUBL  GR7,=1
69      JMI   NEXT          ; is conversion complete?
70      JUMP  LOOP2
71  NEXT  CALL  BCDADD
72      LD    GR6,=0        ; initializes the shift count
73      LD    GR7,=4        ; initializes the output area counter
74  LOOP3 LD    GR5,GR1     ; Copies BCD encoding into GR1
75      SRL   GR5,0,GR6
76      AND   GR5,=#000F
77      OR    GR5,=#0030    ; converts value to a character
78      ST    GR5,OUTBUF,GR7 ; stores the character in output area
79      SUBL  GR7,=1
80      ADDL  GR6,=4        ; increments the shift count
81      CPL   GR6,=16
82      JMI   LOOP3
83      

|   |
|---|
| E |
|---|


84      OR    GR7,=#0030
85      ST    GR7,OUTBUF
86      ST    GR1,ANS
87      ST    GR2,N
88      ST    GR3,M
89      OUT   OUTBUF,OUTLEN
90      RPOP
91      RET
92  INBUF1DS  4
93  INBUF2DS  4
94  INLEN  DC  4
95  M      DS  1
96  N      DS  1
97  ANS    DS  1
98  OUTBUFDS  5
99  OUTLEND 5
100      END

```

Answer group for D

- | | |
|------------------|------------------|
| a) ADDA GR6,=4 | b) ADDL GR4,=1 |
| c) LAD GR4,1,GR4 | d) LAD GR6,1,GR4 |
| e) LAD GR6,4,GR4 | f) LD GR4,GR5 |

Answer group for E

- | | |
|------------------|---------------|
| a) LAD GR6,GR0 | b) LAD GR7,=0 |
| c) LD GR6,=0 | d) LD GR7,GR0 |
| e) SLL GR7,0,GR0 | f) SRL GR6,4 |

Q12-11 □□□

Read the following description of an assembler program and the program itself, and then answer Subquestions 1 and 2.

[Program Description]

The subprogram SETPAR sets the parity bit for each word stored in a continuous N -word block, and also sets 1-word horizontal parities immediately after the block.

- (1) Bit number 15 (the most significant bit enclosed by the dotted line in the figure) of each word is used as the parity bit. An even parity bit is used, that is, the bit is set to 1 when the number of bits that are 1 in bit numbers 0 to 14 of each word is odd, or 0 when even.

Even parity is also used for each horizontal parity bit, that is, the bit is set to 1 when the number of bits that are 1 in the corresponding bit position of each word is odd, or 0 when even. That is to say, the horizontal parity bit is set so the number of bits that are 1 in the shaded portion in the figure is an even number.

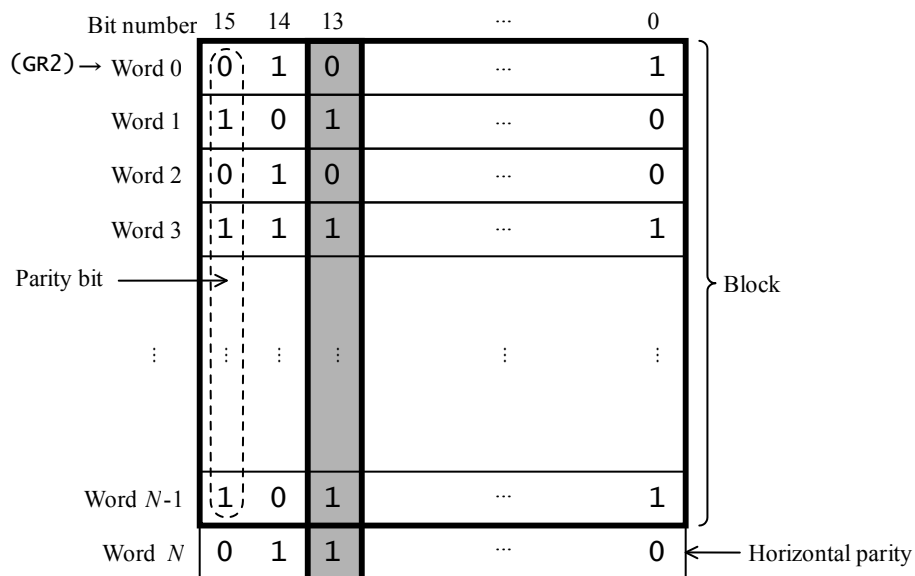


Fig. Parity bits and horizontal parity

- (2) The main program sets the number of words N of the block in GR1, the start address of the block in GR2, stores 0 in the parity bit of each word in the block, and calls the subprogram SETPAR.
- (3) The original contents of the general purpose registers GR1 to GR7 are restored when returning from a subprogram.

[Program]

(Line number)

```

1  SETPAR   START
2
3          LD      GR6,GR2
4          ADDLGR6,GR1
5          LAD     GR4,0          ; Initialize horizontal parity
6  LP1      LD     GR1,0,GR2      ; Fetch 1 word from the block
7          LAD     GR7,0
8  LP2      SLL     GR1,1
9          JZE     CONT
10         
11         XOR     GR7,=#8000    ; Adjust parity bit
12         JUMPLP2
13  CONT     OR     GR7,0,GR2
14         ST      GR7,0,GR2     ; Set parity bit
15          ; Adjust horizontal parity
16         LAD     GR2,1,GR2
17         CPL     GR2,GR6       ; End of block?
18         JNZ     LP1
19         ST      GR4,0,GR6     ; Set horizontal parity
20         RPOP
21         RET
22         END

```

Subquestion 1

From the answer groups below, select the correct answers to insert in the blanks

in the above program.

Answer group for A:

- | | | |
|-------------|-------------|-------------|
| a) JMI CONT | b) JMI LP2 | c) JOV CONT |
| d) JOV LP2 | e) JPL CONT | f) JPL LP2 |

Answer group for B:

- | | |
|------------------|----------------|
| a) OR GR4,0,GR6 | b) OR GR4,GR7 |
| c) OR GR7,0,GR6 | d) OR GR7,GR4 |
| e) XOR GR4,0,GR6 | f) XOR GR4,GR7 |
| g) XOR GR7,0,GR6 | h) XOR GR7,GR4 |

Subquestion 2

The program is to be changed so that 0 is set as the parity bit value when the number of bits that are 1 in bit numbers 0 to 14 of each word is odd, or 1 when even. This can be done by changing the value to be set in GR7 in line number 7 of the program. From the answer group below, select the correct value to be set in GR7.

Answer group:

- | | | |
|----------|----------|----------|
| a) #0001 | b) #7FFF | c) #8000 |
| d) #8001 | e) #FFFE | f) #FFFF |

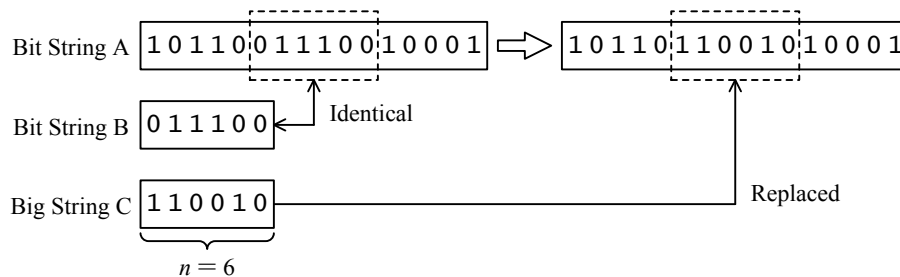
Q12-12 □□□

Read the explanation on the following assembler program as well as the program itself. Then, answer Subquestions 1 and 2.

[Explanation on the Program]

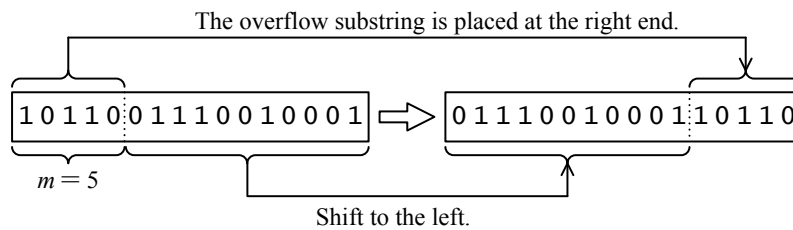
- (1) The subprogram **BREP** is a program that does the following: if a 16-bit string A contains sub-bit strings that are identical to an n -bit string B, the program replaces the string with an n -bit string C.

Example:



- (i) GR1 to GR4 are set to the following contents and are passed from the main program.
- GR1: address of the word where the bit string A is stored
 - GR2: bit string B (set left-aligned, and the remaining bits are filled with 0s)
 - GR3: bit string C (set left-aligned, and the remaining bits are filled with 0s)
 - GR4: n ($1 \leq n \leq 16$)
- (ii) If the bit string A contains numerous sub-bit strings identical to the bit string B, all of those sub-bit strings are replaced by the bit string C.
- (iii) The bit string A is checked from the left end. If a sub-bit string identical to the bit string B is replaced by the bit string C, the check continues from the bit immediately to the right of the sub-bit string just replaced.
- (iv) When returning from the subprogram, the contents of the general registers GR1 to GR7 are restored to their original contents.
- (2) The subprogram **ROTSL** is a program that cyclically shifts a 16-bit string by m bits to the left.

Example:



- (i) GR0 and GR1 are set to the following contents and are passed from the main program.

GR0: m ($0 \leq m \leq 16$)

GR1: Address of the word where the bit string is stored

- (ii) When returning from the subprogram, the original contents of the general registers GR1 to GR7 are restored.

[Program]

```

BREP  START
      RPUSH
      LD   GR5,=16           ; the number of bits not yet checked
      LD   GR6,=#8000        ;
      SRA  GR6,-1,GR4        ; } Creating a mask
LOOP  LD   GR7,0,GR1         ; GR7 ← bit string A
      A           ; sets all bits, except n leftmost bits, to 0.
      CPL  GR7,GR2          ; compares the n leftmost bits and bit string B
      JZE  MATCH            ; matched
      LD   GR0,=1           ; number of cyclic left-shift bits
      JUMP CONT
MATCH LD   GR7,0,GR1         ; GR7 ← bit string A
      SLL  GR7,0,GR4        ;
      SRL  GR7,0,GR4        ; } Sets the n leftmost bits to 0
      B           ; sets the n leftmost bits to bit string C
      ST   GR7,0,GR1        ; Rewrite the original area
      LD   GR0,GR4          ; Number of cyclic left-shift bits
CONT  CALL ROTSL            ; Cyclically shifting bit string A to the left
      SUBA GR5,GR0          ; update number of bits not yet checked
      CPA  GR5,GR4          ; Compare number of unchecked bits with n
      C           ; If less than n, finish
      JUMP LOOP
FIN   LD   GR0,GR5          ; Number of unchecked bits

```

```

CALL ROTSL          ; Restore to the original bit position
RPOP
RET
;
ROTSL RPSH
LD    GR3,GR0        ; GR3 ← m
LD    GR4,=16
SUBA  GR4,GR3        ; GR4 ← (16 - m)
LD    GR5,0,GR1
LD    GR6,GR5
SLL   GR5,0,GR3


D

 ; Bit string overflow
OR    GR5,GR6        ; Set the overflow bit string at the right end
ST    GR5,0,GR1      ; Rewrite the original area
RPOP
RET
END

```

Subquestion 1

From the answer groups, select the correct answers to be inserted in the blanks in the program.

Answer group for A and B:

- | | |
|----------------|----------------|
| a) AND GR7,GR3 | b) AND GR7,GR6 |
| c) OR GR7,GR3 | d) OR GR7,GR6 |

Answer group for C:

- | | |
|------------|------------|
| a) JMI FIN | b) JNZ FIN |
| c) JPL FIN | d) JZE FIN |

Answer group for D:

- | | |
|------------------|------------------|
| a) SLL GR6,0,GR3 | b) SLL GR6,0,GR4 |
| c) SRL GR6,0,GR3 | d) SRL GR6,0,GR4 |

Subquestion 2

From the answer group, select the correct answer to be inserted into the blank in the following description.

Suppose that the bit strings A, B, C, and the value n passed by the main program are as follows, then the subprogram BREP calls the subprogram ROTSL times.

Bit string A: 0001110100111001

Bit string B: 0111

Bit string C: 1001

n : 4

Answer group:

- | | | |
|-------|-------|------|
| a) 2 | b) 6 | c) 8 |
| d) 12 | e) 16 | |

12.5

Software Development (Spreadsheet)**Q12-13** □□□

Read the following description of an investment determination regarding implementation of a new system, and answer Subquestions 1 and 2.

Regarding the implementation of IP phone equipment and related systems (hereinafter “IPC system”), Company *K* decided to consider the initial investment cost, maintenance costs, and the expected economic benefits, in order to make a determination on whether to invest in the system.

(1) Initial investment cost

Table 1 indicates the initial investment cost required for implementation of the IPC system.

Table 1 Initial investment cost required for implementation of IPC system

Unit ¥1,000		
Cost item	Content	Initial investment cost
IP phone equipment acquisition cost	IP phones, IP phone exchanges, etc.	8,000
LAN equipment acquisition cost	Voice priority control switches, powered switching hubs, etc.	7,000
Software purchase cost	Voice mail software, automated answering software	5,000

(2) Maintenance cost**(i) Equipment maintenance cost**

Maintenance cost will not occur for the 1st year after the IPC system begins operation. In years 2 through 4, 10% of equipment acquisition cost will occur as an annual maintenance cost, and in year 5 and onward, 20% of equipment acquisition cost will occur as an annual maintenance cost.

(ii) Software maintenance cost

An annual maintenance cost of 12% of the software purchase cost will occur after the IPC system begins operation.

(3) Expected economic benefit

(i) Communication cost reductions

Prior to implementation of the IPC system, the annual communication cost was ¥4,000,000. As the unit cost of communications is falling, a reduction of 10% over the previous year is expected every year, even without implementation of the IPC system. With implementation of the IPC system, a further reduction of 40% in the annual communication cost is expected from year 1 onward.

(ii) Phone exchange management cost reductions

The annual management cost for existing phone exchanges is ¥1,500,000. If the IP exchanges are implemented, the annual maintenance cost will be 50% that of the existing phone exchanges.

(iii) Cost reductions due to labor saving

Voice mail software will eliminate the need for creating voice messages, and automated answering software will eliminate the work of answering the main phone line. Through this labor saving, annual costs will be reduced by ¥4,000,000 after the IPC system is put into operation.

(4) Investment determination criteria

The company will deem the investment feasible if the following two determination values meet the investment decision criteria.

(i) Payback period determination value

The payback period determination value is the value derived by taking the cumulative total of the expected annual economic benefit minus the annual maintenance cost (hereinafter “incremental cash flow”), and subtracting the initial investment cost. If the time until the payback period determination value becomes positive is six (6) years or less after the IPC system goes into operation, the investment determination criteria can be said to be satisfied.

(ii) Profitability determination value

The profitability determination value is the value derived by subtracting the total amortization cost of the investment (hereinafter “amortization cost”) from the incremental cash flow. If the profitability determination value is positive by the end of year 6 after the IPC system goes into operation, the investment determination criteria can be said to be satisfied.

Table 2 shows the durable years, amortization rate, amortization method, and amortization cost equations for each amortized item.

Table 2 Durable years, amortization rate, amortization method, and amortization cost equations for each amortized item

Amortized item	Durable years	Amortization rate	Amortization method	Amortization cost equations
IP phone equipment	6	0.319	Declining balance method	Unamortized balance = acquisition cost – accumulated amortization
LAN equipment	10	0.206		Amortization cost = unamortized balance × amortization rate
Software	5	0.200	Straight-line method	Amortization cost = acquisition cost × amortization rate

(5) Worksheet for making investment determination

In order to make a determination to invest in implementing the IPC system, spreadsheet software was used to make a worksheet as shown in the figure.

	A	B	C	D	E	F	G	H	I
1	Preconditions	Initial investment cost		Calculation of amortization cost			Annual costs and economic benefit prior to implementation		
2		Cost item	Amount (¥1000)	Amortization method	Durable years (years)	Amortization rate	Item	Amount (¥1000)	
3		IP phone equipment acquisition cost	8,000	Declining balance method	6	0.319	Communication costs prior to implementation	4,000	
4		LAN equipment acquisition cost	7,000	Declining balance method	10	0.206	Management cost for existing phone exchanges	1,500	
5		Software purchase cost	5,000	Straight-line method	5	0.200	Cost reductions due to labor saving	4,000	
6	Profitability by fiscal year (¥1000)								
7	Fiscal years elapsed		1	2	3	4	5	6	
8	Maintenance cost	Equipment maintenance cost	0						
9		Software maintenance cost							
10		Total	600	2,100	2,100	2,100	3,600	3,600	
11	Communication cost	Initially expected communication cost	3,600						
12	Expected economic benefit	Communication cost reductions							
13		Phone exchange maintenance cost reductions							
14		Cost reductions due to labor saving	4,000						
15		Total	6,190	6,046	5,916	5,800	5,695	5,600	
16	Payback period	Incremental cash flow	5,590	3,946	3,816	3,700	2,095	2,000	

17	determination value	Cumulative incremental cash flow	5,590					
18		Payback period determination value	-14,410					
19	Profitability determination value	Unamortized balance of IP phone equipment	5,448					
20		Amortization cost of IP phone equipment	2,552					
21		Unamortized balance of LAN equipment	5,558					
22		Amortization cost of LAN equipment	1,442					
23		Amortization cost of software						0
24		Total amortization cost	4,994	3,883	3,093	2,528	2,122	829
25		Profitability determination value						

Note: Shaded portions are not shown.

Calculated decimal values are rounded to the nearest integer when displayed in cells.

Fig. Worksheet for making determination to invest in implementing IPC system

Subquestion 1

From the answer groups below, select the correct answer to be inserted in each blank

in the following description concerning the worksheet in the figure.

- (1) Initial investment cost, calculation of amortization cost, and annual costs and economic benefit prior to implementation were entered in Rows 3 through 5 as preconditions for making the investment determination.
- (2) The expression " A" to calculate equipment maintenance cost from year 2 onward was entered in cell D8, and was duplicated in cells E8 through H8. The expression " B*0.12" to calculate software maintenance cost for year 1 was entered in cell C9, and was duplicated in cells D9 through H9.
- (3) The initially expected communication cost for year 1 was entered in cell C11. The expression " C*0.9" to calculate the initially expected communication cost for year 2 was entered in cell D11, and was duplicated in cells E11 through H11. Expressions to calculate the amount of communication cost reductions for each elapsed fiscal year were entered in cells C12 through H12, expressions to calculate the amount of phone exchange equipment management cost reductions for each elapsed fiscal year were entered in cells C13 through H13, and expressions to calculate the amount of cost reductions through labor saving for each elapsed fiscal year were entered in cells C14 through H14.
- (4) Expressions to calculate incremental cash flow for each elapsed fiscal year were entered in cells C16 through H16. An expression to calculate cumulative incremental cash flow for year 1 was entered in cell C17. The expression " D" to calculate cumulative incremental cash flow for year 2 was entered in cell D17, and was duplicated in cells E17 through H17. Expressions to derive the payback period determination value for each elapsed fiscal year were input in cells C18 through H18.

- (5) An expression to calculate the unamortized balance for IP phone equipment for year 1 was entered in cell C19, and an expression to derive the amortization cost for IP phone equipment for year 1 was entered in cell C20. The expression “C19 - D20” to calculate the unamortized balance for IP phone equipment for year 2 was entered in cell D19, and was duplicated in cells E19 through H19. The expression “C19 * \$F3” to calculate the amortization cost for IP phone equipment for year 2 was entered in cell D20, and was duplicated in cells E20 through H20. Expressions to calculate the unamortized balance for LAN equipment for each elapsed fiscal year were entered in cells C21 through H21, and expressions to calculate the amortization cost for LAN equipment for each elapsed fiscal year was entered in cells C22 through H22. The expression “E” to calculate the amortization cost for software for year 1 was entered in cell C23, and was duplicated in cells D23 through G23. Expressions to calculate the profitability determination value for each elapsed fiscal year were entered in cells C25 through H25.

Answer group for A

- a) $(C3+C4) * 0.1$
- b) $(C3+C4) * 0.2$
- c) $(\$C3+\$C4) * 0.1$
- d) $(\$C3+\$C4) * 0.2$
- e) $\text{IF}(D7 \geq 5, (\$C3+\$C4) * 0.2, (\$C3+\$C4) * 0.1)$
- f) $\text{IF}(D7 < 5, (\$C3+\$C4) * 0.2, (\$C3+\$C4) * 0.1)$

Answer group for B and C

- | | | |
|---------|----------|---------|
| a) C5 | b) C11 | c) I3 |
| d) \$C5 | e) \$C11 | f) \$I3 |

Answer group for D

- | | |
|------------|------------|
| a) C16+D16 | b) C17 |
| c) C17+D16 | d) E17-E16 |

Answer group for E

- | | |
|--------------|--------------|
| a) C5*F4 | b) C5*F5 |
| c) \$C5*\$F4 | d) \$C5*\$F5 |

Subquestion 2

From the answer group below, select the appropriate statements concerning investment determination criteria that are made clear by the worksheet in the figure.

Answer group

- a) Neither the payback period determination value nor the profitability determination value satisfies the investment determination criteria.
- b) Both the payback period determination value and the profitability determination value satisfy the investment determination criteria.
- c) The payback period determination value does not satisfy the investment determination criteria, but the profitability determination value does satisfy the investment determination criteria.
- d) The payback period determination value satisfies the investment determination criteria, but the profitability determination value does not satisfy the investment determination criteria.
- e) It cannot be determined whether the payback period determination value or the profitability determination value satisfies the investment determination criteria.

Q12-14 □□□

Read the following description concerning selling and sales at a catalog retailer, and answer Subquestions 1-4.

Company *N* is a major catalog retailer. It is characterized by its quality products, full product lineup, and courteous follow-up service. The company's organization consists of a sales department, customer management department, shipping department, and general affairs department. The company has implemented and operates a sales management system (hereinafter system) developed in-house.

[Sales department tasks]

- (1) Twice a year, the sales department produces a product catalog listing all of the products it regularly handles (regular products), and mails the catalogs to customers.
- (2) Every 3 months, the department receives special shipments of products related to a certain theme chosen every time, such as dieting, health, or car accessories. The department creates an overview (pamphlet) of product groups (special products), differing from its regular products, according to these specified themes, and mails them to the customers.
- (3) The products listed in Company *N*'s catalogs and pamphlets are also introduced on its Web site.

[Customer management department tasks]

- (1) The customer management department accepts catalog requests from new customers and mails the catalogs.
- (2) The department accepts orders via phone, FAX, mail, or Internet, and enters the content of the order into the system. Simultaneously, the order information is sent to the shipping department's information terminals.
- (3) When an order is received from a new customer, attribute data (customer information) such as customer code, customer name, address, phone number, date of birth, gender, hobbies, and family structure, are registered in the system.
- (4) When further orders are received, the customer attribute data registered in the system is updated. This update is based on responses to the company's customer questionnaire that accompanied the order form, or based on the content given by the customers to the company's operators during ordering.
- (5) When an inquiry from a customer about product details is received, the company's operators respond by calling up and referencing the detailed information on products that was registered in the system at the time the product catalogs and pamphlets were created.
- (6) The department responds appropriately to requests concerning products, complaints

about the company, and so on. At the same time, it registers requests concerning its products, and the content of its responses to customers, in the system.

In recent years, growth in Company *N*'s sales amount has been slow compared to industry competitors, and profits have also hit a ceiling. Thus, Mr. *F*, an entry-level system administrator, who belongs to the sales department, will survey and analyze current problem areas under the direction of his supervisor, and will consider future countermeasures. First, Mr. *F* has decided to conduct an analysis of sales performance according to the following procedures.

[Procedure 1]

To accurately ascertain the status of the company's sales, sales performance for the past 3 years will be totaled.

- (1) The company's fiscal year runs from April through the following March.
- (2) Composition ratio is each month's total sales expressed as a percentage of annual sales.
- (3) As there is seasonal variation within monthly sales, quantified seasonal variations are expressed as seasonal indexes. A seasonal index is the 3-year total sales for the month in question, as a percentage of 3-year monthly average sales.
- (4) The Determination column displays the following: "○○" for months in which the seasonal index exceeds 150%; "○" for months in which the seasonal index exceeds 120% and is less than 150%; "●" for months in which the seasonal index exceeds 90% and is less than 120%; and "▲" for months in which the seasonal index is 90% or less.

[Procedure 2]

Cumulative performance, moving average, and moving total are calculated, based on totaled sales performance.

- (1) Cumulative performance totals each month's sales performance for each accounting year.
- (2) Moving average is the average sales performance for the past 1 year (12 months). For example, the moving average as of June 2007 is the average value of sales performance from July 2006 to June 2007.
- (3) Moving total is the total sales performance for the past 1 year (12 months). For example, the moving total as of June 2007 is the total value of sales performance from July 2006 to June 2007.

[Procedure 3]

A Z graph is created based on sales performance, cumulative performance, and moving total, and the status of sales is visually checked.

Subquestion 1

Table 1 is a worksheet created by Mr. F for the purpose of checking sales performance for the past 3 years. Expressions are entered into the cells H2 and I2, and are duplicated in cells H3 through H13 and cells I3 through I13, respectively. From the answer groups below, select the appropriate expressions to be inserted in each blank in Table 1.

Table 1 Sales performance table

	A	B	C	D	E	F	G	H	I
1		FY 2005	FY 2006	FY 2007	Monthly total	Monthly average	Composition ratio	Seasonal index	Determination
2	April	5,608	5,553	5,441	16,602	5,534	7.6%	<input type="text"/>	<input type="text"/>
3	May	5,599	5,544	5,433	16,576	5,525	7.6%		
4	June	5,111	5,061	4,959	15,131	5,044	6.9%		
5	July	6,138	6,078	5,956	18,172	6,057	8.3%		
6	August	7,659	7,584	7,432	22,675	7,558	10.4%		
7	September	4,926	4,878	4,780	14,584	4,861	6.7%		
8	October	5,484	5,430	5,321	16,235	5,412	7.4%		
9	November	6,469	6,405	6,276	19,150	6,383	8.7%		
10	December	4,190	4,149	4,066	12,405	4,135	5.7%		
11	January	3,669	3,633	3,560	10,862	3,621	5.0%		
12	February	9,805	9,708	9,513	29,026	9,675	13.3%		
13	March	9,274	9,183	8,999	27,456	9,152	12.5%		
14	FY total	73,932	73,206	71,736	218,874	72,958	100.0%		

Note: Because cells F2 through F13 show values rounded up to the nearest integer and cells G2 through G13 show values rounded up to the nearest first decimal place, their respective totals do not match the FY totals in F14 and G14.

Answer group for A

- a) $E2/(\$E\$14/12)*100$
- b) $E2/(\$F\$14/12)*100$
- c) $\$E2/(\$F\$14/12)*100$
- d) $\$E\$2/(\$E\$14/12)*100$

Answer group for B:

- a) IF(H2<150, '○○', IF(H2<120, '○', IF(H2<90, '●', '▲'))))
- b) IF(H2>149, '○○', IF(H2>119, '○', IF(H2>89, '●', '▲'))))
- c) IF(H2>150, '○○', IF(H2>120, '○', IF(H2>90, '●', '▲'))))
- d) IF(H2>=150, '○○', IF(H2>=120, '○', IF(H2>=90, '●', '▲'))))

Subquestion 2

The statements below summarize the expressions and procedures for arranging cumulative performance, moving average, and moving total in the Table 2 worksheet, based on totaled sales performance. From the answer groups below, select the appropriate answers to be inserted in each blank in the description below.

Table 2 Worksheet

	K	L	M	N	O	P
1	FY	Month	Sales performance	Cumulative performance	Moving average	Moving total
2	FY2005	April	5,608			
3		May	5,599			
4		June	5,111			
11		January	3,669			
12		February	9,805			
13		March	9,274			
14	FY2006	April	5,553		<input type="text"/>	<input type="text"/>
15		May	5,544			
16		June	5,061			
23		January	3,633			
24		February	9,708			
25		March	9,183			
26	FY2007	April	5,441			
27		May	5,433			
28		June	4,959			
35		January	3,560			
36		February	9,513			
37		March	8,999			

Note: Rows 5 through 10, Rows 17 through 22, and Rows 29 through 34 are not shown.

- (1) Sales performance in Column M is duplicated from the appropriate locations in “Table 1 Sales performance table.”
- (2) To calculate cumulative performance, is entered in cell N2 and is entered in cell N3, and the expression in N3 is duplicated in cells N4 through N13. Moreover, cells N2 through N13 is duplicated in cells N14 through N25 and in cells N26 through N37.
- (3) To calculate moving average and moving total, is entered in O14 and is entered in P14, and these are duplicated in cells O15 through O37 and in cells P15 through P37, respectively.

Answer group for C and D:

- | | | |
|-----------|--------------|------------------|
| a) M2 | b) M\$2 | c) N2+M3 |
| d) \$M\$2 | e) \$N\$2+M3 | f) \$N\$2+\$M\$3 |

Answer group for E and F:

- | | |
|--------------------------|----------------------------|
| a) TOTAL(M3:M14) | b) TOTAL(\$M3:\$M\$14) |
| c) TOTAL(\$M\$3:\$M\$14) | d) AVERAGE(M3:M14) |
| e) AVERAGE(\$M3:\$M\$14) | f) AVERAGE(\$M\$3:\$M\$14) |

Subquestion 3

Mr. F, who created a Z graph using Table 2, next conducted hearings regarding current workflow with the sales department and customer management department, the departments that have direct contact with customers.

[Results of hearings with the sales department]

- (1) The product catalog for regular products is mailed to all customers registered in the system. If catalogs are returned due to an incomplete address or refusal by the customer, the customer information is updated so that the catalog is not mailed again later.
- (2) New customers typically increase steadily every year, but there is also a growing trend of customers who have a history of purchasing but who do not purchase again, resulting in poor growth in sales and profits.
- (3) The number of customers making repeated orders for regular products is barely increasing in recent years, and the repeat order rate per customer is in a downward trend.

- (4) The special products pamphlet consists of related products collected according to theme. For purposes of effective sales promotion, it is currently mailed only to customers who have purchased products of a certain value or higher in the past one year. However, among customers who were mailed the pamphlet, the ratio of customers who actually order products (the response rate) is nearly the same as that of regular products.

[Results of hearings with the customer management department]

- (1) When product inquiries are received, the department sometimes is asked about details of products related to another product, or replacement purchase of the same type of product. However, within the system currently operated, the functionality for introducing products is designed to emphasize descriptions of individual products, and provides a difficult environment for effectively offering advice during inquiries such as the above.
- (2) The department also accepts orders for consumables and regularly replaced parts, and references purchasing history when customer inquiries are responded to. However, the order volume for such products is extremely low compared to the sales volume of the main products that use the consumables and parts. The department wishes to see orders increase.
- (3) Requests for responding to requests or complaints concerning products are made to the necessary department or persons in charge, with the outcome of the response recorded in the system. Requests or complaints concerning the same product may come from multiple customers, but even in cases concerning the same content, the current system requires a search with a full-text search function, which does not allow a prompt reply.
- (4) Compared to the past, inquiries from customers with an interest in products are increasingly received by e-mail. Replies from the customer management department use e-mail, and the response history, including the customer's mail address, is recorded in the system.

After the hearings and upon reporting the results to his superiors, Mr. *F* was ordered to draft proposed solutions to the current problems. At the same time, to escape from the situation of stagnant sales and profits, he was also instructed to draft a new sales promotion proposal using active direct mail (DM) and e-mail, with the aim of expanding customers who make repeated orders and improving profits.

To improve the repeat order rate per customer and the response rate to the pamphlet in accordance with the instructions of his superior, what sales promotion activities using DM and e-mail should Mr. *F* carry out? From the answer group below, select the appropriate answer.

Answer group:

- a) Performing detailed analysis of not only the purchase amount for the past one (1) year, but also of purchase history taking into account family composition, hobbies, etc.; narrowing down customer groups which are appropriate targets for providing information on related products and replacement purchase periods, as well as on consumables and regular replacement parts for purchased products, etc.; and sending DM and e-mail in timely fashion
- b) From the standpoint that service should be uniform, regularly and uniformly sending product catalogs and pamphlets in digital format as e-mail attachments to all customers for which customer data is managed
- c) Stopping the use of DM in conventional paper media; constructing a shopping site for product purchases on the company's Web site, and increasing customers' use of the site. Using e-mail to conduct a focused sales push toward customers particularly with no purchase history in the past one (1) year

Subquestion 4

How should the system be improved to respond promptly to inquiries or complaints from customers? Based on the results of the hearings, select the appropriate answer from the answer group below.

Answer group:

- a) Accepting all inquiries and complaints only through Internet-based means, using e-mail or placing inquiry information on the Web site
- b) From a human resource staffing company or other source, employing human resources as needed who are equipped with knowledge of specific products and are able to accurately respond to inquiries, thereby improving the customer handling capability of departments in charge
- c) Organizing information for each product for the purpose of responding to customer inquiries and complaints, and enabling prompt responses through item searches for similar past cases, as necessary
- d) On screens that introduce specific products, enabling easy search and displaying of information on related products

Q12-15 □□□

Read the following description concerning a class placement test, and then answer Subquestions 1 through 4.

Company *E* conducts a course for the acquisition of qualifications. Course applicants take a 100-question test consisting of Q1 through Q100, and based on results, are placed into one of five (5) classes for the course. An index called “score” is calculated as per the equation below, and class placement is performed using score as a criterion, as shown in the Table.

$$\text{Score} = \frac{\text{the course applicant's number of correct answers} - \text{the average number of correct answers of all past course applicants}}{\text{the standard deviation of the number of correct answers of all past course applicants}}$$

Table Criteria for class placement according to score

Score	Class
Less than -1.5	1
-1.5 or more, but less than 0.5	2
-0.5 or more but less than 0.5	3
0.5 or more but less than 1.5	4
1.5 or more	5

Conducting and grading the test requires time with the current method of class placement, and thus Mr. *U* of Company *E* has decided to use spreadsheet software and consider the methods shown below for performing class placement using fewer questions.

- (1) For the 100 questions currently used for class placement, analyze the grading results used in past class placement, for each of classes 1-5.
- (2) From among the 100 questions, select 10 questions that allow efficient class placement, and conduct new class placement tests using only those 10 questions.
- (3) Based on the status of the accuracy of the 10-question test used in the new class placement, perform class placement by stochastically considering which classes have persons with the highest probability of resulting in that status.

Mr. *U* totaled the worksheet in Fig. 1 and created the “Grading” worksheet shown in Fig. 2 to display the number of correct answers for each course applicant as well as the average number of correct answers and the standard deviation for all course applicants.

	A	B	...	E	F	G	H
1	Course applicant	Number of correct answers		Average	60.0	Standard deviation	10.0
2	DA0001	63					
3	DA0002	56					
4	DA0003	74					
5	DA0004	52					
⋮	⋮	⋮					
1001	DA1000	95					

Fig. 2 “Grading” worksheet

When data among multiple worksheets is referenced, expressions are specified in the format “sheet_name!cell”. When cells in this format are duplicated, cells in the duplication destination are automatically updated relatively. For example, when the expression “Accuracy!A2” is entered into cell A2 of the “Grading” worksheet and is then duplicated in cell A3, the value in cell A3 of the “Accuracy” worksheet is displayed in cell A3 of the “Grading” worksheet.

Next, to calculate the number of correct answers for each course applicant in the Fig. 2 worksheet, Mr. *U* enters equation C in cell B2, and duplicated this in cells B3 through B1001. Moreover, to calculate the average number of correct answers for all course applicants, he enters the expression D in cell F1, and to calculate the standard deviation, enters the expression E in cell H1.

Answer group:

- a) TOTAL(B2:B1001)
- b) TOTAL(Accuracy!B2:Accuracy!B1001)
- c) TOTAL(Accuracy!B2:Accuracy!CW2)
- d) STANDARDDEVIATION(B2:B1001)
- e) STANDARDDEVIATION(Accuracy!B2:Accuracy!B1001)
- f) STANDARDDEVIATION(Accuracy!B2:Accuracy!CW2)
- g) AVERAGE(B2:B1001)
- h) AVERAGE(Accuracy!B2:Accuracy!B1001)
- i) STANDARDDEVIATION(Accuracy!B2:Accuracy!CW2)

Subquestion 3

From the answer groups below, select the appropriate phrases to be inserted in each blank in the description below concerning scores and classes for all course applicants.

To display the scores and classes for all course applicants, Mr. *U* duplicated the Fig. 2 worksheet and created the “Class placement” worksheet shown in Fig. 3.

	A	B	C	D	E	F	G	H
1	Course applicant	Number of correct answers	Score	Class	Average	60.0	Standard deviation	10.0
2	DA0001	63						
3	DA0002	56						
4	DA0003	74						
5	DA0004	52						
:	:	:						
1001	DA1000	95						

Note: The calculated values for the shaded parts are not shown.

Fig. 3 “Class placement” worksheet

Next, Mr. *U* input the expression F to compute scores in cell C2, and duplicated this in cells C3 through C1001. In addition, he input the expression “IF(C2 G, H, IF(C2 ≥ 1.5, 5, INTEGER(I) + 3))” to display class in cell D2, and duplicated this in cells D3 through D1001.

Answer group for F:

- | | |
|-------------------|-------------------|
| a) (B2–F1)/H1 | b) (B2–H1)/F1 |
| c) (B2–F\$1)/H\$1 | d) (B2–H\$1)/F\$1 |
| e) (B2–\$F1)/\$H1 | f) (B2–\$H1)/\$F1 |

Answer group for G:

- | | | | |
|----------|----------|----------|----------|
| a) <–1.5 | b) ≤–1.5 | c) =–1.5 | d) ≥–1.5 |
| e) >–1.5 | f) <1.5 | g) ≤1.5 | h) =1.5 |
| i) ≥1.5 | j) >1.5 | | |

Answer group for H:

- a) 0 b) 1 c) 2
d) 3 e) 4 f) 5

Answer group for I:

- a) C2-2.5 b) C2-1.5 c) C2-0.5 d) C2
e) C2+0.5 f) C2+1.5 g) C2+2.5

Subquestion 4

From the answer group below, select the appropriate phrases to be inserted in each blank in the description below concerning the new class placement method.

For past course applicants, Mr. *U* calculated each question's correct answer ratio for each of the classes 1 through 5, and created the "Correct answer ratio" worksheet shown in Fig. 4.

	A	B	C	D	E	F	...	CW
1		Q1	Q2	Q3	Q4	Q5	...	Q100
2	Class 1	0.50	0.69	0.80	0.35	0.10	...	0.38
3	Class 2	0.55	0.77	0.84	0.43	0.15	...	0.55
4	Class 3	0.63	0.79	0.85	0.56	0.35	...	0.67
5	Class 4	0.68	0.85	0.93	0.64	0.68	...	0.73
6	Class 5	0.78	0.88	0.99	0.73	0.93	...	0.88

Fig. 4 "Correct answer ratio" worksheet

The Fig. 4 worksheet shows that the correct answer ratio for Q1 was 0.50 for Class 1, 0.55 for Class 2, and so on.

Next, Mr. *U* used the Fig. 4 worksheet to create the "Class determination" worksheet shown in Fig. 5, and performed class placement by inputting the status of course applicants' accuracy in Row 2.

	A	B	C	D	E	F	...	K	L
1		Q5	Q25	Q27	Q37	Q43	...	Q98	Probability
2	Accuracy	1	0	0	1	0	...	1	
3	Class 1	0.10	0.20	0.17	0.18	0.19	...	0.28	
4	Class 2	0.15	0.36	0.23	0.22	0.41	...	0.33	
5	Class 3	0.35	0.43	0.45	0.43	0.56	...	0.57	
6	Class 4	0.68	0.69	0.68	0.63	0.78	...	0.78	
7	Class 5	0.93	0.98	0.80	0.88	0.95		0.91	
8	Probability of Class 1			0.83	0.18	0.81		0.28	
9	Probability of Class 2	0.15	0.64	0.77	0.22	0.59		0.33	
10	Probability of Class 3	0.35	0.57	0.55	0.43	0.44		0.57	
11	Probability of Class 4	0.68	0.31	0.32	0.63	0.22		0.78	
12	Probability of Class 5	0.93	0.02	0.20	0.88	0.05		0.91	

Note: The calculated values for the shaded parts are not shown.

Fig. 5 “Class determination” worksheet

In the Fig. 5 worksheet, the 10 questions Q5, Q25, Q27, ... Q98 are selected as the test to be used for new class placement. The correct answer ratio for each question, by class, references the Fig. 4 worksheet and is displayed in cells B3 through K7.

For a Class 1 person, the probability that Q5 is correct and Q25 is incorrect is . Mr. U decided to apply the method for calculating the probabilities for these 2 questions to the selected 10 questions, and to perform class placement using the method shown below.

- (1) Enter the accuracy of course applicants with regard to the selected 10 questions in Column 2.
- (2) In cell B8, enter the expression to calculate the probability of Class 1 persons obtaining the result in Cell B2, and duplicate this in cells B8 through K12.
- (3) In cell L8, enter the expression to calculate all values for cells B8 through K8, and duplicate this in cells L9 through L12.
- (4) Enter the expression “MAX(L8:L12)” in cell L2.
- (5) Within cells L8 through L12, search for cells with the same value as cell L12, and determine the class that corresponds to that cell.

To efficiently perform class placement using this method, the selected 10 questions need only be questions that

M

.

Answer group for J:

- | | | |
|---------|---------|---------|
| a) 0.02 | b) 0.08 | c) 0.10 |
| d) 0.15 | e) 0.20 | f) 0.30 |

Answer group for K:

- | | |
|--|--|
| a) $B\$2 * B3$ | b) $B\$2 * (1 - B3)$ |
| c) $(1 - B\$2) * B3$ | d) $(1 - B\$2) * (1 - B3)$ |
| e) $B\$2 * B3 + (1 - B\$2) * (1 - B3)$ | f) $(1 - B\$2) * B3 + B\$2 * (1 - B3)$ |
| g) $(1 - B\$2) * B3 * B\$2 * (1 - B3)$ | |

Answer group for L:

- | | | |
|----------|------------|------------|
| a) Total | b) Product | c) Average |
|----------|------------|------------|

Answer group for M:

- a) have large differences in the correct answer rate
- b) have small differences in the correct answer rate
- c) are difficult
- d) are easy
- e) are randomly-chosen

Appendix

- Scope of questions in Morning Exam
- Commonly used notations in questions
- Common notations used for pseudo-languages
- Explanation of APIs used in Java programs
- Specification of assembler language
- Functions and terminology of spreadsheet software

■ About APIs used in Java programs

The Java Language Specification, Third Edition, is available from the URL below:

<http://docs.oracle.com/javase/specs/>

Also other explanations can be found in Java reference books.

It is advisable to consult these resources by yourself.

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