

Q3. For three sets A , B and C , which of the following equalities holds? Here, \cup and \cap are the union and intersection symbols, respectively.

- a) $(A \cup B) \cap (A \cap C) = B \cap (A \cup C)$
- b) $(A \cup B) \cap C = (A \cup C) \cap (B \cup C)$
- c) $(A \cap C) \cup (B \cap A) = (A \cap B) \cup (B \cap C)$
- d) $(A \cap C) \cup (B \cap C) = (A \cup B) \cap C$

Q11. Which of the following is an appropriate term for a special register that contains the address of the next instruction to be fetched?

- a) Accumulator
- b) Instruction register
- c) Program counter
- d) Status register

Q13. Which of the following is a computer architecture where each instruction is divided into multiple stages (e.g., fetch, decode, and execute) in the processor and multiple functional units execute two or more instructions in parallel by slightly shifting execution stages of the instructions?

- a) Multicore b) Pipeline c) RISC d) VLIW

Q14. Which of the following is a connection method that is referred to as a daisy chain?

- a) A keyboard, a mouse, and a printer are connected to a USB hub, and the USB hub is connected to a PC.
- b) A PC and a measuring device are connected with RS-232C, and the PC and a printer are connected by USB.
- c) A PC is connected from its own Thunderbolt connection port with a cable to one of the two (2) 4K displays, each of which is equipped with two (2) Thunderbolt connection ports, and the display is connected to the other display with a cable.
- d) Several network cameras and PCs are connected to a network hub.

Q20. Which of the following is an appropriate explanation of an actuator?

- a) It amplifies weak electrical signals sent from microphones, sensors, and so on.
- b) It compares a given target value and a controlled value obtained from a sensor and outputs an operation amount so that the controlled value is matched with the target value.
- c) It converts the power from an energy source into rotation, translational motion, or other movements based on the control signals.
- d) It detects position, angle, velocity, acceleration, force, temperature, and so on, and converts them into electric information.

Q11. Which of the following is a special register that contains the address of the next instruction to be fetched?

- a) Accumulator
- b) Program Counter (PC)
- c) Stack Pointer
- d) Timer

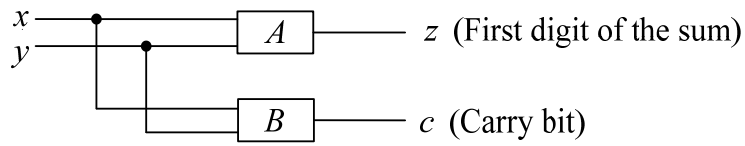
Q13. Which of the following is a computer system or architecture where the CPU sequentially reads and executes the programs that are stored in the main memory?

- a) Addressing system
- b) DMA control architecture
- c) Stored program architecture
- d) Virtual memory system

Q14. Which of the following is an appropriate description of USB 3.0?

- a) It is a serial interface that adopts isochronous transmission that is suitable for audio or video, and has a broadcast transmission mode.
- b) It is a serial interface that has a data transmission mode of 5 Gbit/s that is called super speed.
- c) It is a serialized ATA specification that connects a PC to a peripheral device.
- d) It is an interface that uses four (4) pairs of signal lines transmitting two (2) bits of information in one (1) clock and has a maximum throughput of 1 Gbit/s.

Q21. The half adder in the diagram below adds two (2) single-digit binary numbers, x and y , and produces z (the first digit of the sum) and c (the carry bit) as outputs. Which of the following is the appropriate combination of gate devices A and B ?



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

Q23. Which of the following is an appropriate purpose of check digit?

- a) To detect an error that an alphabet or a symbol is contained in a numeric item field
- b) To detect an error that the number of digits of an entered code is incorrect
- c) To detect an error that the value of an entered code is incorrect
- d) To detect an error that the value of an entered data is not within a specified range

Q24. Which of the following explains a drawing software?

- a) It can create a picture on a screen using the mouse as a brush that can be saved to a bitmap image file.
- b) It can create a scenario-based content by editing and arranging several materials, such as text, images, video, and sound.
- c) It can create a simple movie from a series of still images by gradually changing the differences among images.
- d) It can create vector graphics composed of lines and curves defined mathematically with geometric characteristics that can then be transformed or combined.

Q4. For an 8-bit code with the most significant bit as its parity bit, which of the following is used to obtain the lower seven (7) bits other than parity?

- a) Perform a bitwise AND operation with 0F in hexadecimal
- b) Perform a bitwise AND operation with 7F in hexadecimal
- c) Perform a bitwise OR operation with 0F in hexadecimal
- d) Perform a bitwise XOR (exclusive OR) operation with FF in hexadecimal

Q11. Which of the following causes an external interrupt?

- a) Notification of elapsed time by a timer
- b) The execution of a division-by-zero instruction
- c) The execution of a non-existent operation code
- d) The occurrence of a page fault

Q12. Which of the following is an appropriate explanation of a device driver?

- a) Software to control peripheral devices that are connected to a PC
- b) Software to install an application on a PC
- c) Software to invade another PC and cause damage
- d) Software to register the operation procedures for a keyboard or other devices and to automate this operation

Q20. Which of the following is an appropriate description of DRAM?

- a) It is memory that requires a refresh operation, and it is used as the main memory of a PC.
- b) It is non-volatile memory of a NAND type or a NOR type, and it is used as an SSD.
- c) It is non-volatile memory that is capable of erasing and writing data in byte units, and it is used when data need to be retained even when the power supply is turned off.
- d) Its memory cells consist of flip-flops, and it is used for cache memory.

Q21. Which of the following is a secondary (rechargeable) battery?

- a) Alkaline–manganese dry-cell battery
- b) Fuel cell
- c) Lithium-ion battery
- d) Silver-oxide battery

Q9. Which of the following is a characteristic of a RISC processor when it is compared with a CISC processor?

- a) The RISC processor uses a micro-code architecture.
- b) The RISC processor uses a uniform instruction length to process tasks in a pipeline.
- c) The RISC processor uses a variable instruction length to optimize task process capability.
- d) The RISC processor uses complex instructions to process various tasks with few instructions.

Q10. Which of the following is classified as an internal interrupt?

- a) An interrupt due to an abnormal power condition, such as a momentary loss of the commercial power supply
- b) An interrupt due to having performed division by zero
- c) An interrupt due to the completion of input or output
- d) An interrupt due to the occurrence of a memory parity error

Q11. Which of the following is an appropriate characteristic of SRAM compared with DRAM?

- a) Compared with DRAM, SRAM consumes more power while it is idle.
- b) Compared with DRAM, SRAM needs a fewer number of transistors to store one bit of data.
- c) SRAM does not need to be refreshed periodically as flip-flops retain data, and DRAM needs to be refreshed at fixed intervals to retain data.
- d) SRAM stores data in a combination of capacitors and transistors, and DRAM stores data in a set of transistors called flip-flops.

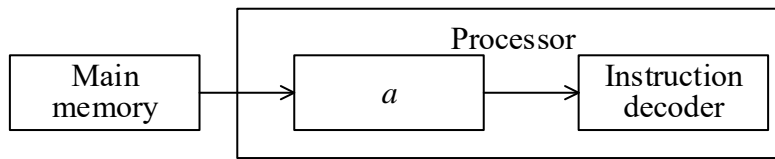
Q12. Which one of the following serial transmission methods is used in asynchronous data communication?

- a) I²C b) PCI Express c) SPI d) UART

Q21. Which of the following is an appropriate description of flash memory?

- a) Data must be rewritten periodically.
- b) Flash memory can be rewritten at high speed and is used in the cache memory of the CPU.
- c) The content can be erased electrically in units of blocks.
- d) The entire content can be erased by ultraviolet rays.

Q12. The figure shows the storage sequence of instructions fetched by a processor. Which of the following corresponds to *a*?



- a) Accumulator
- b) Data cache
- c) Instruction register
- d) Program register (program counter)

Q13. Which of the following is an appropriate description of cache memory?

- a) Cache memory is used to fill a gap in memory capacity between the physical memory and the virtual memory.
- b) Due to significant improvements in the access speed of semiconductor memory, the need for cache memory is decreasing.
- c) If a cache miss occurs, an interrupt is generated, and data is transferred from the main memory to the cache memory by the program.
- d) When the write instruction is executed, the cache memory is rewritten in two ways. In one, both the cache memory and the main memory are rewritten, and in the other, only the cache memory is rewritten, and the main memory is rewritten when the relevant data is removed from the cache memory.

Q22. Which of the following is a sequential circuit that has two (2) stable states?

- a) Adder circuit
- b) Capacitor
- c) Flip-flop
- d) NAND gate

Q23. Which of the following is an appropriate description of flash memory?

- a) All its contents can be erased at once with ultraviolet rays.
- b) Data can be electronically erased in block units.
- c) It can be rewritten at a high speed and is used for the cache memory of a CPU.
- d) It needs to rewrite data periodically.

Q10. Which of the following is an appropriate characteristic of SRAM compared to DRAM?

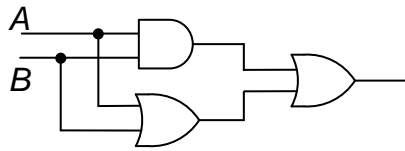
Here, SRAM and DRAM are compared in products manufactured in the same or similar semiconductor geometric process.

- a) SRAM consumes more power, particularly when idle, compared to DRAM.
- b) SRAM is non-volatile, whereas DRAM is volatile.
- c) SRAM needs to be refreshed, whereas DRAM does not.
- d) SRAM uses more transistors in a memory cell compared to DRAM.

Q11. In a memory system that has a cache memory, which of the following causes an increase in the average memory access time?

- a) A decrease in the access time to the cache memory
- b) A decrease in the cache hit rate
- c) A decrease in the cache miss penalty
- d) A decrease in the cache miss rate

Q23. Which of the following is a logical expression that is equivalent to the logic circuit shown below?



- a) $A \text{ AND } B$
- c) $A \text{ OR } B$

- b) $A \text{ AND } (A \text{ OR } B)$
- d) $B \text{ AND } (A \text{ OR } B)$

Q1. Which of the following is a logical expression equivalent to the exclusive-OR operation of logical variables p and q ? Here, “ \vee ”, “ \wedge ”, and “ \neg ” are OR, AND, and NOT operators, respectively.

a) $\neg p \vee q$

b) $(p \vee q) \wedge \neg(p \wedge q)$

c) $\neg(p \vee q) \vee (p \wedge q)$

d) $(p \wedge \neg q) \vee \neg(q \wedge p)$

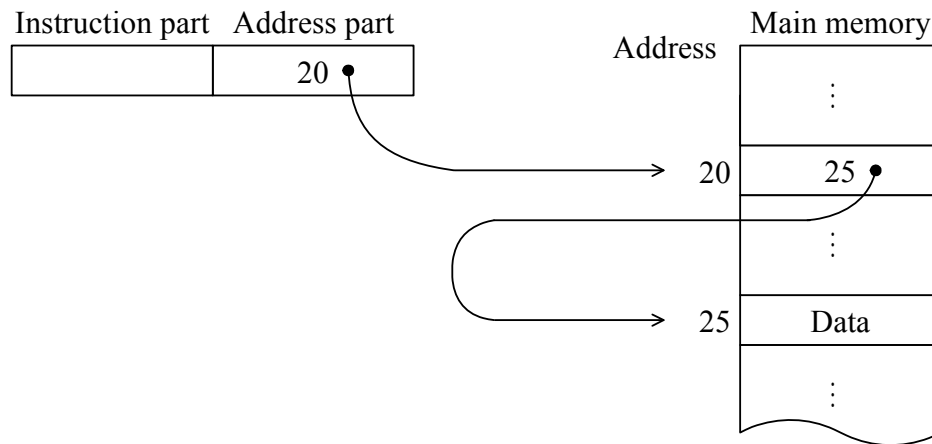
Q9. In a web environment, which of the following is the name of a program that runs on a web server and achieves dynamic processing?

- a) Java applet
- b) Java servlet
- c) JavaScript
- d) VBScript

Q10. Which of the following is a special purpose register that stores the result of a comparison or the sign of the result of an arithmetic operation?

- a) Accumulator
- b) Flags register
- c) Instruction register
- d) Program counter

Q11. Which of the following is the addressing mode that references data in main memory as shown in the figure below?



- a) Direct addressing
- b) Indexed addressing
- c) Indirect addressing
- d) Relative addressing

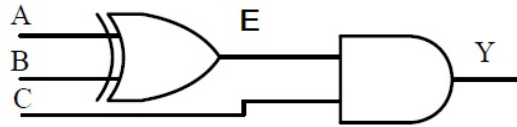
Q13. Which of the following is an appropriate explanation of USB 3.0?

- a) It uses a serial interface that has a 5 Gbps data transfer mode called super speed.
- b) It uses a serial interface that has both an isochronous transfer mode suitable for voice, video, and other data, and a broadcast transfer mode.
- c) It uses an interface that transmits 2 bits of information in one (1) clock cycle with four (4) pairs of signal lines, and has a maximum throughput of 1 Gbps.
- d) It uses the serial version of ATA interface that is standardized for the connection of a PC to peripheral devices.

Q21. Which of the following is a criterion for a page to be replaced in a Least Recently Used (LRU) algorithm?

- a) The cumulative total number of references
- b) The first referenced time
- c) The frequency of references per unit of time
- d) The last referenced time

Q22. There is a logic circuit shown below. When the input values are $A = 1$, $B = 0$, and $C = 1$, which of the following is the combination of the values of E and Y ?



- a) $E = 0, Y = 0$
- c) $E = 1, Y = 0$

- b) $E = 0, Y = 1$
- d) $E = 1, Y = 1$

Q2. When three sets A , B and C are given, which of the following equalities holds? Here, \cup and \cap are union and intersection symbols, respectively.

- a) $(A \cup B) \cap (A \cap C) = B \cap (A \cup C)$
- b) $(A \cup B) \cap C = (A \cup C) \cap (B \cup C)$
- c) $(A \cap C) \cup (B \cap A) = (A \cap B) \cup (B \cap C)$
- d) $(A \cap C) \cup (B \cap C) = (A \cup B) \cap C$

Q3. For two logical variables X and Y , a logical operation $X \text{ NAND } Y$ is defined as a composite operation $\text{NOT } (X \text{ AND } Y)$. Which of the following is equivalent to the logical operation $X \text{ OR } Y$?

- a) $((X \text{ NAND } Y) \text{ NAND } X) \text{ NAND } Y$
- b) $(X \text{ NAND } X) \text{ NAND } (Y \text{ NAND } Y)$
- c) $(X \text{ NAND } Y) \text{ NAND } (X \text{ NAND } Y)$
- d) $X \text{ NAND } (Y \text{ NAND } (X \text{ NAND } Y))$

Q9. Which of the following addressing modes determines the effective address by adding the value of the instruction address register (program counter) to the value recorded in the address part of the instruction?

- a) Absolute addressing
- b) Base addressing
- c) Indexed addressing
- d) Relative addressing

Q11. Which of the following is an output device for the computer?

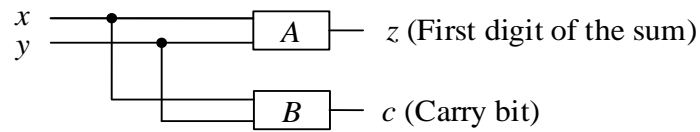
a) Camera

b) Mouse

c) Printer

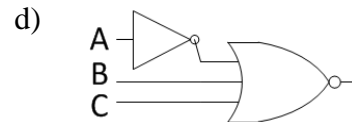
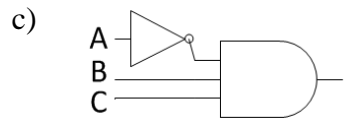
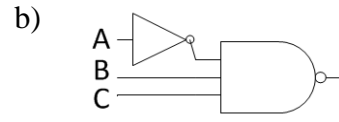
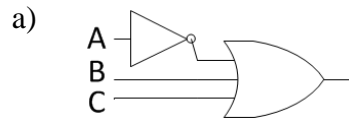
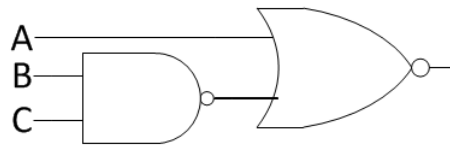
d) Scanner

Q22. The half adder in the diagram below adds two (2) single-digit binary numbers x and y , and produces z (the first digit of the sum) and c (the carry bit) as output. Which of the following is the appropriate combination of gate devices A and B ?



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

Q23. Which of the following is equivalent to the logic circuit shown below?



Q10. To determine an effective address from the value recorded in the address part of instruction, various addressing modes are used. Which of the following modes uses the value of the address part as an effective address?

- a) Absolute addressing
- b) Base plus index addressing
- c) Indexed addressing
- d) PC relative addressing

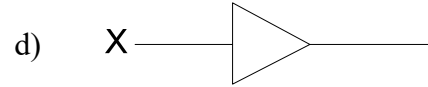
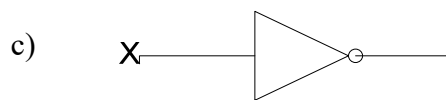
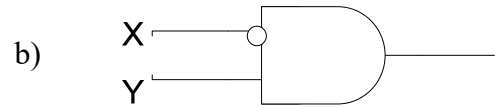
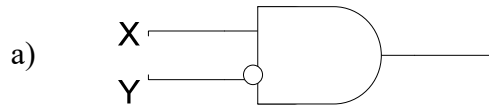
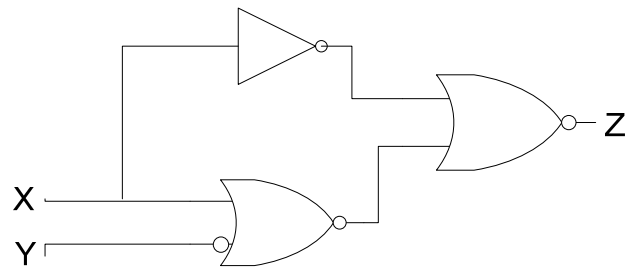
Q11. Which of the following is a memory device that stores programs or data in factories, and only has the read operation for the stored programs or data?

- a) DRAM b) Flash memory c) Mask ROM d) SRAM

Q12. Which of the following is an appropriate role of a device driver?

- a) It decides the next task to be executed from tasks queued up for execution.
- b) It directly controls the hardware according to requests from an application program.
- c) It interprets the command strings that are entered by the user, and starts the applicable program.
- d) It manages the display status on the screen in multiple windows.

Q21. Which of the following is equivalent to the logic circuit below?



Q22. Which of the following is a logic gate combination that provides an output 1 when both inputs are 0?

- a) AND or XOR
- b) NAND or XOR
- c) NOR or XNOR
- d) OR or XNOR

Q23. Which of the following uses a flip-flop circuit in a memory cell?

- a) DRAM b) EEPROM c) SDRAM d) SRAM

Q1. For an 8-bit binary number, which of the following sets the middle 4 bits to 1s while inverting the remaining bits?

- a) Performing a bitwise AND operation with 00111100
- b) Performing a bitwise NAND operation with 11000011
- c) Performing a bitwise OR operation with 11000011
- d) Performing a bitwise XOR operation with 00111100

Q2. Which of the following is logically equivalent to the expression below? Here A , B , C , and D are integers, ' $<$ ' is a less-than operator, and ' \leq ' is a less-than-or-equal-to operator.

$$\text{not } ((A \leq B) \text{ or } (C < D))$$

a) $(A < B) \text{ and } (C \leq D)$

b) $(A < B) \text{ or } (C \leq D)$

c) $(B < A) \text{ and } (D \leq C)$

d) $(B < A) \text{ or } (D \leq C)$

Q10. Which of the following is the addressing mode where the instruction contains the address and the address is modified by a value from another register?

- a) Direct addressing mode
- b) Indexed addressing mode
- c) Memory indirect addressing mode
- d) Register indirect addressing mode

Q11. Which of the following is the computer architecture where processors execute multiple instruction streams on multiple data streams in parallel?

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

Q12. Which of the following is an appropriate explanation of memory interleaving?

- a) It allows CPU to access different banks of the main memory simultaneously.
- b) It improves CPU performance by connecting I/O interface directly to the main memory.
- c) It makes use of a fast memory between the CPU and the main memory, which serves as a buffer for frequently accessed data.
- d) It widens the data bus to read or write several bytes between the CPU and the main memory in a single process.

Q13. Which of the following is an appropriate role for a device driver?

- a) It decides the next task to be executed from tasks waiting for execution.
- b) It directly controls hardware according to requests from an application program.
- c) It interprets command strings that are entered by the user, and starts the applicable program.
- d) It manages the display status on the screen in multiple windows.

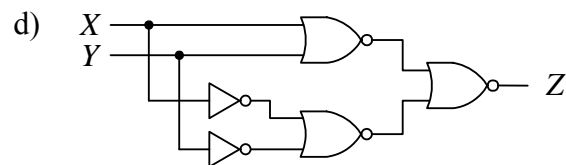
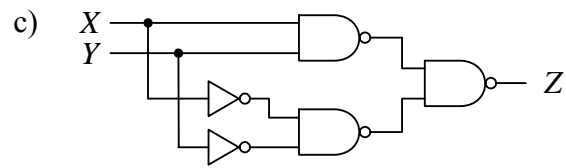
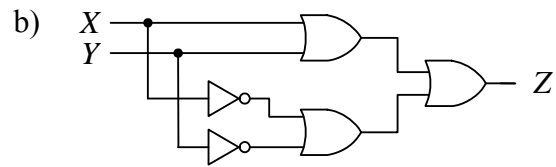
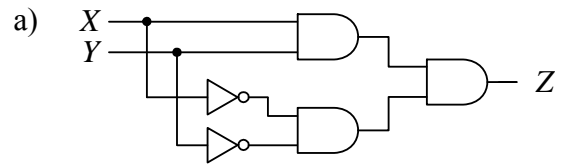
Q14. Which of the following is an appropriate term to describe the phenomenon when files produced in the process of saving are scattered to different parts of the whole hard disk rather than in continuous clusters?

- a) Contiguity b) Fragmentation c) Sector d) Segmentation

Q23. Which of the following is a characteristic of DRAM?

- a) Even if the power supply is cut, it can retain stored data.
- b) Memory refresh to retain stored data is not necessary.
- c) The memory cell structure is simple, so high integration is possible and a low price per bit can be achieved.
- d) Writing and erasing data are performed in blocks or in a whole chip.

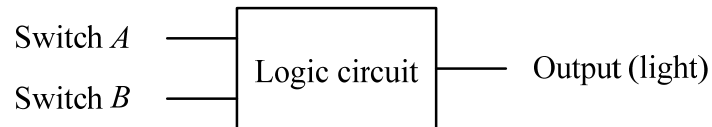
Q24. Which of the following is the logical circuit that generates “1” as the output signal Z , only when the input signals X and Y have the same value?



Q25. Which of the following logic circuits meets the condition described below?

[Condition]

A light is turned on and off by using switches *A* and *B* located at the top and bottom of the stairs. The light can be turned on and off by using one switch, regardless of the status of the other switch.



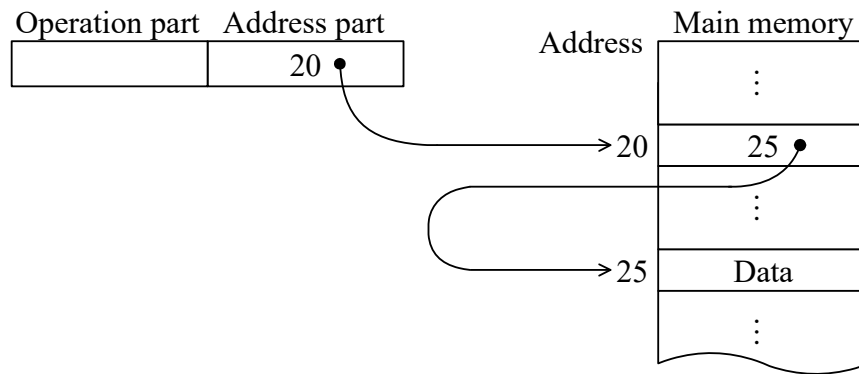
a) AND

b) NAND

c) NOR

d) XOR

Q9. Which of the following is the addressing method that references data in the main memory as shown in the figure below?



- a) Direct addressing
- b) Indexed addressing
- c) Indirect addressing
- d) Relative addressing

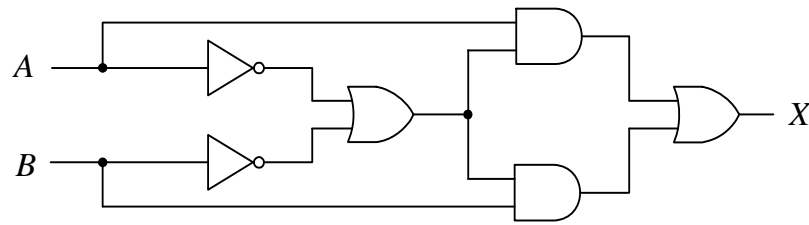
Q10. Which of the following is classified as an internal interrupt?

- a) An interrupt because of the occurrence of a memory parity error
- b) An interrupt because of the operation of division by zero (0)
- c) An interrupt caused by a power failure, such as an instantaneous failure of the commercial power supply
- d) An interrupt caused by the completion of I/O

Q21. Which of the following is a characteristic of DRAM and not of SRAM?

- a) It does not require refresh nor access operations in order to retain data.
- b) It has a simple memory cell structure, and thus the price per bit is low.
- c) It is mainly used for cache memory
- d) It uses flip-flops for the memory cells to save data.

Q22. Which of the following is a logical expression that is equivalent to the digital circuit shown in the figure below? Here, “•” is the logical product, “+” the logical sum, and “ \overline{X} ” the negation of X .



a) $X = A \cdot B + \overline{A} \cdot \overline{B}$

b) $X = A \cdot B + \overline{A} \cdot \overline{B}$

c) $X = A \cdot \overline{B} + \overline{A} \cdot B$

d) $X = (\overline{A} + B) \cdot (A + \overline{B})$

Q23. Which of the following is the name of a phenomenon where multiple ON/OFF signals are generated within a few milliseconds after a push-button switch with a mechanical contact is pressed once?

- a) Buffering
- b) Chattering
- c) Sampling
- d) Sharing

Q2. Which of the following is a solution for the logical equation on variable X below? Here, A , B , and C are logical constants; the operators “+”, “ \cdot ”, and “ $\bar{}$ ” denote logical OR, logical AND, and NEGATION, respectively.

$$A \cdot B + X + B \cdot C = A \cdot B + \bar{A} \cdot C$$

a) $A \cdot C$

b) $\bar{B} \cdot \bar{C}$

c) $\bar{B} + C$

d) $\bar{A} \cdot C$

Q12. Which of the following is the computer architecture where a processor executes the same instruction on multiple data?

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

Q13. Which of the following is an addressing mode that provides an offset to the program counter (PC) content to determine the address of the operand?

- a) Immediate addressing mode
- b) Indirect addressing mode
- c) Register indirect addressing mode
- d) Relative addressing mode

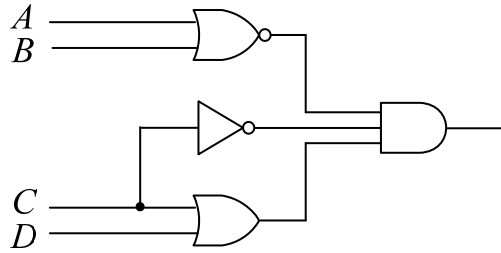
Q14. Which of the following is used to translate a logical address generated by a CPU into a physical address?

- a) Direct Memory Access Controller (DMAC)
- b) Memory Address Register (MAR)
- c) Memory Management Unit (MMU)
- d) Translation Lookaside Buffer (TLB)

Q15. Which of the following is an appropriate description concerning cache memory?

- a) In a multi-tasking environment, a cache memory maintains data from each task to improve performance.
- b) Multiprocessors where each has a cache memory need to synchronize values within the cache to maintain coherency.
- c) The operating system manages the data transfer between registers and a cache memory.
- d) The speed and size of a cache memory are the only consideration when improving performance.

Q24. Which of the following is a logical (or Boolean) expression that is equivalent to the logic circuit shown below? Here, “+” is the logical sum, “.” is the logical product, and “ \overline{X} ” is the negation of X .



a) $\overline{A \cdot B \cdot C} \cdot C \cdot D$

b) $(\overline{A} + \overline{B}) \cdot \overline{C} \cdot (C + D)$

c) $\overline{A \cdot B} + \overline{C} + D$

d) $\overline{A} \cdot \overline{B} \cdot \overline{C} \cdot D$

Q25. Which of the following is a sequential circuit that has two (2) stable states?

- a) Adder circuit
- b) Flip-flop
- c) NAND gate
- d) NOR gate

Q26. Which of the following is an appropriate input for a common anode seven-segment display to display a character shown as output? Here, A represents the most significant bit (MSB) and G represents the least significant bit (LSB).

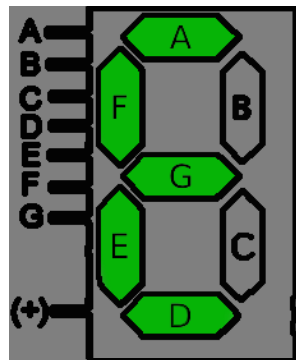


Figure: Display of character “E” in a seven-segment display

a) 0110000

b) 0000110

c) 1001111

d) 1111001

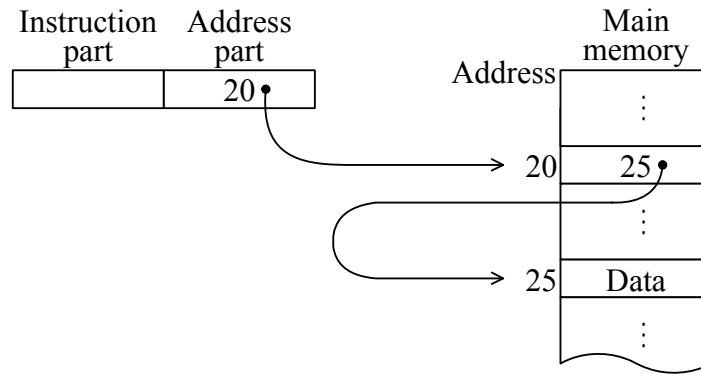
Q27. Which of the following is more suitable for outline fonts than for bitmap fonts?

- a) To display single-byte and double-byte characters at the same time
- b) To display characters as quickly as possible
- c) To display characters in monospace
- d) To enlarge characters by a given scale factor

Q2. Which of the following is the logical expression equivalent to $\overline{A} + B \cdot \overline{C} + \overline{B}$?

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

Q10. Which of the following is the addressing method that references data in main memory as shown in the figure below?



- a) Direct addressing
- b) Index addressing
- c) Indirect addressing
- d) Relative addressing

Q11. When data is read into a processor and there are no hits in the cache memory, which of the following is the action that the cache memory control unit performs?

- a) The required data is read from disk cache to main memory by using the block transfer mechanism.
- b) The required data is read from main memory to cache memory by using the block transfer mechanism.
- c) The required data is read from the hard disk to cache memory by using the block transfer mechanism.
- d) The required data is written from cache memory to the hard disk by using the block transfer mechanism.

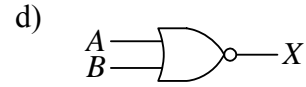
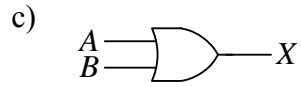
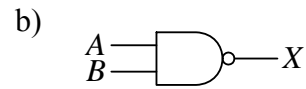
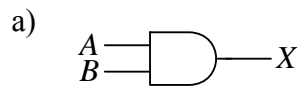
Q12. Which of the following statement is true for DMA Controller?

- a) DMA controller enables data transfer directly between input/output devices and the memory while the CPU can perform some other operations.
- b) DMA controller enables data transfer directly between the cash memory and the main memory while the processor is at the waiting state.
- c) DMA controller enables input/output devices to read from and write to the main memory through CPU and system bus.
- d) DMA controller enables the CPU to access the main memory directly while input/output devices communicate among themselves at the same time.

Q21. Which of the following is an appropriate explanation of DRAM?

- a) It is memory that needs to be refreshed, and is used for main memory in a PC.
- b) It is non-volatile memory that can erase and write data in units of one byte, and it is used when data preservation is required even if the power supply is interrupted.
- c) It is non-volatile memory that has NAND types and NOR types, and is used for SSD.
- d) Its memory cells are composed of flip-flops, and it is used for cache memory.

Q22. Which of the following is the logic circuit that generates the same result as the logical expression $X = \overline{A} \cdot B + A \cdot \overline{B} + \overline{A} \cdot \overline{B}$? Here, “ \cdot ” is the logical product, “ $+$ ” is the logical sum, and \overline{A} is the negation of A .



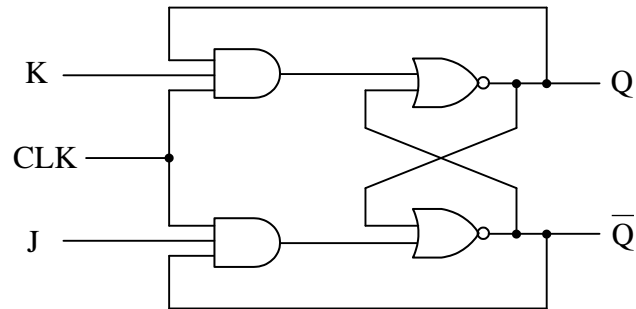
Q14. Which of the following is an appropriate explanation of a capacitive touch panel?

- a) An electric field is formed on the surface, and the touched position is detected on the basis of the change in the surface electric charge.
- b) Electrode switches are aligned in a matrix shape, and the touched position is detected by the electronically conducted electrode.
- c) The touched position is detected on the basis of the change in the reflection of the infrared ray that is blocked by touching the panel.
- d) Voltage is applied to an electrically resistant film, and the touched position is detected on the basis of the change in resistance.

Q20. Which of the following is an explanation of the function of an archiver that is one of the data management utilities?

- a) Compiling several files into one file, or returning a file to its original condition in order to perform data backup and distribution
- b) Creating both an area for recording data and an area for managing data on a single hard disk
- c) Keeping data secure through file protection for safeguarding data from unauthorized use and destruction, and also through copy protection for preventing unauthorized copying
- d) Rearranging a file into contiguous areas, to the extent possible, on a hard disk in which fragmentation has occurred

Q23. The logic circuit below shows a JK flip-flop. Which of the following is the appropriate truth table for the JK flip-flop. Here, the state of each output signal is affected only when the clock signal CLK changes from 0 to 1. “No Change” means that each output signal maintains its previous state, and “Toggle” means that each output signal switches (or toggles) its state “from 0 to 1” or “from 1 to 0.”



a)

Input signals		Output signals	
J	K	Q	\bar{Q}
0	0	No change	
0	1	0	1
1	0	1	0
1	1	Toggle	

b)

Input signals		Output signals	
J	K	Q	\bar{Q}
0	0	Toggle	
0	1	0	1
1	0	1	0
1	1	No change	

c)

Input signals		Output signals	
J	K	Q	\bar{Q}
0	0	No change	
0	1	1	0
1	0	0	1
1	1	Toggle	

d)

Input signals		Output signals	
J	K	Q	\bar{Q}
0	0	Toggle	
0	1	1	0
1	0	0	1
1	1	No change	

Q25. Which of the following is a memory module that uses a flip-flop circuit in a memory cell?

- a) DRAM b) EEPROM c) SDRAM d) SRAM

Q9. Which of the following is a computer architecture that enables the processor to execute instructions in parallel by using hardware to dynamically allocate the arithmetic units that execute multiple instructions at the same time?

- a) Pipeline b) Super-pipeline c) Superscalar d) VLIW

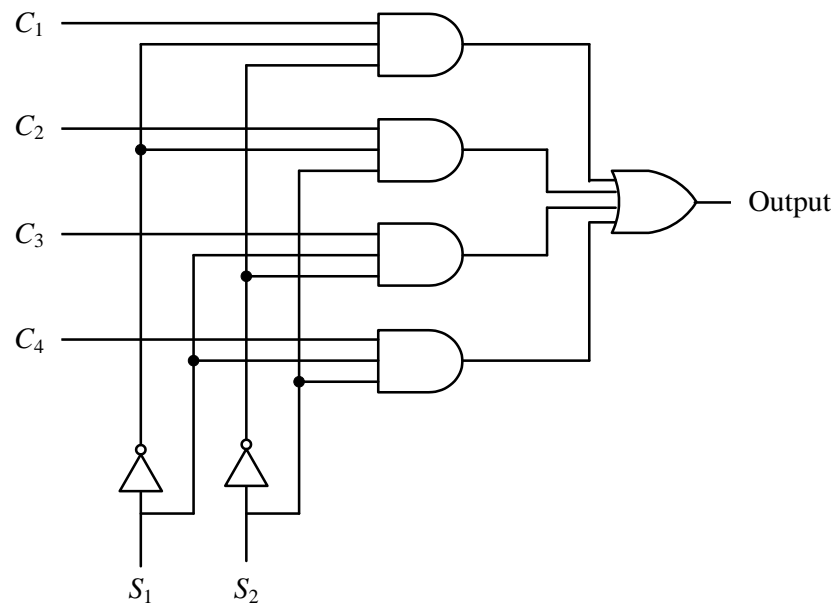
Q11. Which of the following is the addressing mode where the operand of an instruction is used to point to the memory address that contains the address of the data to be operated upon?

- a) Direct addressing
- b) Immediate addressing
- c) Indirect addressing
- d) Register addressing

Q12. Which of the following is an appropriate characteristic of Bluetooth?

- a) A maximum of 127 devices can be connected to a single host.
- b) The communication ports must be positioned in a straight line facing each other.
- c) The short range (up to about 100 m) of wireless voice/data communication is defined.
- d) The standard allows communication to be performed at a distance of 1,000 m or more.

Q21. The logic circuit shown below has four input signals (C_1 , C_2 , C_3 , and C_4) and two selector signals (S_1 and S_2). The two selectors are used to control the four input signals so that only one input signal can pass to the output port. Which of the following is an appropriate combination of the selector signals S_1 and S_2 that allows C_3 to pass to the output port?



	S_1	S_2
a)	0	0
b)	0	1
c)	1	0
d)	1	1

Q23. Which of the following is an appropriate description concerning flash memory?

- a) It can write data electrically and erase it all at once with ultraviolet light.
- b) It can write data electrically and erase it electrically in units of blocks.
- c) It is often used as cache memory because of the high-speed rewritable capability.
- d) It needs to rewrite (i.e., refresh) data within a given period of time.

Q11. Which of the following is the addressing mode where the register specified is used to point to the memory address of the data to be operated upon?

- a) Base register addressing mode
- b) Indirect addressing mode
- c) Register addressing mode
- d) Register indirect addressing mode

Q13. Which of the following is a computer architecture where each instruction is divided into multiple stages (e.g., fetch, decode, and execute) in the processor, and multiple functional units execute two or more instructions in parallel by slightly shifting the instructions in stages?

- a) Multicore b) Pipeline c) Superscalar d) VLIW

Q14. Which of the following is an appropriate explanation of memory interleaving?

- a) Cache memory is divided into two segments: one for instructions and the other for data, in order to remove factors which disturb pipeline processing.
- b) Data is written to both cache memory and main memory at the same time in order to accelerate access from the CPU to main memory.
- c) High-speed and low-capacity memory is allocated in order to remove a bottleneck caused by the gap in access speed between the CPU and main memory.
- d) Main memory is divided into multiple banks, and each bank is concurrently accessed in order to accelerate access from the CPU to main memory.

Q16. Which of the following is widely used as storage media for image data in digital cameras or for music data in portable music players?

- a) DRAM
- b) Flash memory
- c) Mask ROM
- d) SRAM

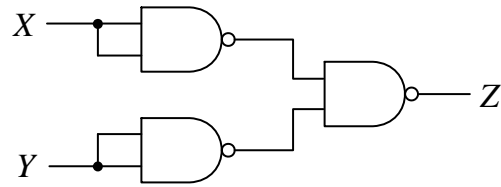
Q17. When a 12-point character is displayed in bitmap on a 96-dpi display screen, how many dots are used for the height of a square font? Here, 1 point is $1/72$ inch.

- a) 8 b) 9 c) 12 d) 16

Q24. Which of the following is classified as an external interrupt?

- a) An interrupt that is caused by access to a non-existent page in virtual memory
- b) An interrupt that is caused by an arithmetic overflow or divide-by-zero
- c) An interrupt that is caused by an interval timer when the specified time elapses
- d) An interrupt that is caused by the execution of a software interrupt instruction

Q27. Which of the following is the logical expression that indicates the output Z of the combinational circuit below? Here, “ \cdot ” is used for the logical product, “ $+$ ” for the logical sum, and “ \overline{X} ” for the negation of X .



a) $X \cdot Y$

b) $X + Y$

c) $\overline{X \cdot Y}$

d) $\overline{X + Y}$

Q28. Which of the following is a characteristic of DRAM, in comparison with SRAM?

- a) DRAM has the disadvantage of higher cost.
- b) DRAM is suitable for a higher level of integration.
- c) DRAM stores data in an electronic circuit called a flip-flop.
- d) DRAM transfers data at a faster speed.

Q2. When two logical variables “ p ” and “ q ” are given, which of the following is a logical expression that is equivalent to the XOR (exclusive OR) operation? Here, “ \vee ”, “ \wedge ”, and “ \neg ” represent the logical “OR”, “AND”, and “NOT” operations respectively.

a) $\neg p \vee q$

b) $(p \vee q) \wedge \neg(p \wedge q)$

c) $\neg(p \vee q) \vee (p \wedge q)$

d) $(p \wedge \neg q) \vee \neg(q \wedge p)$

Q12. Which of the following is the appropriate course of actions to be taken by a processor at the occurrence of an interrupt?

- (1) Saving of the program register (i.e., program counter)
- (2) Transition from the user mode to the privilege mode
- (3) Determination of the start address of the interrupt processing routine
- (4) Execution of the interrupt processing routine

a) $1 \rightarrow 3 \rightarrow 4 \rightarrow 2$

b) $1 \rightarrow 4 \rightarrow 2 \rightarrow 3$

c) $2 \rightarrow 1 \rightarrow 3 \rightarrow 4$

d) $2 \rightarrow 3 \rightarrow 4 \rightarrow 1$

Q13. Which of the following is the appropriate combination of characteristics of SRAM in comparison with DRAM?

	Integration degree	Access speed	Usage	Circuit component
a)	higher	faster	Cache memory	Condensers and transistors
b)	higher	slower	Main memory	Flip-flops
c)	lower	faster	Cache memory	Flip-flops
d)	lower	slower	Main memory	Condensers and transistors

Q14. Which of the following is an appropriate description concerning cache memory?

- a) Cache can be accessed at a high speed, so it is used in the same way as a general-purpose register.
- b) If a cache-miss occurs, the entire cache is erased all at once, and then the latest data is transferred from main memory.
- c) In machines with the large time gap between access to main memory and instruction execution, the effective access time can be shortened by multi-level cache.
- d) When the transfer block size of cache is set to the same size as that of virtual memory, the execution efficiency of a program is enhanced.

Q15. Which of the following is an explanation of USB?

- a) A serial interface to connect devices in a tree topology via hubs
- b) A serial interface to transfer data to devices such as printers by using infrared rays
- c) A parallel interface to connect CD-ROM or DVD drives housed in PCs
- d) A parallel interface to connect hard disks or printers in a daisy chain topology

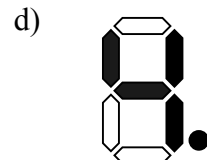
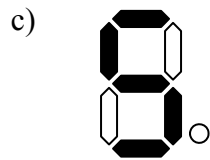
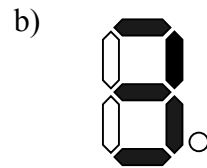
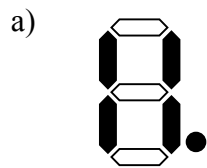
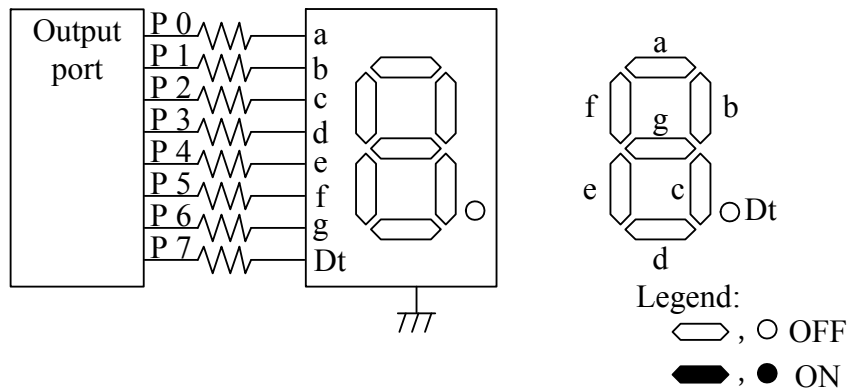
Q16. Which of the following is an appropriate explanation of a plasma display?

- a) It consists of many tiny cells between two glass panels containing a mixture of noble gases with a phosphor coating, and displays images by using a gas discharge.
- b) It displays images by making an electron beam discharged from an electron gun hit against the fluorescent material on the surface of the tube to emit light.
- c) It displays images by making use of the fact that light is emitted when a voltage is applied to an organic compound sandwiched between electrodes.
- d) It does not emit light by itself, so the backlight is used to enhance the visibility of images to be displayed.

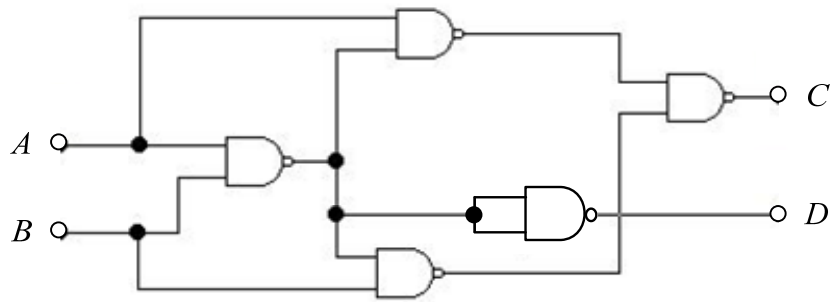
Q27. Which of the following is a sequential circuit that is capable of exhibiting either of two stable states and switching between them?

- a) Accumulator
- b) Condenser
- c) Flip-flop
- d) NAND gate

Q28. In an LED lighting circuit with seven segments and one dot as shown below, when 6D in hexadecimal is written out to the output port, which of the following is displayed? Here, P7 is the most significant bit, P0 is the least significant bit, and each segment or a small dot of the LED lights up only when the corresponding bit is 1.



Q29. Which of the following is an appropriate combination of Boolean expressions that are logically equivalent to the logic circuit shown below? Here, “.”, “+”, and “ \oplus ” represent the logical product, logical sum, and exclusive logical sum operations respectively, and “ \overline{X} ” is the logical negation of “X”.



	C	
a)	$A \oplus B$	$A + B$
b)	$A \oplus B$	$A \cdot B$
c)	$\overline{A \oplus B}$	$A + B$
d)	$\overline{A \oplus B}$	$A \cdot B$

Q2. There are several formats for representing an integer in a computer. When a set of unsigned binary integers that are arranged in ascending order is interpreted in different formats and then sorted again in ascending order of their values, which of the following is the format that maintains the same order as the original unsigned binary integers?

- a) Biased (i.e., offset binary) format
- b) One's complement format
- c) Signed magnitude format
- d) Two's complement format

Q6. Which of the following is the logical expression whose resulting value is zero (0) only when the binary values of “ x_1, x_2, \dots, x_n ” are all zeros (0s) or all ones (1s)? Here, “ \cdot ” and “ $+$ ” represent the logical product and logical sum operators respectively, and “ \bar{x} ” is the logical negation of “ x ”.

a) $(x_1 \cdot x_2 \cdots x_n) + (x_1 + x_2 + \cdots x_n)$

b) $(x_1 \cdot x_2 \cdots x_n) + \overline{(x_1 + x_2 + \cdots x_n)}$

c) $\overline{(x_1 \cdot x_2 \cdots x_n) + (x_1 + x_2 + \cdots x_n)}$

d) $\overline{(x_1 \cdot x_2 \cdots x_n) + \overline{\overline{(x_1 + x_2 + \cdots x_n)}}}$

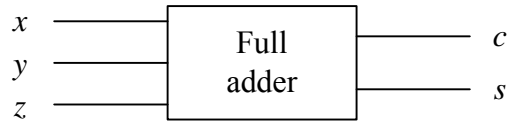
Q11. Which of the following is a role of the program register (i.e., program counter) of the CPU?

- a) In order to decode an instruction, it contains the instruction that is read out from the memory.
- b) In order to execute a conditional branch instruction, it contains the state of operation results.
- c) In order to perform an arithmetic or logical operation, it contains data that is read out from the memory.
- d) In order to read out an instruction, it contains the address where the next instruction is stored.

Q26. Which of the following is an appropriate explanation of DRAM?

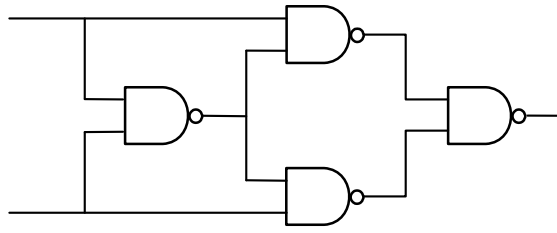
- a) It is a memory chip on which data can be written using a specially-designed device and erased by exposure to ultraviolet light.
- b) It is often used as main memory, and one bit is represented depending on whether or not its capacitor is charged.
- c) It is used as memory to store microprograms that are written at the time of manufacturing.
- d) It is used as high-speed memory such as cache which is composed of flip-flops, and the manufacturing cost is high.

Q27. The figure below shows a logic circuit representing a full adder. When 1, 0, and 1 are entered into x , y , and z respectively, which of the following is the appropriate combination of the output values of c (carry) and s (sum)?



	c	s
a)	0	0
b)	0	1
c)	1	0
d)	1	1

Q28. Which of the following is the logic gate that is equivalent to the logic circuit shown below?



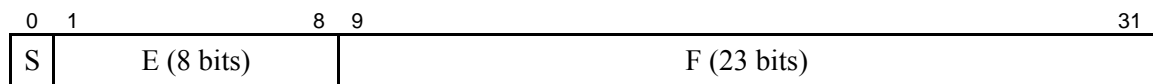
a) AND

b) NAND

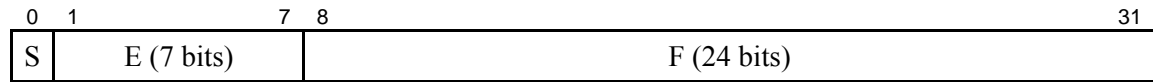
c) XNOR

d) XOR

Q1. Computer *A* uses the single precision of “IEEE Standard for Binary Floating-Point Arithmetic” (IEEE 754) as shown below.



On the other hand, computer *B* can represent 32-bit floating-point numbers as shown below.



Which of the following is the appropriate description concerning the comparison of range and precision of floating-point values represented by computers *A* and *B*? Here, “S” is a sign bit, “E” is an exponent field, and “F” is a fraction field.

- a) The range and precision of computer *A* are greater than those of computer *B*.
- b) The range and precision of computer *A* are smaller than those of computer *B*.
- c) The range of computer *A* is greater than that of computer *B*, but the precision is smaller.
- d) The range of computer *A* is smaller than that of computer *B*, but the precision is greater.

- Q2.** When two 2-bit binary numbers “ $x_1 x_0$ ” and “ $y_1 y_0$ ” are added and the resulting binary number “ $z_2 z_1 z_0$ ” is obtained, the two binary digits z_0 and z_2 can be represented as shown below.

$$z_0 = x_0 \oplus y_0$$

$$z_2 = ((x_0 \cdot y_0) \cdot (x_1 + y_1)) + (x_1 \cdot y_1)$$

Which of the following represents the remaining bit z_1 ? Here, “+”, “ \cdot ”, and “ \oplus ” denote the logical OR, logical AND, and exclusive OR operations respectively.

a) $z_1 = ((x_0 \cdot y_0) \oplus x_1) \oplus y_1$

b) $z_1 = ((x_0 + y_0) \oplus x_1) \oplus y_1$

c) $z_1 = ((x_0 \cdot y_0) \oplus x_1) \oplus y_0$

d) $z_1 = ((x_0 \cdot y_0) \oplus x_1) + y_1$

Q13. “LOAD GR, B , AD ” is an instruction whereby an effective address is calculated by adding the content of base register B to the immediate address value indicated by AD and then the data stored in the main memory indicated by the effective address is loaded into general register GR.

When the instruction “LOAD GR, 1, 200” is executed in the figure shown below, which of the following is the data loaded into general register GR?

		Address
Main memory	100	1100
	101	1101
	⋮	⋮
	200	1200
	201	1201
	⋮	⋮
	300	1300
	301	1301
	⋮	⋮
	1200	2200
	1201	2201
	⋮	⋮
	1300	2300
	1301	2301

Base register 1	100
-----------------	-----

a) 1201

1300

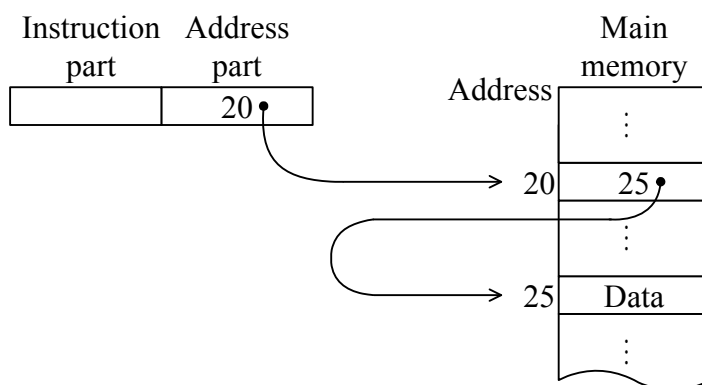
2200

2300

Q14. Which of the following is an event that generates an external interrupt?

- a) Access to main memory that causes a page fault
- b) An attempt to divide by zero
- c) Completion of an I/O operation by peripheral I/O devices
- d) Execution of a system call instruction

Q15. Which of the following is the addressing scheme where data in main memory is referenced as shown in the figure below?



- a) Direct addressing
- b) Index addressing
- c) Indirect addressing
- d) Relative addressing

Q17. Which of the following is an explanation of memory interleaving?

- a) It accelerates hard disk access by using semiconductor memory as a data buffer between the CPU and the hard disk drive.
- b) It accelerates main memory access by dividing the main memory into multiple independent groups which are accessed concurrently.
- c) It accelerates main memory access by proceeding to the next memory access request after completing the access request, data read/write process, and post-processing.
- d) It accelerates memory access by copying some of the data on the main memory to a cache memory and thereby narrowing the gap in access speed between the CPU and the main memory.

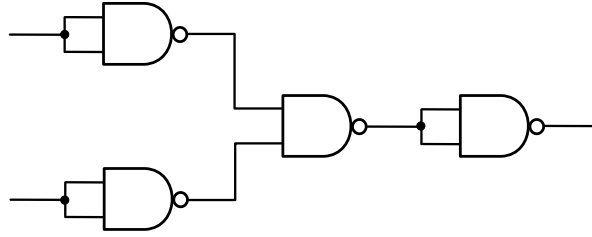
Q18. Which of the following is an advantage of using mask ROM as program memory in an embedded system?

- a) It can be used as an auxiliary memory when the main memory runs out during operation.
- b) It enables the prevention of unauthorized rewriting of programs after shipment.
- c) It enables the writing of data for the identification of an individual unit, such as a serial number, after the mass production of a product.
- d) Memory components can be reused after the content is erased using ultraviolet radiation.

Q19. Which of the following is an appropriate description of a capacitive touch panel?

- a) An electric field is formed on the surface of the touch panel, and the touched position is detected by capturing the change in the surface charge.
- b) Electrode switches are arranged in a matrix, and the touched position is detected by sensing the pressed electrode switch.
- c) The touched position is detected by capturing the change in infrared reflection when the panel is touched and an infrared beam is interrupted.
- d) Voltage is applied to a resistance film, and the touched position is detected by capturing the change in the resistance value.

Q29. Which of the following is the logic gate that is equivalent to the logic circuit shown below?



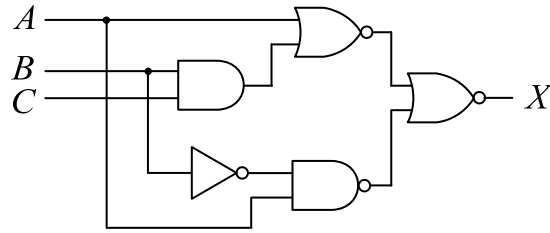
a) AND

b) NAND

c) NOR

d) OR

Q30. Which of the following is a logical expression that is equivalent to the logic circuit shown below? Here, “+” is the logical sum, “.” is the logical product, and \overline{X} is the negation of X .



- | | |
|--|---|
| a) $X = A \cdot \overline{B}$ | b) $X = \overline{A + B \cdot C}$ |
| c) $X = \overline{(A + B \cdot C)} \cdot (A \cdot \overline{B})$ | d) $X = (A + B \cdot C) \cdot (A \cdot \overline{B})$ |

Q2. Which of the following is equivalent to the logical expression below? Here, “AND” has higher precedence than “OR”, and “NOT” has the highest precedence.

$$x \text{ AND } (y \text{ OR } z) \text{ OR } y \text{ AND } (x \text{ OR } z) \text{ OR } x \text{ AND } y \text{ AND } z$$

- a) $x \text{ AND } y \text{ OR } x \text{ AND } z \text{ OR } y \text{ AND } z$
- b) $x \text{ AND } y \text{ OR } x \text{ AND } z \text{ OR } y \text{ AND } z \text{ OR } x \text{ AND } (\text{NOT } y)$
- c) $x \text{ AND } y \text{ OR } z \text{ OR } y \text{ AND } x \text{ OR } z \text{ OR } x \text{ AND } y \text{ AND } z$
- d) $x \text{ AND } z \text{ OR } y \text{ AND } z \text{ OR } x \text{ AND } y \text{ AND } z$

Q13. Which of the following is most suitable for cache memory?

- a) DDR SDRAM
- b) Flash memory
- c) Nonvolatile DRAM
- d) SRAM

Q14. Which of the following is an appropriate description concerning cache memory?

- a) A write instruction rewrites cache in two ways: one is to rewrite both cache and main memory, and the other is to rewrite only cache until the cache data is removed.
- b) Cache memory is used to fill the gap in memory capacity between real memory and virtual memory.
- c) The substantial improvement in the access speed of semiconductor memory is making cache memory less necessary.
- d) When a cache miss occurs, an interrupt is generated so that the program can transfer data from main memory to cache memory.

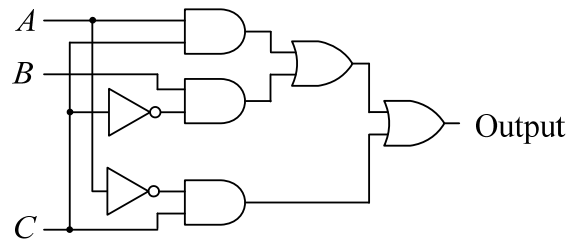
Q15. Which of the following is an example of a daisy chain connection?

- a) A keyboard, a mouse, and a printer are connected to a USB hub, and then the USB hub is connected to a PC.
- b) A PC is connected to a measuring device and a printer via RS-232C and USB respectively.
- c) Industrial cameras with each having two IEEE 1394 ports are serially connected, and then one end is connected to a PC.
- d) Several network cameras are connected to a PC through an Ethernet hub or an Ethernet switch.

Q16. When analog audio signals are converted into digital audio signals using the PCM method at a sampling rate of 44.1 kHz, which of the following determines the amount of the encoded digital data.

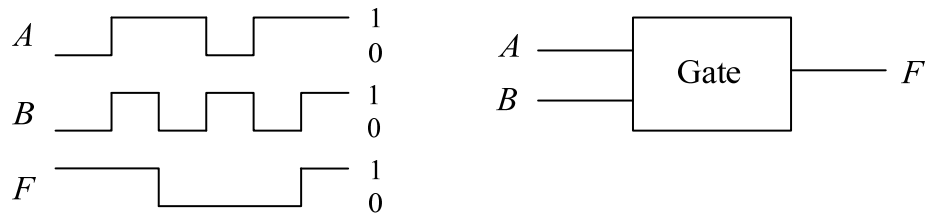
- a) The maximum amplitude of the audio signals
- b) The maximum frequency of the audio signals
- c) The playback frequency of the audio data
- d) The quantization bit width of the audio data

Q26. In a logic circuit shown below, which of the following is an appropriate combination of input signals *A* through *C* that can generate the output signal “0”?



	<i>A</i>	<i>B</i>	<i>C</i>
a)	0	0	1
b)	1	0	0
c)	1	1	0
d)	1	1	1

Q27. The figure shown below represents a logic gate and its timing chart. Which of the following is an appropriate logical function of this gate? Here, both A and B are the input signals, and F is the output signal.



- a) AND
- b) Exclusive-NOR
- c) Exclusive-OR
- d) NOR

Q28. Which of the following is the name of a phenomenon where multiple ON/OFF signals are generated during a few milliseconds after a push-button switch with a mechanical contact is pressed once?

- a) Buffering
- b) Chattering
- c) Filtering
- d) Switching

Q2. Which of the following is equivalent to the logical expression “not ($A \leq B$ or $C < D$)”? Here, A , B , C , and D are variables, and the resulting values of “ $A \leq B$ ” and “ $C < D$ ” can be either 1 for true or 0 for false.

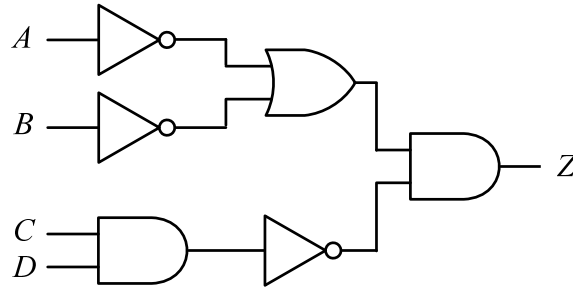
a) $A < B$ and $C \leq D$

b) $A > B$ and $C \geq D$

c) $A < B$ or $C \leq D$

d) $A > B$ or $C \geq D$

Q3. Which of the following is a logical equation that is equivalent to the logic circuit shown below? Here, the “.” is the logical product, “+” is the logical sum, and \overline{X} is the negation of X .



a) $Z = (\overline{A} + \overline{B}) + (\overline{C} \cdot \overline{D})$

b) $Z = (\overline{A} + \overline{B}) + (C \cdot D)$

c) $Z = (\overline{A} \cdot \overline{B}) \cdot (\overline{C} + \overline{D})$

d) $Z = (\overline{A} \cdot \overline{B}) \cdot (C + D)$

Q10. Which of the following is the characteristic of pipeline control?

- a) Each machine instruction is replaced with a combination of lower level microinstructions at the time of execution.
- b) In order to execute multiple instructions simultaneously, each instruction is assigned to a specific computing unit when the compiler generates an object code.
- c) Multiple instructions are executed simultaneously by dynamically deciding which computing unit to use at the time of executing each instruction.
- d) The processing of each instruction is divided into multiple stages in the processor, and thus multiple instructions are executed in parallel.

Q11. Which of the following is a method of creating a program that can use the instruction cache effectively?

- a) The frequently executed parts of the program are put together.
- b) The program is created so that the entire code can be executed evenly.
- c) The program is created so that the entire work area can be accessed evenly.
- d) The work areas to be accessed by the program are put together.

Q14. Which of the following is a self-luminous display that is classified as a kind of light-emitting diode technology?

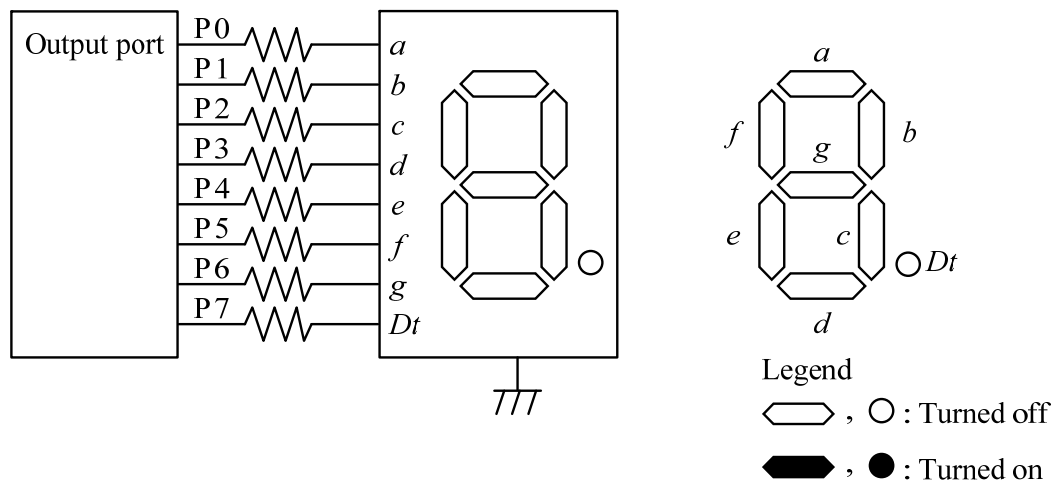
- a) CRT display
- b) Liquid crystal display
- c) OLED display
- d) Plasma display

Q25. Which of the following is the appropriate logic circuit with two inputs and one output where the output X is 0 only when the two inputs A and B are both 1s?



- | | |
|----------------|-----------------|
| a) AND circuit | b) NAND circuit |
| c) OR circuit | d) XOR circuit |

Q26. On a seven-segment LED lighting circuit as illustrated below, when 6D in hexadecimal is written out to the output port, which of the following is displayed? Here, P7 is the MSB (Most Significant Bit), and P0 is the LSB (Least Significant Bit). When 1 is written to a port, the corresponding LED segment is turned on.

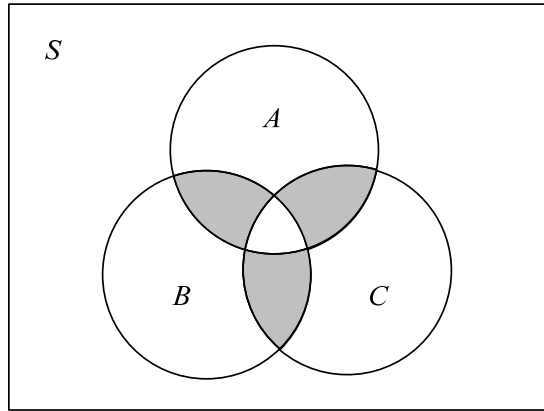


- a)
- b)
- c)
- d)

Q27. Which of the following is an appropriate explanation of flash memory?

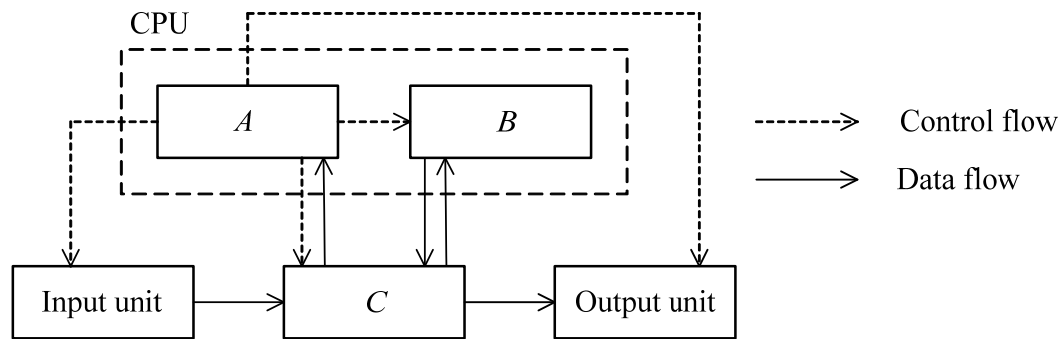
- a) Data can be written electrically only once.
- b) Data is rewritten (i.e., refreshed) within a given period of time.
- c) Data is written electrically and erased with ultraviolet light.
- d) Data is written or erased electrically and erased either all at once or in blocks.

- Q2.** When three subsets A , B , and C exist in the universal set S as shown in the diagram below, which of the following represents the shaded area? Here, each of A , B , and C indicates the area encompassed by the corresponding circle. $X \cup Y$ stands for the union set of X and Y , $X \cap Y$ for the intersection set of X and Y , $X - Y$ for the relative complement set of Y in X , and $X \oplus Y$ for the mutually exclusive set of X and Y .



- a) $(A \cap B) \cup (A \cap C) \cup (B \cap C)$
- b) $((A \cap B) \cup (A \cap C) \cup (B \cap C)) \cap (A \oplus B \oplus C)$
- c) $(A \cup B \cup C) - (A \cap B \cap C)$
- d) $(A \cup B \cup C) - (A \cap B \cap C)$

Q13. The basic configuration of a computer, which includes five major units (or sometimes called five major functions), is shown in the figure below. Which of the following is the appropriate combination of configuration elements to be inserted in blanks *A* through *C*?



	<i>A</i>	<i>B</i>	<i>C</i>
a)	Control unit	Memory	Operation unit
b)	Control unit	Operation unit	Memory
c)	Memory	Control unit	Operation unit
d)	Operation unit	Control unit	Memory

Q14. In a processor equipped with cache memory, there are two major types of write policies: write-back and write-through. Which of the following is an appropriate description concerning write-back cache?

- a) Every write to cache causes a write to main memory, so no inconsistency between cache and main memory occurs.
- b) When data is flushed out of cache, main memory need not be updated.
- c) When data is repeatedly written to the same address, the number of accesses to main memory increases.
- d) Write-back is more efficient than write-through because of the reduced number of accesses to main memory.

Q15. There are various types of USB connectors. When an external storage device is connected to a PC by using a USB cable, which of the following types of plugs should be inserted into an available USB receptacle of the PC?

- a) USB A b) USB B c) USB mini A d) USB mini B

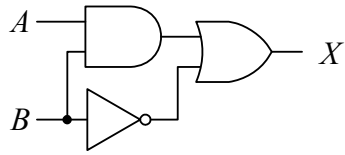
Q16. When a PC is equipped with a sound card, which of the following ports can be used for enabling the PC to communicate and synchronize with electronic musical instruments, such as synthesizers and drum machines?

- a) DVI b) HDMI c) MIDI d) RJ45

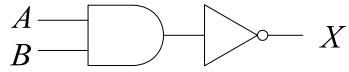
Q17. Which of the following is an appropriate explanation of a plasma display?

- a) It displays images by using light emitted from gas discharge.
- b) It does not emit light itself, so it uses a backlight module to display images.
- c) It emits electron beams from an electron gun that hit and light up the phosphors on the surface of a cathode ray tube to display letters and images.
- d) It has a structure consisting of a pair of electrodes and an organic compound layer, which emits light when electricity is applied.

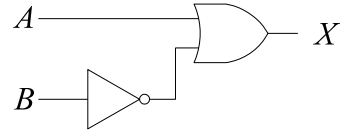
Q26. Which of the following can obtain the same output result as the logic circuit shown below?



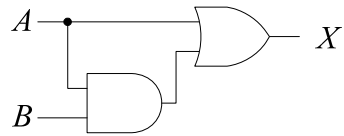
a)



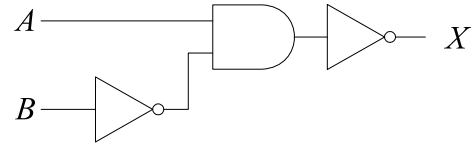
b)



c)



d)



Q27. Which of the following is a basic component of a sequential circuit that has two stable states and is used in a memory cell of SRAM?

- a) Adder
- b) AND gate
- c) Capacitor
- d) Flip-flop

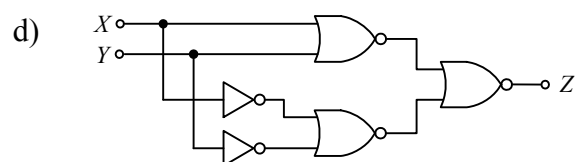
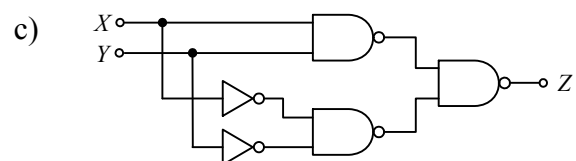
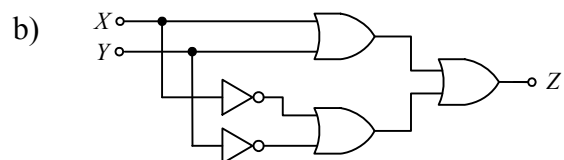
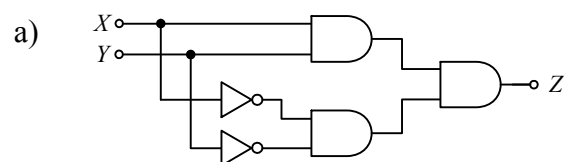
Q2. When a single-bit “half adder” circuit is used for simply adding two input signals x_1 and x_2 , which of the following is the appropriate combination of logical expressions for two output signals s (sum) and c (carry)? Here, “+” stands for the logical OR operation and “ \cdot ” for the logical AND operation.

	s	c
a)	$x_1 + x_2$	$x_1 \cdot x_2$
b)	$\overline{x_1 \cdot x_2}$	$x_1 + x_2$
c)	$(x_1 + x_2) \cdot \overline{(x_1 \cdot x_2)}$	$x_1 \cdot x_2$
d)	$\overline{(x_1 + x_2)} + (x_1 \cdot x_2)$	$x_1 + x_2$

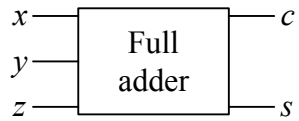
Q16. Which of the following is the appropriate purpose of defragmentation of hard disks?

- a) To access disk files faster and more efficiently
- b) To clean up temporary and junk files
- c) To delete IBG and increase capacity
- d) To protect disk drives from physical failures

Q26. Which of the following circuits can write out “1” to the output line Z only when the input lines X and Y have the same value?



Q27. The figure below shows a logic circuit representing a full adder. When 1, 0, and 1 are entered into x , y , and z respectively, which of the following is the appropriate combination of the output values of c (carry) and s (sum)?



	c	s
a)	0	0
b)	0	1
c)	1	0
d)	1	1

- Q2.** In the truth table shown below, which of the following is the correct combination of output values x_1 , x_2 , and x_3 ? Here, “ \cdot ” stands for the logical product, “ $+$ ” for the logical sum, “ \oplus ” for the exclusive OR, and “ \overline{X} ” for the logical negation of “ X ”.

Input				Output
A		C	D	$(\overline{A} \cdot B) + (C \oplus \overline{D})$
0	1	0	1	x_1
1	1	1	0	x_2
1	1	0	0	x_3

	x_1	x_2	x_3
a)	0	0	1
b)	1	0	0
c)	1	0	1
d)	1	1	0

Q14. Which of the following stands for the processor architecture in which a single stream of instructions can operate on multiple pieces of data in parallel?

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

Q15. Which of the following is classified as an internal interrupt?

- a) Interrupt by divide-by-zero
- b) Interrupt by I/O completion
- c) Interrupt by power failures such as a momentary blackout of commercial power
- d) Interrupt by the occurrence of a memory parity error

Q17. Which of the following is an optical disc that uses organic dye for the recording layer of the storage media and makes the traces of burning by laser light called pits to record the data?

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

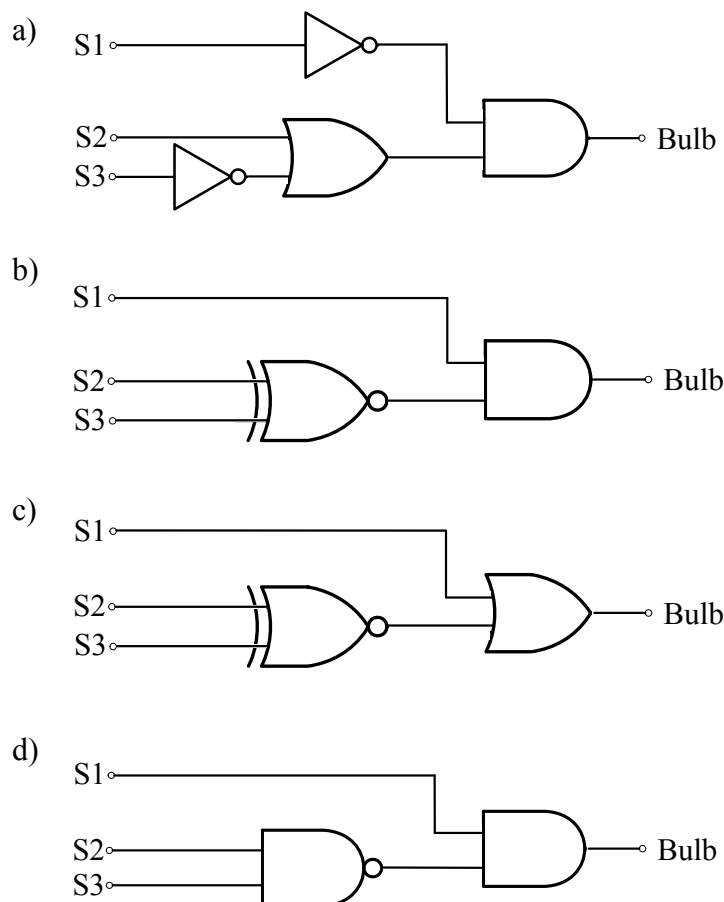
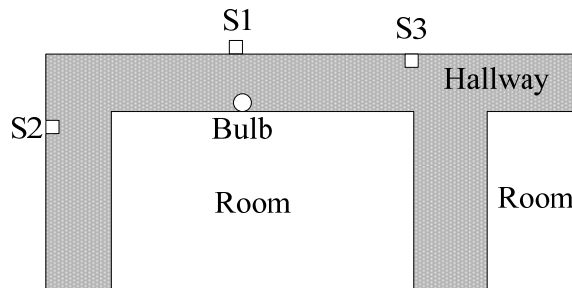
Q18. Which of the following is an appropriate explanation of memory-mapped I/O?

- a) It is a technology for assigning the registers of I/O devices to the specifically dedicated I/O address space in main memory.
- b) It is a technology in which the whole processing time is decreased by partially overlapping the execution stage of multiple instructions and simultaneously performing them.
- c) It is a technology where a dedicated control circuit enables an I/O device to transfer information directly to or from memory.
- d) It is a transmission technology in which the CPU passes data between hard disk drives and main memory.

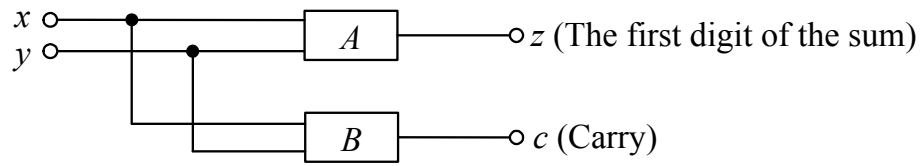
Q29. Which of the following is the appropriate explanation of DRAM?

- a) Data can be written with dedicated equipment. It can be erased with ultraviolet irradiation.
- b) Data is written when it is manufactured. It is used as memory for storing microprograms.
- c) It can represent one bit, depending on whether the capacitor is electrically charged or not. It is often used as main memory.
- d) It consists of flip-flops. Although the access speed is fast, the manufacturing cost is high. It is used for cache memory.

Q30. As shown in the floor layout below, there are three sensors S1, S2, and S3 that control a light bulb in the middle of a hallway. The sensor S1 is a light sensor that generates the output signal “0” only when sunlight (or some other external light source) is detected. In case of no light, the output signal of S1 is “1”. The two sensors S2 and S3 are infrared sensors that generate the output signal “0” only when either S2 or S3 detects the movement of a thermal target in its effective range. If no movement is detected, the output signal is “1”. Which of the following logic circuits can be used to control a switch of the light bulb? Here, the bulb is turned on only when the output signal “Bulb” of the given logic circuit is “1”. Sunlight streams in the hallway through the windows, and the light bulb in the hallway does not affect the sensor S1.



Q31. The half adder in the diagram below adds one-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 the appropriate combination of elements A and B ?



	A	B
a)	Exclusive logical sum	Logical product
b)	Logical product	Logical sum
c)	Negative logical product	Negative logical sum
d)	Negative logical sum	Exclusive logical sum

Q3. Which of the following is the appropriate reason why the mantissa is normalized in the floating point representation?

- a) The arithmetic operation algorithm can be simplified.
- b) The maximum number of significant digits can be maintained.
- c) The range of representable values can be expanded.
- d) The relative size relationships can be investigated as if in fixed point numbers.

Q7. Which of the following expressions results in a loss of trailing digits when calculated by a computer whose floating-point representation has a 23-bit mantissa? Here, the numbers in “()₂” are represented in binary.

a) $(10.101)_2 \times 2^{-16} - (1.001)_2 \times 2^{-15}$

b) $(10.101)_2 \times 2^{16} - (1.001)_2 \times 2^{16}$

c) $(1.01)_2 \times 2^{18} + (1.01)_2 \times 2^{-5}$

d) $(1.001)_2 \times 2^{20} + (1.1111)_2 \times 2^{21}$

- Q9.** As shown in the truth table below, when an output signal is generated using three input signals A, B, and C, which of the following Boolean expressions can be applied to the output signal? Here, “ \cap ” stands for the logical product, “ \cup ” for the logical sum, and “ \bar{X} ” for the logical negation of “X”.

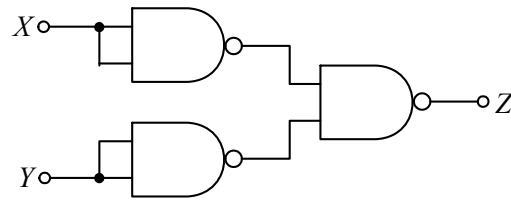
Input signal			Output signal
A	B	C	
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

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

Q10. A “negative AND” operation “ $X \text{ NAND } Y$ ” of X and Y is defined as “NOT ($X \text{ AND } Y$)”. Which of the following is the logical expression that represents “ $X \text{ OR } Y$ ” by using NAND only?

- a) $((X \text{ NAND } Y) \text{ NAND } X) \text{ NAND } Y$
- b) $(X \text{ NAND } X) \text{ NAND } (Y \text{ NAND } Y)$
- c) $(X \text{ NAND } Y) \text{ NAND } (X \text{ NAND } Y)$
- d) $X \text{ NAND } (Y \text{ NAND } (X \text{ NAND } Y))$

Q17. Which of the following expressions shows the output Z of the combinational circuit using NAND gates as shown below? Here, “ \cdot ” stands for the logical product, “ $+$ ” for the logical sum, and \overline{X} for the logical negation of X .



a) $X \cdot Y$

b) $X + Y$

c) $\overline{X + Y}$

d) $\overline{X \cdot Y}$

Q20. Which of the following architectures in a uniprocessor requires multiple functional units that can execute two or more instructions in parallel during a clock cycle by simultaneously dispatching the instructions to the functional units?

- a) Pipeline b) Super-pipeline c) Superscalar d) VLIW

Q21. Which of the following is used to hold the address of the instruction being executed or the address of the next instruction to be executed, and is automatically incremented after fetching an instruction?

- a) Accumulator
- b) Base address register
- c) Index register
- d) Program counter

Q23. Which of the following is a method that serves to enhance the reliability of memory access and makes it possible to automatically correct some of data errors?

- a) Checksum
- b) CRC
- c) ECC
- d) Parity

Q25. Which of the following USB transfer modes is mainly used for a mouse, joystick, etc.?

- a) Bulk transfer
- b) Control transfer
- c) Interrupt transfer
- d) Isochronous transfer

Q27. Which of the following input devices is classified as a pointing device and used for graphics input in a CAD system?

- a) Image scanner
- b) OCR
- c) OMR
- d) Tablet

Q31. Which of the following descriptions about file storage is appropriate as the explanation of an archive?

- a) It bundles multiple files into one file and stores it in a storage device.
- b) It stores the same file on two hard disks and ensures the reliability of data storage.
- c) It stores the specific main memory data and the register values in other storage devices temporarily.
- d) It stores the update history of a file on a hard disk.

Q36. Which of the following is the most appropriate description concerning the interconnection interfaces between computers and peripheral devices or between peripheral devices?

- a) Bluetooth is a serial bus interface which can provide a small amount of power, eliminating the need for external power cables for most peripherals, besides the capability of transferring data to and from peripheral devices at low, high, or full speed.
- b) FireWire is a wireless technology which is designed primarily to replace cables for low cost, short-range radio links between PCs and peripheral devices or between peripheral devices.
- c) IEEE 802.11 refers to a family of specifications for wireless LAN, and includes several standards, such as IEEE 802.11a, 802.11b, and 802.11g, which define over-the-air interfaces between a wireless client and a base station or between two wireless clients.
- d) USB is a type of serial bus interface, officially known as IEEE 1394a/b/c, which is used for transferring data to and from multimedia peripherals and other high-speed devices like the latest hard disk drives and printers.

- Q5.** When multiple values are added arithmetically, it is recommended that the values be added sequentially, starting from the number whose absolute value is the smallest. Which of the following errors can be reduced by means of this method?
- a) Cancellation of significant digits
 - b) Loss of trailing digits
 - c) Truncation error
 - d) Underflow

- Q9.** The decision table shown below is used to determine whether or not an order can be accepted in a sales order processing system. Which of the following logical expressions is equivalent to “Accept order”? Here, “NOT” is used for the logical negation, “AND” for the logical product, and “OR” for the logical sum.

Bad debt within 2 Years (X)	Y	Y	Y	Y	N	N	N	N
Credit excess \$10,000 (Y)	Y	Y	N	N	Y	Y	N	N
Age of customer > 10 Years (Z)	Y	N	Y	N	Y	N	Y	N
Accept order					X		X	X
Reject order	X	X	X	X		X		

- a) (NOT X) AND (NOT Y OR NOT Z)
- b) (NOT X) AND (NOT Y OR Z)
- c) (NOT X) AND (Y OR Z)
- d) X AND (NOT Y OR NOT Z)





Q10. Which of the following sets is equivalent to the set $S - (T \cup R)$? Here, “ \cap ” stands for a product set operation, “ \cup ” for a union set operation, and “ $-$ ” for a difference set operation.

a) $(S - T) - R$

b) $(S - T) \cup (S - R)$

c) $(S - T) \cup (T - R)$

d) $(S - T) \cap (T - R)$

Q17. Which of the following logic circuits (i), (ii), and (iii) is or are equivalent to the circuit shown in Figure 1? Here, A and B are input signals and F is an output signal.  stands for an OR gate,  for an AND gate,  for a NAND gate, and  for a NOT gate.

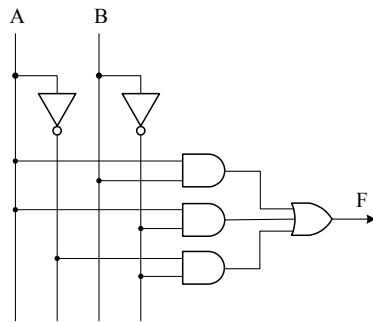
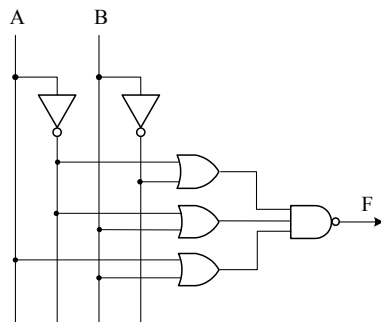
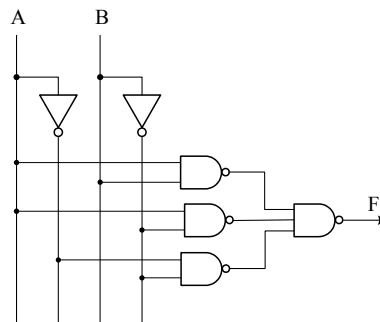


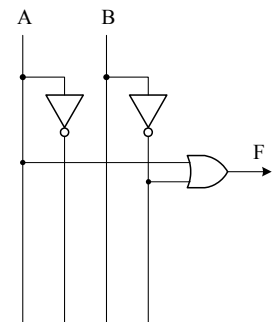
Figure 1



(i)



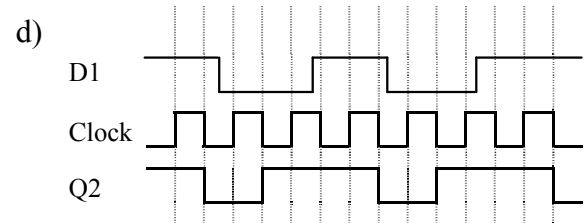
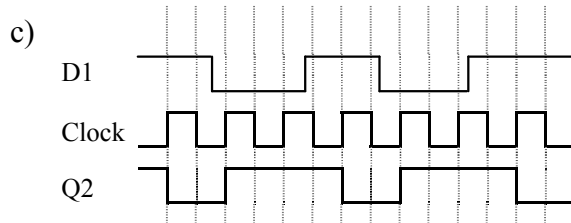
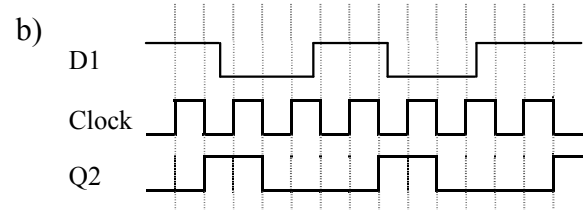
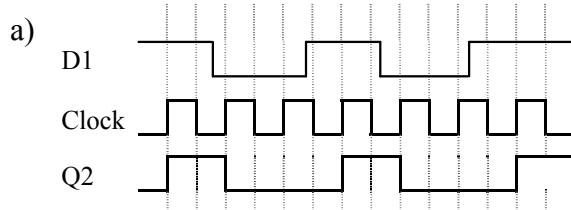
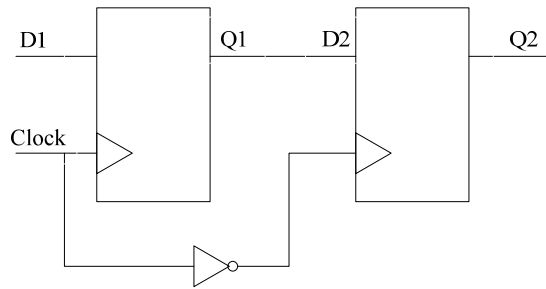
(ii)



(iii)

- a) (i) only
b) (i) and (ii) only
c) (ii) and (iii) only
d) (i), (ii), and (iii)

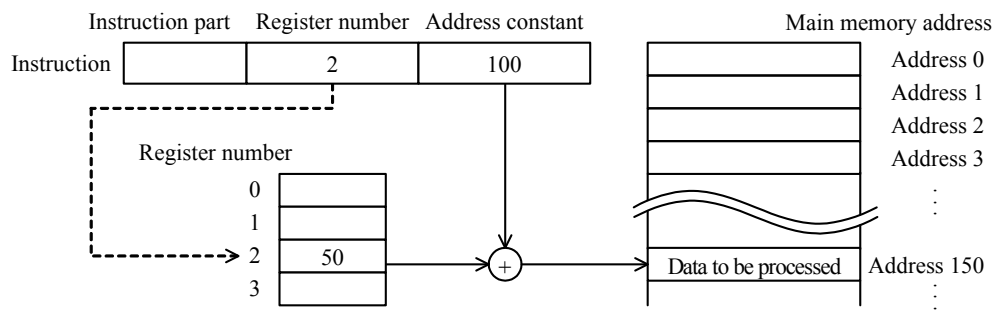
Q18. When two D flip-flops are connected as shown below, which of the following timing charts represents this logic circuit? Here, in D flip-flop, an input signal is read in and held as an output signal only when a clock signal is changed from zero (or low) to one (or high). In other cases, no state transition occurs.



Q19. Which of the following is a high-speed memory technology that uses flip-flop circuits?

- a) DRAM b) RDRAM c) SDRAM d) SRAM

Q21. Which of the following addressing modes is shown in the figure below?



- a) Direct addressing mode
- b) Indexed addressing mode
- c) Register indirect addressing mode
- d) Relative addressing mode

Q25. Which of the following is an explanation of USB?

- a) A serial interface that connects devices in a tree topology via hubs
- b) A serial interface that uses infrared rays to transfer data to devices such as printers
- c) A parallel interface that connects devices such as hard disks and printers in a daisy-chain configuration
- d) A parallel interface that connects PCs to internal devices such as CD-ROM drives and DVD drives

Q26. When an image file is transferred from a PC at hand to another PC separated by a partition without any connection cables, which of the following interfaces can be used?

- a) Bluetooth b) IEEE 1394 c) IrDA d) Serial ATA

Q9. Which of the following is equivalent to the logical expression shown below? Here, “•” is used for the logical product, and “+” is for the logical sum.

$$((X + Y) \cdot (X + Z)) + ((X \cdot Y) + (X \cdot Z))$$

- a) $(X + (Y \cdot Z)) + (X \cdot (Y + Z))$
- b) $(X + (Y \cdot Z)) \cdot (X \cdot (Y + Z))$
- c) $(X \cdot (Y \cdot Z)) + (X \cdot (Y + Z))$
- d) $((X + Y) \cdot Z) + (X \cdot (Y + Z))$

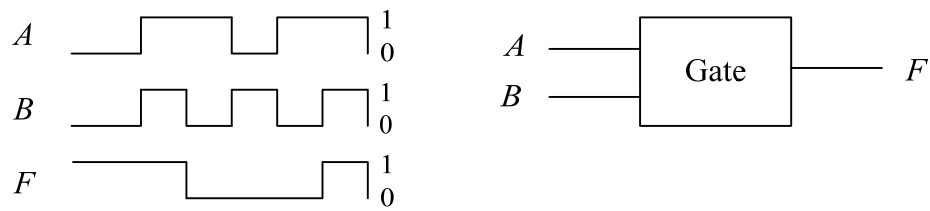
Q10. Which of the following Boolean expressions is equivalent to the sentence below?

“The output z is true if at least two of the three inputs x_1 , x_2 , and x_3 are true.”

Here, “ \bar{x}_n ” is used for the logical negation of x_n , “+” for the logical sum, “ \cdot ” for the logical product, and “ \oplus ” for the exclusive disjunction (or exclusive OR).

- a) $z = \bar{x}_1 \cdot x_2 \cdot x_3 + x_1 \cdot \bar{x}_2 \cdot x_3 + x_1 \cdot x_2 \cdot \bar{x}_3$
- b) $z = (\bar{x}_1 + x_2 + x_3) \cdot (x_1 + \bar{x}_2 + x_3) \cdot (x_1 + x_2 + \bar{x}_3)$
- c) $z = (x_1 \oplus x_2) \cdot (x_2 \oplus x_3) \cdot (x_1 \oplus x_3)$
- d) $z = x_1 \cdot x_2 + x_2 \cdot x_3 + x_1 \cdot x_3$

Q17. The figure shown below represents a logic gate and its timing chart. Which of the following is an appropriate logical function of this gate? Here, both A and B are the input signals and F is the output signal.



- a) AND
- b) Exclusive-NOR
- c) Exclusive-
- d) NOR

Q18. Which of the following is an appropriate description concerning registers in processors?

- a) A base register stores the starting address of the computer system.
- b) A complement register generates integer complements in order to perform operations in the adder circuit.
- c) An accumulator stores a collection of flag bits for a processor.
- d) An index register stores the instruction being performed in a processor.

Q20. Which of the following is the appropriate diagram that explains pipeline control?

Here, the meanings of the capital letters in the diagrams are as follows:

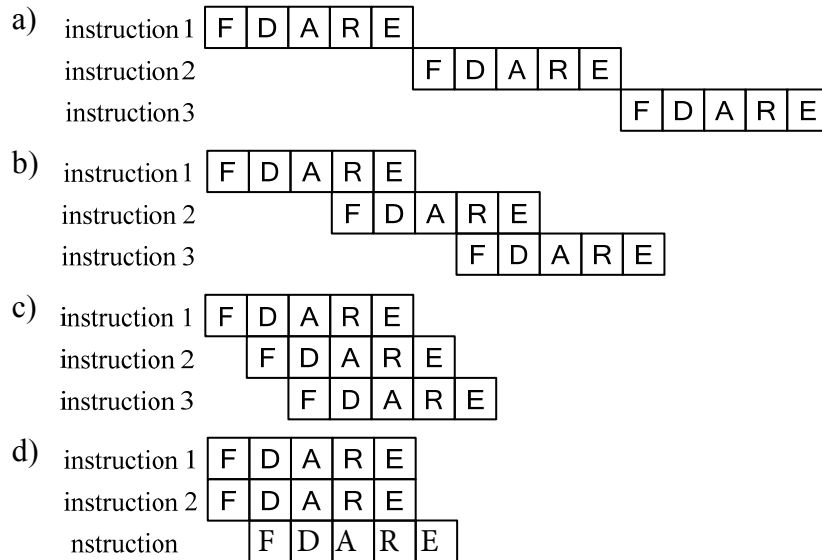
F: Fetching instruction

D: Decoding

A: Address calculation

R: Reading operand

E: Executing



Q21. Which of the following is the appropriate description of CPU clock frequencies for PCs?

- a) LAN communication speed changes depending on the clock frequency. The higher the frequency, the faster the communication speed on the LAN gets.
- b) The instruction execution timing in a CPU varies depending on the clock frequency. The higher the frequency, the faster the instruction execution speed gets.
- c) The interrupt interval of real-time processes changes depending on the clock frequency. The higher the clock frequency, the higher the frequency of interrupt processing gets, increasing the processing speed of real-time processes.
- d) The revolution speed of the hard disk varies depending on the clock frequency. The higher the frequency, the faster the revolution speed gets, increasing the transfer speed of the hard disk.

Q24. Which of the following is used in ECC memory to detect 2-bit errors and correct 1-bit errors?

- a) Checksum
- b) Even parity
- c) Hamming code
- d) Vertical parity

Q26. Which of the following storage devices has the fastest access time?

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

Q27. Which of the following is widely used as a computer port for a modem connection?

- a) IEEE 1394 port
- b) Parallel port
- c) SCSI port
- d) Serial port

Q3. In fixed-point representation that expresses negative numbers by two's complement, which range of integers can be expressed with n bits? Here, the position of the binary point is to the right of the least significant bit.

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

Q4. In a certain program, in order to stay in a loop, variable X must be in the range from 1 through 10 ($X \geq 1$ AND $X \leq 10$). In this program, which of the following is the condition of exiting the loop? Here, “AND” and “OR” are the logical product and logical sum operations respectively. In addition, comparison operators $<$, \leq , $>$, and \geq are less than, less than or equal to, greater than, and greater than or equal to, respectively.

- | | |
|------------------------------|------------------------------|
| a) $X < 1$ AND $X > 10$ | b) $X \geq 1$ OR $X \leq 10$ |
| c) $X \leq 1$ OR $X \geq 10$ | d) $X < 1$ OR $X > 10$ |

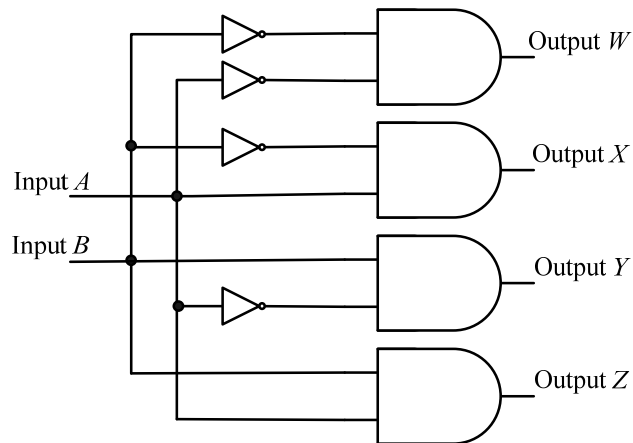
- Q5.** When the results of the logical operation “ $x \# y$ ” are shown in the table below, which of the following expressions is equivalent to the operation “ $x \# y$ ”? Here, “AND” is used for the logical product, “OR” is for the logical sum, and “NOT” is for the logical negation.

x	y	$x \# y$
True	True	False
True	False	False
False	True	False
False	False	True

- a) x AND (NOT y) b) x OR (NOT y)
c) (NOT x) AND (NOT y) d) (NOT x) OR (NOT y)

Q18. When two input signals A and B are given in the logic circuit shown below, which of the following tables describes the correct combination of output signals W , X , Y , and

Z ? Here,  is used for an AND gate, and  for a NOT gate.



a)

Input		Output			
A	B	W	X	Y	Z
0	0	1	0	0	0
0	1	0	0	0	1
1	0	0	0	1	0
1	1	0	1	0	0

b)

Input		Output			
A	B	W	X	Y	Z
0	0	1	0	0	0
0	1	0	0	1	0
1	0	0	1	0	0
1	1	0	0	0	1

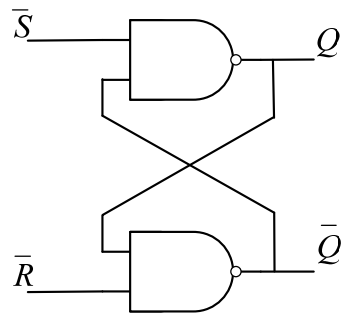
c)

Input		Output			
A	B	W	X	Y	Z
0	0	0	0	0	1
0	1	0	0	1	0
1	0	1	0	0	0
1	1	0	1	0	0

d)

Input		Output			
A	B	W	X	Y	Z
0	0	0	0	0	1
0	1	0	0	1	0
1	0	0	1	0	0
1	1	1	0	0	0

Q19. The figure shows an RS flip-flop using two NAND gates. Which of the following is the correct truth table for the flip-flop? Here, “unchanged” shown in the table means the outputs maintain a previous state, and “unstable” means the outputs are in an unstable state.



a)

Input		Output	
\bar{S}	\bar{R}	Q	\bar{Q}
0	0	unchanged	
0	1	0	1
1	0	1	0
1	1	unstable	

b)

Input		Output	
\bar{S}	\bar{R}	Q	\bar{Q}
0	0	unchanged	
0	1	1	0
1	0	0	1
1	1	unstable	

c)

Input		Output	
\bar{S}	\bar{R}	Q	\bar{Q}
0	0	unstable	
0	1	0	1
1	0	1	0
1	1	unchanged	

d)

Input		Output	
\bar{S}	\bar{R}	Q	\bar{Q}
0	0	unstable	
0	1	1	0
1	0	0	1
1	1	unchanged	

Q20. Which of the following interrupts can signal to OS that a program might have gone into an infinite loop?

- a) Machine check interrupt
- b) Program Interrupt
- c) Supervisor call interrupt
- d) Timer Interrupt

Q21. Which of the following appropriately explains the pipeline processing method of processors?

- a) Method whereby each of the multiple processors executes different instructions with its own data while communicating with each other
- b) Method whereby each of the multiple processors executes the same single instruction with its own data in a parallel way while synchronizing with the other processors
- c) Method whereby one processor reduces its execution time of a single instruction as much as possible
- d) Method whereby one processor simultaneously executes multiple instructions with slight delays in time

Q22. Which of the following appropriately describes cache memory?

- a) An interrupt occurs if a cache miss is detected when the main memory is accessed, and the program transfers data from the main memory to the cache memory.
- b) The cache memory is used to make up the difference of capacity between the real memory and the virtual memory.
- c) The demand for cache memory is decreasing due to the rapid increase in the access speed of semiconductor memory.
- d) Two methods exist: one is to rewrite both the cache and main memory when a write instruction is executed; the other is to rewrite only the cache memory while the main memory is not rewritten until the data is removed from the cache memory.

Q25. Which of the following is an appropriate description concerning the characteristics of USB?

- a) It has three data transfer modes: high-speed mode for external hard disks, full-speed mode for printers and scanners, and low-speed mode for keyboards and mice.
- b) It is a high-speed interface suitable for data transfer that requires real-time processing, such as transfer of audio and visual data; it is also called FireWire.
- c) It is a parallel interface for connecting a small computer such as a PC to a peripheral device such as a hard disk or a laser printer.
- d) It is a serial interface that was originally the standard used for modem connections but is now used to connect PCs to peripheral devices as well.

Q26. A computer consists of units that execute five functions: input, storage, processing, control, and output. From which unit is an instruction fetched and by which unit is the instruction decoded?

	Fetch	Decode
a	Control	Processing
b	Input	Processing
c	Processing	Control
d	Storage	Control

Q5. Which of the following is the reason why a large number of computers use “complement representation” to simplify arithmetic circuits?

- a) Addition can be processed by subtraction.
- b) Division can be processed by a combination of subtractions.
- c) Multiplication can be processed by a combination of additions.
- d) Subtraction can be processed by addition.




Q10. Which of the following is equivalent to the logical expression $A \bullet B + B \bullet C \bullet (B + C)$?
Here, “ \bullet ” is the logical product, and “ $+$ ” is the logical sum.

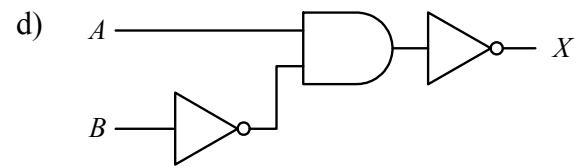
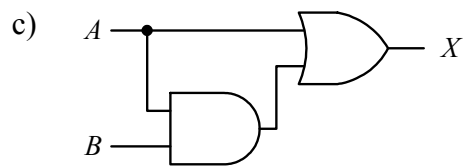
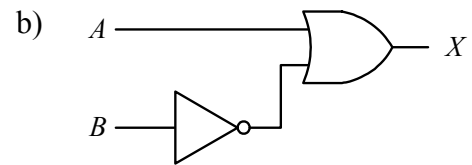
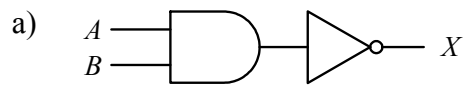
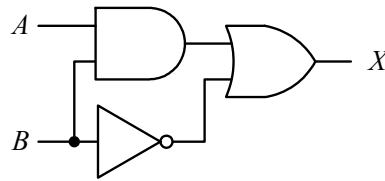
a) $A \bullet B + A \bullet C$

b) $A \bullet C + B$

c) $B \bullet (A + C)$

d) $B + A \bullet C$

Q19. Which of the following logic circuits generates the same output as the logic circuit shown in the figure below? Here,  ,  , and  represent the logical product, the logical sum, and the logical negation respectively.



Q20. Which of the following leads to the von Neumann bottleneck?

- a) Capacity of main memory
- b) CPU performance
- c) Data transfer speed between CPU and I/O devices
- d) Data transfer speed between CPU and main memory

Q21. Which of the following is the highest priority process just after execution of each instruction on CPU?

- a) Check if there are any instructions waiting
- b) Check if there are any interrupts waiting
- c) Fetch the next instruction
- d) Transfer to an interrupt-handling program

Q24. Which of the following is classified as an external interrupt?

- a) An interrupt which is caused by overflow in floating point operations
- b) An interrupt which is generated when a request for a service, such as a demand for input/output, is issued to OS
- c) An interrupt which occurs when a page not existing in the main memory is to be accessed
- d) An interrupt which takes place when hardware detects malfunctions

Q26. Which of the following appropriately describes the purpose of the cache memory used by processors?

- a) To compensate for the difference between the main memory access speed and the processor speed
- b) To manage frequently-used programs on a resident basis
- c) To perform virtual memory address conversion at high speed
- d) To perform virtual memory paging process at high speed

Q27. Which of the following appropriately describes “memory interleaving” that is one of the high-speed computer technologies?

- a) It is a method for bridging the gap between register and main memory access speeds by copying a part of the main memory data to the cache.
- b) It is a method for dividing the memory into multiple independently-operating groups and accessing each group in parallel.
- c) It is a method for transferring data directly between the main memory and an I/O device or between main memories without passing through the CPU.
- d) It is a method for writing data to the cache or writing data to the main memory if the cache overflows, when sending data to the main memory.

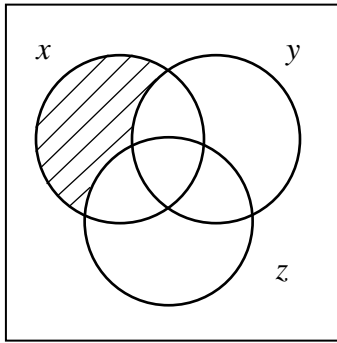
Q31. Which of the following appropriately describes a method of recording data on CD-R?

- a) A two-layer structure is provided in which two disks are bonded together. The recording layer is subjected to phase changes by means of laser beams, thereby recording the data.
- b) Laser beams are radiated on the magnetized disk recording film to heat the film and to change the magnetization direction by means of a magnetic head, thereby recording the data.
- c) Laser beams are radiated onto an organic dye layer in a disk. As a result, a series of burned spots called pits are created on that layer, thereby recording the data.
- d) The magnetization direction of the magnetic substance applied to a disk is changed by means of a magnetic head, thereby recording the data.

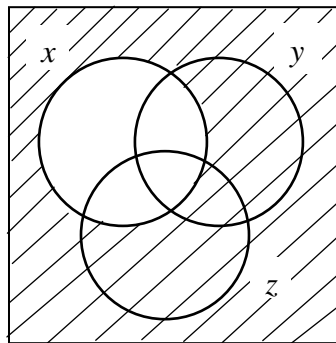
Q3. In a floating-point number format, which of the following is the correct operation for adjusting the radix point and the exponent so that the most significant digit of the mantissa can be a non-zero value? Here, an absolute value is used for the mantissa.

- a) Carry b) Normalize c) Round down d) Round up

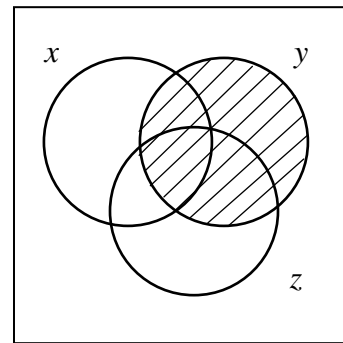
Q6. In the Venn Diagrams labeled 1 to 3, which of the following is the result of Boolean “OR” operations for all three to be combined? Here, “•” is used for “logical AND,” “+” for “logical OR,” and “ \bar{A} ” for the “logical NOT” of A. Each set corresponding to x , y , or z is depicted by a circle



1



2



3

a) $x \bullet y \bullet \bar{z} + \bar{x} + \bar{y}$

b) $x \bullet \bar{y} \bullet \bar{z} + x + y$

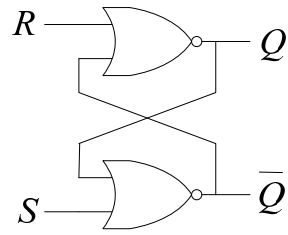
c) $x \bullet \bar{y} \bullet \bar{z} + \bar{x} + y$

d) $x \bullet \bar{y} \bullet \bar{z} + x + \bar{y}$

Q17. Which of the following is a re-writable, erasable memory, using electrical signals, which is widely used for various devices such as digital cameras and digital music players and can maintain the data even after the power is turned off?

- a) DRAM
- b) Flash memory
- c) Mask ROM
- d) SRAM

Q18. The figure shows an RS flip-flop using two NOR gates. Which of the following is the correct truth table for the flip-flop? Here, “unchanged” shown in the table means the outputs maintain a previous state, and “unstable” means the outputs are in an unstable state.



a)

Inputs		Ou	
S	R	Q	\bar{Q}
0	0	unchanged	
0	1	0	1
1	0	1	0
1	1	unstable	

b)

Inputs		Ou	
S	R	Q	\bar{Q}
0	0	unchanged	
0	1	1	0
1	0	0	1
1	1	unstable	

c)

Inputs		Ou	
S	R	Q	\bar{Q}
0	0	unstable	
0	1	0	1
1	0	1	0
1	1	unchanged	

d)

Inputs		Ou	
S	R	Q	\bar{Q}
0	0	unstable	
0	1	1	0
1	0	0	1
1	1	unchanged	

Q19. Which of the following is the correct combination of various addressing modes? Here, X_1 is an address which is stored in a program counter. X_2 is an address part of an instruction which is addressed by X_1 . X_3 is an address in which an operand needed to execute an instruction is stored. X_4 is a value in an index register. (X_2) means the contents of location X_2 .

Addressing mode	Direct	Indirect	PC (Program Counter)-relative	Indexed
a)	$X_3 = X_2$	$X_3 = X_2 + X_4$	$X_3 = (X_2)$	$X_3 = X_1 + X_2$
b)	$X_3 = X_2$	$X_3 = (X_2)$	$X_3 = X_1 + X_2$	$X_3 = X_2 + X_4$
c)	$X_3 = X_2$	$X_3 = (X_2)$	$X_3 = X_2 + X_4$	$X_3 = X_1 + X_2$
d)	$X_3 = (X_2)$	$X_3 = X_2$	$X_3 = X_1 + X_2$	$X_3 = X_2 + X_4$

Q21. Which of the following is an appropriate statement in regard to interrupts?

- a) Applications must constantly detect the occurrence of interrupts.
- b) A priority is individually assigned to the cause of an interrupt in preparation for the occurrence of multiple interrupts.
- c) The operation completion notice from an I/O device is classified as an internal interrupt.
- d) When the CPU accepts an interrupt, it stops the program currently being executed and stores the information needed to restart the program in the designated area of the hard disk.

Q22. Which of the following is an appropriate description concerning cache memory?

- a) Cache memory is used to compensate the difference in capacity between real storage and virtual storage.
- b) If a cache miss occurs in access to main memory, an interrupt occurs and data is transferred from main memory to cache memory by the program.
- c) In one method, when executing a write instruction, data is written to both cache memory and main memory. In the other method, data is written only to a block in cache, and the modified block is written back into main memory only when it is replaced.
- d) The need for cache memory is diminishing these days because of the significant improvement in access speeds of semiconductor memory.

Q24. Which of the following is an appropriate description of memory interleaving?

- a) Compensating the difference between the access time of main memory and that of hard disk.
- b) Dividing main memory into several banks and speeding up access to sequential addresses in memory.
- c) Updating cache and main memory simultaneously.
- d) Writing data not needed in cache to main memory when fetching new data to cache memory.

Q27. What is an advantage of DVD-RAM in comparison with DVD-RW and DVD+RW?

- a) Higher access speed
- b) Higher capacity
- c) More durable rewritable disc
- d) Support of dual-layer DVD format

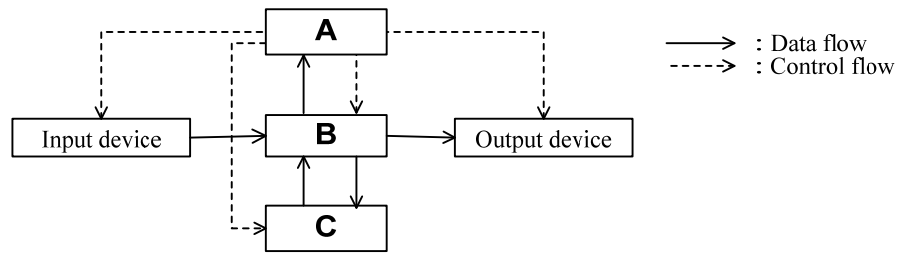
Q28. Which of the following is the appropriate combination of 4 color inks or toners for a full-color printer?

- a) Aqua, Orange, Brown, and Black
- b) Cyan, Magenta, Yellow, and Black
- c) Red, Green, Blue, and Black
- d) Red, Green, Blue, and Gray

Q29. Which of the following is the most appropriate index indicating the performance of a laser printer?

- a) Number of dots per inch (2.54 cm) and number of pages that can be printed per minute
- b) Number of horizontal dots and number of vertical dots used to print a character and number of characters that can be printed per second
- c) Spacing of printed lines and number of lines that can be printed per second
- d) Types of characters printed and number of characters that can be printed per second

Q31. The figure shows the basic configuration of a computer. Which of the following is the correct combination of A, B, and C to be inserted in the figure?



	A	B	C
a)	ALU	Memory	Control unit
b)	Control unit	ALU	Memory
c)	Control unit	Memory	ALU
d)	Memory	Control unit	ALU

Q32. Which of the following is an input device classified as a pointing device and can be used for graphical input in a CAD system?

- a) Image scanner b) OCR c) OMR d) Tablet

Q33. Which of the following is a display, with low-voltage operation and low-power consumption, which does not need backlighting because it emits light when voltage is applied?

- a) CRT b) OLED c) PDP d) TFT LCD

Q1. For logical variables A and B , which of the following is equivalent to the NOR operation on A and B ? Here, $A + B$, $A \cdot B$, and \bar{A} are OR, AND, and NOT operations on the corresponding variables, respectively.

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

Q2. For non-negative integer A , which of the following has the same value as $(A \bmod 32) + 64$?
Here, mod, +, AND, and OR are remainder-after-division, arithmetic addition, bitwise-AND, and bitwise-OR operators, respectively.

- | | |
|--|---|
| a) $A \text{ AND } 31) \text{ OR } 64$ | b) $(A \text{ AND } 32) \text{ OR } 32$ |
| c) $A \text{ OR } 31) \text{ AND } 64$ | d) $(A \text{ OR } 64) \text{ AND } 32$ |

Q12. What is the approximate average access time in milliseconds (ms) of a magnetic disk with the specifications shown in the table below? Approximate average access time is the sum of average seek time, track-to-track seek time, and average rotational delay. Here, the controller overhead can be ignored.

Average seek time	7.5 ms
Track to track seek time	1.2 ms
Rotational speed	7,200 rpm

- a) 11.67 b) 12.87 c) 15.83 d) 25.

Q13. Which of the following is the list that contains A through D sorted starting with the shortest effective access time of the main memory?

	Cache memory			Main memory
	Does the system have cache memory? (yes/no)	Access time (nanoseconds)	Hit rate (%)	Access time (nanoseconds)
A	No	-	-	15
B	No	-	-	30
C	Yes	20	60	70
D	Yes	10	90	80

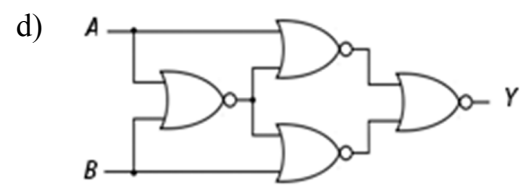
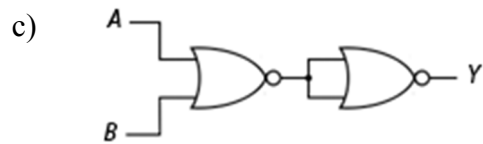
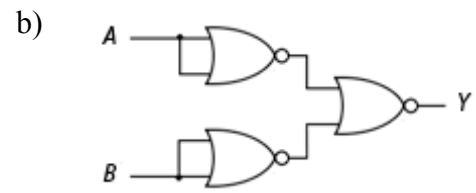
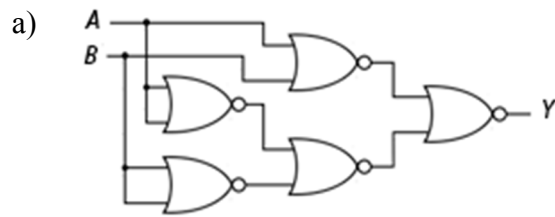
a) A, B, C, D

b) A, D, B, C

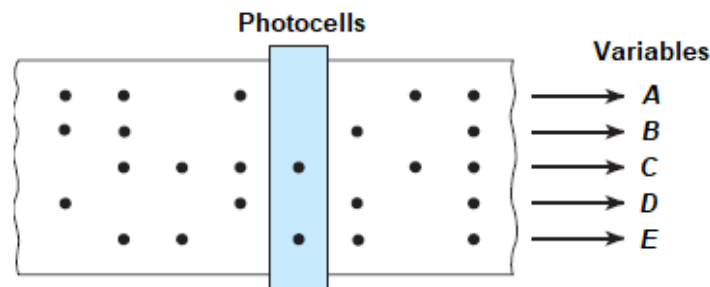
c) C, D, A, B

d) D, C, A, B

Q21. Which of the following is the Exclusive-NOR logic function that is implemented with two-input NOR gates?



Q22. A paper tape reader used as a computer input device reads a tape with five rows of holes as shown below. A hole punched in the tape indicates logic 1, and no hole indicates logic 0. As each hole pattern passes under the photocells, the pattern is translated into logic signals as a variable: *A*, *B*, *C*, *D*, or *E*. A valid pattern on the tape has at least one hole, and an invalid pattern has no hole or all five holes punched. Which of the following is a logical expression that has logic 1 when a valid pattern is being read and logic 0 when an invalid pattern is being read? Here, + represents logical OR, • represents logical AND, and \bar{A} represents the negation of *A* in the logic expression. In the figure, • represents a punched hole on the tape.



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

Q1. What is the octal equivalent value of the hexadecimal number 7B5?

- a) 735 b) 3665 c) 7551 d) 7561

Q2. For a non-negative integer x , which of the following gives the remainder after division of x by 8 as a result?

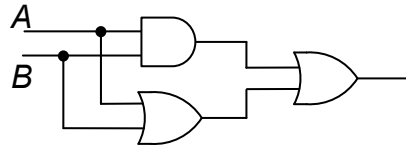
- a) Performing a bitwise AND operation on x and 7
- b) Performing a bitwise AND operation on x and 248
- c) Performing a bitwise OR operation on x and 8
- d) Performing a bitwise OR operation on x and 15

Q12. In memory systems, when data is detected in the cache, it is known as a hit. When data is not detected in the cache, it is read from the main memory and is known as a miss. Which of the following is the approximate hit ratio for the specifications in the table below? Here, effective access time is calculated as the weighted average of hit time and miss time, and other overhead is ignored.

Specifications	Time (ns)
Access time of the cache	100
Access time of the main memory	900
Effective access time of the processor	250

- a) 0.25 b) 0.35 c) 0.73 d) 0.81

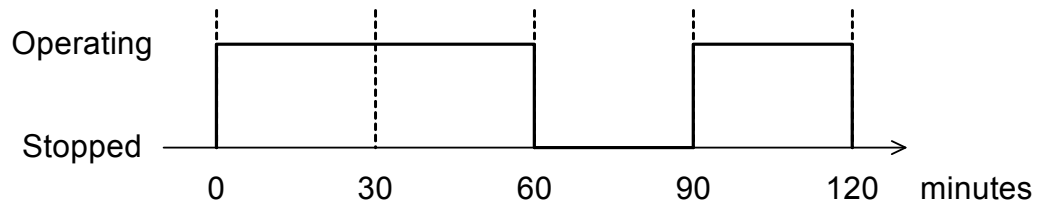
Q21. Which of the following is a logical expression that is equivalent to the logic circuit shown below?



- a) $A \text{ AND } B$
- c) $A \text{ OR } B$

- b) $A \text{ AND } (A \text{ OR } B)$
- d) $B \text{ AND } (A \text{ OR } B)$

Q22. A device, which operates using a 100V household power supply and through which a current of 10 A flows during operation, is operated from 0 minutes to 120 minutes as shown in the figure below. How much electrical energy, in watt-hour, is consumed during this time? Here, the value of the voltage and current is the effective value, no current flows when the device stops, and the power factor is 1.



- a) 1,000 b) 1,200 c) 1,500 d) 2,000

Q1. Which of the following is equivalent to the logic expression below?

$$(x + y) \cdot (x + z)$$

Here, the letters are logic variables; $x + y$, $x \cdot y$, and \bar{x} are OR, AND, and NOT operations on the corresponding variables, respectively.

a) $x \cdot (y + z)$

b) $x + y \cdot z$

c) $x \cdot y + y \cdot z$

d) $(\bar{x} + y) \cdot z$

Q12. Which of the following is the performance of a CPU in MIPS when the instruction mix of the CPU is as listed in the table below? Here, the CPU does not use a pipeline architecture.

Instruction type	Instruction execution time in μ s	Appearance ratio
Register to register operation	0.1	40%
Register from memory operation	0.3	50%
Unconditional branch operation	0.6	10%

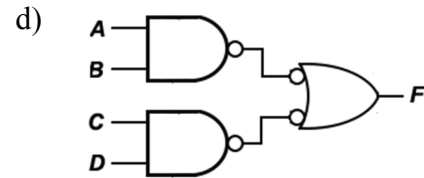
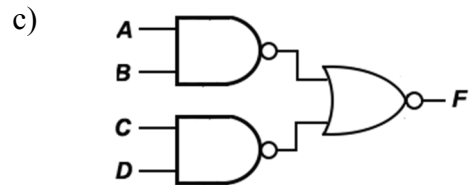
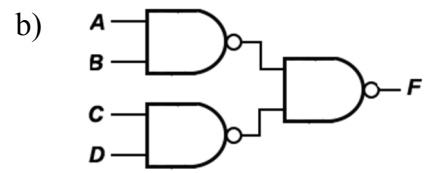
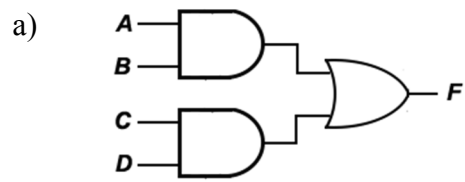
a) 0.04

b) 0.25

c) 4

d) 25

Q22. Which of the following is **not** an implementation of the function $F = A \cdot B + C \cdot D$? Here, “ \cdot ” represents the logic AND operation, and “ $+$ ” represents the logic OR operation in the expression.



Q1. When the decimal arithmetic expression, $7 / 32$, is evaluated, which of the following represents the result in binary?

- a) 0.001011 b) 0.001101 c) 0.00111 d) 0.0111

Q2. A contradiction is a Boolean expression that always evaluates as FALSE for any assignment of truth values to its variables. Which of the following is a contradiction? Here, " \cdot ", " $+$ ", and " $\bar{}$ " represent the AND, OR, and NOT operators, respectively.

a) $(p \cdot (\bar{p} + q)) \cdot \bar{q}$

b) $(p \cdot \bar{q}) \cdot (\bar{p} + \bar{q})$

c) $p + (p \cdot q)$

d) $\bar{p} + (p \cdot \bar{q}) + q$

Q10. When the CPU needs data, it first accesses the cache memory. When the data is not available in the cache memory, the CPU accesses the main memory. If the miss ratio is 0.2 and the access times for cache memory and main memory are as shown below, what is the approximate average memory access time in ns for the CPU? Here, there are only cache memory and main memory for the CPU, the access time for main memory includes the time to confirm whether the data is available in cache memory, and the overhead time for the cache management can be ignored.

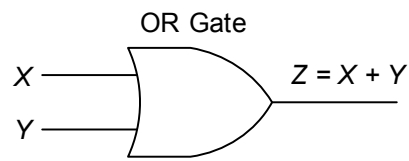
Access destination	Access time (ns)
Cache Memory	75
Main Memory	1500

- a) 315 b) 360 c) 1,215 d) 1,260

Q13. ECC is used for error detection and correction in memory. When $n+2$ redundant bits are required for a data bus having a width of 2^n bits, what is the number of redundant bits that are required for a data bus having a width of 128 bits?

- a) 3 b) 8 c) 9 d) 10

Q22. Which of the following is the correct gate that converts the 2-input OR gate shown below into a NAND gate if the output of the added gate is respectively connected to input X and input Y?



a) AND

b) NOR

c) NOT

d) OR

Q1. For two 8-bit signed integers A and B in 2's complement format, which of the following will cause an overflow when the addition of A and B is executed?

	A	B
a)	0111 1111	1111 1110
b)	0111 1111	0111 1110
c)	1000 0000	0111 0000
d)	1111 1111	1111 1111

Q19. 32-bit virtual address space is mapped to 4 k-byte pages. How many pages can be created?
Here, 1k bytes represent 1,024 bytes.

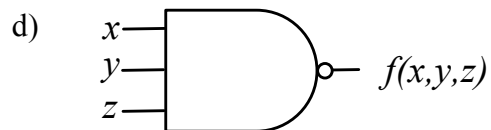
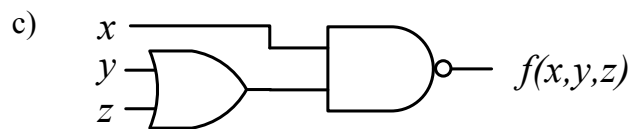
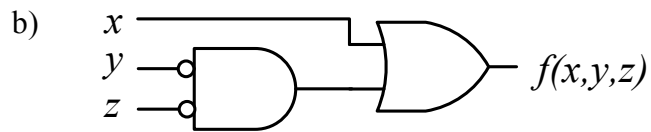
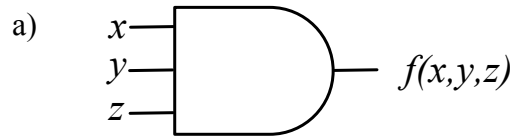
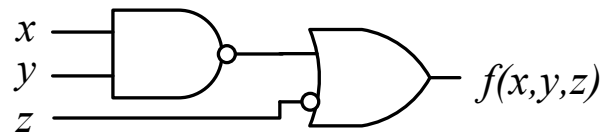
a) 2^4

b) 2^{10}

c) 2^{20}

d) 2^{32}

Q22. Which of the following is equivalent to the circuit below?



Q23. Which of the following is an appropriate equation of the XOR operator? Here, “ \cdot ” represents the logical AND, “ $+$ ” represents the logical OR, and \overline{P} represents the inverse of P in the logical expression.

a) $X = (A \cdot B) \cdot (\overline{A \cdot B})$

b) $X = (A + B) \cdot (\overline{A \cdot B})$

c) $X = (A \cdot B) \cdot (\overline{A + B})$

d) $X = (A + B) \cdot (\overline{A + B})$

Q1. For logical variables p and q , which of the following is a logical expressions that evaluates to true for any values of p and q ?

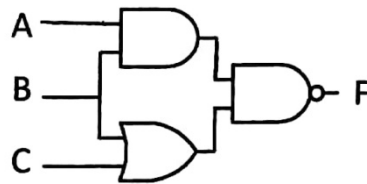
a) $\bar{p} + (p \cdot q)$

b) $(p \cdot q) + (\bar{p} + (p \cdot \bar{q}))$

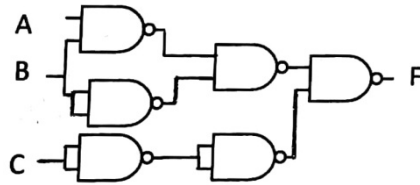
c) $(p \cdot \bar{q}) \cdot (\bar{p} + q)$

d) $((\bar{p} \cdot q) \cdot (p \cdot q)) \cdot \bar{q}$

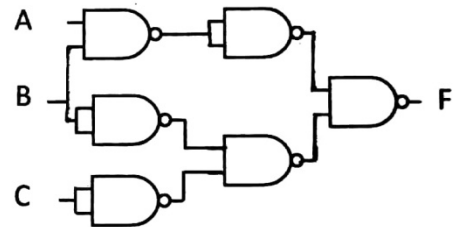
Q24. Which of the following is an equivalent representation of the circuit below where only NAND gates are used?



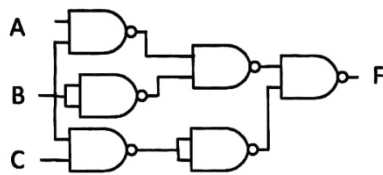
a)



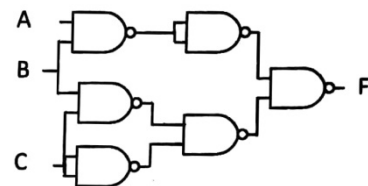
b)



c)



d)



Q1. For an eight-bit integer x represented in two's complement format, which of the following yields the value of $5x$? Here, the overflow or underflow can be ignored in this multiplication.

- a) Shift x to the left by 1 bit, then add the initial value of x to it.
- b) Shift x to the left by 2 bits, then add the initial value of x to it.
- c) Shift x to the right arithmetically by 1 bit, then subtract the initial value of x from it.
- d) Shift x to the right arithmetically by 2 bits, then subtract the initial value of x from it.

Q12. There exists a storage system in which one (1) block is composed of eight (8) sectors of 500 bytes each, and the storage area is block-wise allocated to the files. When a 2,000-byte file and 9,000-byte file are to be saved, what is the total number of sectors that is allocated to these two (2) files? Here, the sectors that are occupied by the directory information and other such management information can be ignored.

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

Q17. Which of the following is a method that performs data transfer between the main memory and a low-speed output device via a high-speed auxiliary storage device to increase the throughput of the entire system?

- a) Blocking
- b) Paging
- c) Spooling
- d) Swapping

Q2. Among the bit strings of length 4, how many of them either start with 1 or end with 00?

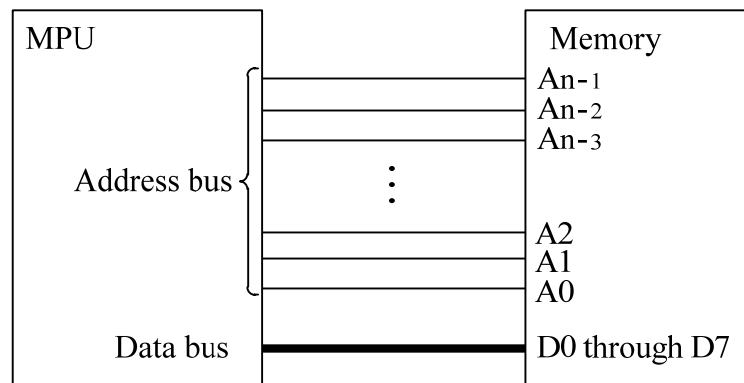
a) 4

b) 8

c) 10

d) 12

Q12. When a 1-megabyte memory is connected to the MPU as shown in the figure below, what is the minimum number of signal lines (represented as n) required by address buses? Here, the memory is accessed in units of bytes. In addition, 1 megabyte = 1,024 kilobytes and 1 kilobyte = 1,024 bytes.



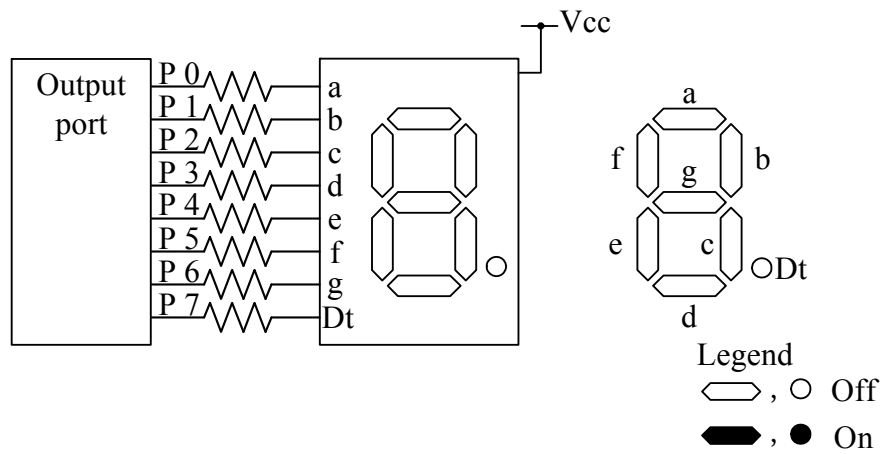
a) 18

b) 19

c) 20

d) 21

Q24. In a lighting circuit for an anode-common type LED with seven (7) segments, when 92 in hexadecimal is written out to the output port, which of the following is displayed? Here, P7 is the most significant bit (MSB), P0 is the least significant bit (LSB), and the LED lights up when the port output is 0.



- a)
- b)
- c)
- d)

Q25. Currently, the number of customers is 8,000 with annual increase rate of 20%. By assigning a fixed length code using 26 uppercase alphabet A-Z to each customer, what is the minimum code length required to accommodate all the customers for next three years?

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

Q1. There is a register where an integer value is stored in binary. Let x be a positive integer which is stored into the register, then perform the operations below.

- (1) Shift the content of the register to the left by 2 bits
- (2) Add x to the register.

How many times larger than the integer x is the content of the register?

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

Q10. A computer has two levels of memories, cache memory and main memory, with an access time of $0.01\ \mu\text{s}$ and $0.1\ \mu\text{s}$ respectively. If the hit ratio of the cache memory is 90%, which of the following is the appropriate average memory access time for this system? In this scenario, if the data is in the cache memory, the processor accesses the data directly with an access time of $0.01\ \mu\text{s}$. However, if a cache miss occurs, the data is required to be transferred from the main memory to the cache memory first, and then subsequently accessed from the cache memory. Thus, the access time becomes $0.11\ \mu\text{s}$.

- a) $0.011\ \mu\text{s}$ b) $0.019\ \mu\text{s}$ c) $0.020\ \mu\text{s}$ d) $0.091\ \mu\text{s}$

Q12. What is the average rotational latency of a hard disk drive in milliseconds when its rotation speed is 2000 rotations per minute?

- | | |
|-------|-------|
| a) 10 | b) 15 |
| c) 25 | d) 30 |

Q1. What is the octal representation of a hexadecimal fraction F1B0.C?

a) 170660.6

b) 361540.14

c) 743300.6

d) 5213052.3

Q1. If a given bit string contains at least one 1-bit, the algorithm below leaves the rightmost 1-bit unchanged but makes all the others 0. For example, if the given bit string is 00101000, the result will be 00001000. Which of the following is the appropriate logical operation to be filled in D ?

Step 1: By regarding the given bit string A as an unsigned binary number, let B be the result of subtracting 1 from A .

Step 2: Calculate the XOR (exclusive logical sum) of A and B , and let C be the result.

Step 3: Calculate the D of A and C , then set the result back to A .

- | | |
|--------------------------|------------------------------------|
| a) AND (logical product) | b) NAND (negative logical product) |
| c) OR (logical sum) | d) XOR (exclusive logical sum) |

Q2. When 4-bit signed numbers in 2's complement are used, which of the following operations will cause either an overflow or an underflow?

- a) Add B to A when A is 0110 and B is 1111.
- b) Add B to A when A is 1110 and B is 0110.
- c) Subtract B from A when A is 0111 and B is 1010.
- d) Subtract B from A when A is 1111 and B is 1111.

Q11. ECC is used for error detection and correction in memory. If $n + 2$ redundant bits are required for a data bus with a width of 2^n bits, how many redundant bits are required for a data bus with a width of 128 bits?

- a) 7 b) 8 c) 9 d) 10

Q12. Which of the following lists contain *A* through *D* in the order of shorter effective memory access time of the main memory?

	Cache memory			Main memory
	Existence	Access time (nanoseconds)	Hit rate (%)	Access time (nanoseconds)
<i>A</i>	No	-	-	15
<i>B</i>	No	-	-	30
<i>C</i>	Yes	20	60	70
<i>D</i>	Yes	10	90	80

a) *A, B, C, D*

b) *A, D, B, C*

c) *C, D, A, B*

d) *D, C, A, B*

Q1. Which of the following decimal values is equivalent to a hexadecimal fraction 0.B1?

a) $2^0 + 2^{-2} + 2^{-3} + 2^{-7}$

b) $2^0 + 2^{-3} + 2^{-4} + 2^{-8}$

c) $2^{-1} + 2^{-3} + 2^{-4} + 2^{-7}$

d) $2^{-1} + 2^{-3} + 2^{-4} + 2^{-8}$

Q11. In a CPU with a four (4)-stage pipeline composed of fetch, decode, execute, and write back, each stage takes 10, 6, 8, and 8 ns, respectively. Which of the following is an approximate average instruction execution time in nanoseconds (ns) in the CPU? Here, the number of instructions to be executed is sufficiently large. In addition, the overhead for the pipelining process is negligible, and the latency impact from all hazards is ignored.

- a) 6 b) 8 c) 10 d) 32

Q1. What is the sum of two binary fractions 1.0101 and 1.0111 expressed in decimal?

a) 2.5

b) 2.75

c) 2.875

d) 2.9375

Q13. Consider a disk drive that has a capacity of 8 GB. The drive has 5 platters with two surfaces, 10,000 tracks per surface and 200 sectors per track. How many bytes are in each sector? Here, 1GB is 1,000,000,000 bytes.

a) 100

b) 200

c) 400

d) 800

Q1. Which of the following is the appropriate combination that represents the decimal number “–19” in 8-bit one’s complement binary and 8-bit two’s complement binary?

	One’s complement binary	Two’s complement binary
a)	00010011	11101100
b)	00010011	11101101
c)	11101100	11101100
d)	11101100	11101101

Q2. Which of the following is the appropriate binary fraction that is equivalent to the decimal value 5.525? Here, the binary string enclosed in parentheses is repeated infinitely.

a) 101.11

b) 101.1000011

c) 101.10(0011)

d) 101.100(0011)

Q11. As shown the figure and table below, there are two types of CPUs X and Y that have the same configuration except that the access times of cache memory and main memory are different from each other. All other conditions of the two CPUs are the same. When a certain program is executed on both CPU X and CPU Y , the processing time of each CPU is the same. Under these conditions, what is the hit ratio of the cache memory? Here, there are no effects from other than CPU processing.

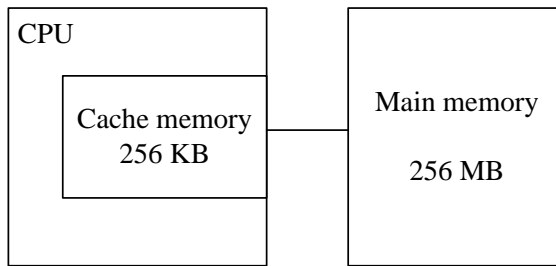


Figure Configuration

Table Access time

Unit: Nanosecond		
	CPU X	CPU Y
Cache memory	40	20
Main memory	400	580

- a) 0.75 b) 0.90 c) 0.95 d) 0.96

Q1. When a total of 400 data records are stored in contiguous memory starting from the address 0274_8 , which of the following is the address where the last data record is stored? Here, each data record occupies one address location, and each address is represented in radix notation.

a) 0673_8

b) 0674_8

c) 1113_8

d) 1114_8

Q10. In a paged virtual storage system, when a TLB (Translation Lookaside Buffer) is used to translate a virtual address to a physical address under the conditions shown below, how many clock cycles on average are required to translate an address through the TLB?

[Conditions]

1. It takes 1 clock cycle to translate an address at the time of a TLB hit.
2. It takes 40 clock cycles to translate an address at the time of a TLB miss hit.
3. The TLB miss rate is 0.5%.

- a) 1.039 b) 1.040 c) 1.195 d) 1.200

- Q1.** Which of the following is equivalent to the calculation result of the arithmetic expression shown below? Here, each number is represented in radix notation; that is, the radix is represented by a subscript following the number.

$$6140_8 + 10011100_2 - C46_{16}$$

- a) $1011\ 0101_2$ b) 256_8 c) 180_{10} d) $B6_{16}$

- Q4.** What is the minimum number of bits required to uniquely encode upper-case alphabetic characters (i.e., A through Z) and numeric characters (i.e., 0 through 9) in the same number of bits?
- a) 5 b) 6 c) 7 d) 8

Q15. Which of the following is the list that arranges *A* through *D* in order of effective access time of main memory from shortest to longest?

	Cache memory			Main memory
	Use of cache memory	Access time (nanoseconds)	Hit ratio (%)	Access time (nanoseconds)
<i>A</i>	No	–	–	15
<i>B</i>	No	–	–	30
<i>C</i>	Yes	20	60	70
<i>D</i>	Yes	10	90	80

- a) *A, B, C, D*
c) *C, D, A, B*

- b) *A, D, B, C*
d) *D, C, A, B*

- Q1.** When the hexadecimal value 2A is stored in an 8-bit register and is logically shifted left three bits, which of the following is the resulting value in decimal? Here, the bit positions vacated on the right are filled with zeros, and bits shifted out on the left are discarded.
- a) 2 b) 5 c) 80 d) 160

Q1. Which of the following is the result of calculating the arithmetic expression “ $B6-7C$ ”?
Here, all numbers are represented in unsigned hexadecimal.

- a) 32 b) 3A c) B2 d) BA

Q13. There is a digital video recording system installed with four security cameras. In this system, the video data from each camera is captured at 30 frames per second with a resolution of 640×480 pixels and a color depth of 16 bits per pixel, and then it is stored in the hard disk drive. Which of the following is the approximate storage capacity that is required for recording all video data for one minute? Here, 1 MB is 10^6 bytes, and 1 GB is 10^9 bytes.

- a) 19 MB b) 74 MB c) 1.2 GB d) 4.5 GB

Q14. Cache memory is usually organized at multiple levels, such as L1 for level 1 and L2 for level 2, with L1 having the smallest storage capacity but the fastest memory speed. The data in L1, L2, and main memory can be accessed using 1, 10, and 100 clock cycles, respectively. When the cache miss rates in L1 and L2 are 5% and 50% respectively, what is the average memory access time in clock cycles?

- a) 2.8 b) 3.7 c) 37 d) 52.3

Q15. The magnetic head of a hard disk drive is currently positioned at cylinder number 100, and the cylinder numbers 120, 90, 70, 80, 140, 110, and 60 are lined up in the I/O request queue. What is the total number of cylinders that the head moves to satisfy the conditions below?

[Conditions]

- (1) The seek optimization method is applied to I/O requests, which are sorted in order of increasing cylinder number so that the head can move in the same direction to the extent possible.
- (2) The head is currently moving in the direction where cylinder number increases.
- (3) When there are no more I/O requests in the current direction, the direction of movement is reversed.
- (4) The results are not affected by the processing order of I/O requests.
- (5) New I/O requests do not occur during the process.

- a) 80 b) 120 c) 160 d) 220

Q29. When a 60-minute monaural audio signal is digitalized using a PCM format with a sampling frequency of 44.1 kHz and a quantization bit rate of 16 bits, what is the approximate data volume in Mbytes? Here, the data is not compressed.

- a) 80 b) 160 c) 320 d) 640

Q3. When the decimal integer “-24” is represented in 8-bit binary by using one’s complement and two’s complement, which of the following is the correct combination?

	One’s complement	Two’s complement
a)	00011001	00011010
b)	00011010	00011001
c)	11100111	11101000
d)	11101000	11100111

Q1. Which of the following is the binary fraction that is equivalent to the decimal fraction 115.625?

- a) 1100111.1001110001
- c) 1110011.1001110001

- b) 1100111.101
- d) 1110011.101

Q4. How many binary numbers can be represented using a 6-bit number that does not have two contiguous 1s? For example, “101010” does not have two contiguous 1s.

a) 8

b) 13

c) 21

d) 34

Q1. Which of the following is equivalent to the result of the arithmetic expression “ $753_8 - A6_{16}$ ”? Here, each number is written in radix notation; that is, the radix is represented by a subscript following the number.

- a) 101001101_2 b) 501_8 c) 325_{10} d) 135_{16}

Q4. An empty tank can be filled with water in 20 minutes by using Pipe *A* or in 30 minutes by Pipe *B*, and the tank filled with water can be emptied of water in 40 minutes by using Pipe *C*. When the three pipes *A*, *B*, and *C* work together, approximately how long (in minutes) does it take to fill the empty tank with water?

- a) 9.2 b) 10.0 c) 17.1 d) 24.0

Q12. In a virtual storage computer system with cache memory, main memory, and disk storage, it takes 2 nanoseconds, 10 nanoseconds, and 10 milliseconds, on average, to access data available in the cache, main memory, and disk storage, respectively. When the cache hit ratio and the main memory hit ratio (after a cache miss) are 0.95 and 0.99 respectively, which of the following is the approximate average time in microseconds to access the necessary data?

- a) 4.7 b) 4.9 c) 5.0 d) 5.2

Q13. When the size of a still image is $1,600 \times 1,200$ pixels and each pixel has a 256-level gray scale ranging from 0 to 255, approximately how many megabytes are needed at least to store five such still images?

- a) 2 b) 4 c) 10 d) 15

Q3. When the true and measured values are 1.744 and 1.720 respectively, what is the approximate relative error in percentage?

- a) -2.4 b) -1.4 c) 1.4 d) 2.4

Q29. Audio is sampled 11,000 times a second, and each sampled value is recorded as 8-bit data. How many minutes of audio at maximum can be recorded in flash memory with a capacity of 512×10^6 bytes?

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

- Q1.** There is an 8-bit register where integers are represented in binary by using 2's complement for negative numbers. When the decimal integer “-24” is stored in the register and then arithmetically shifted 2 bits right, what is the resulting value in decimal? Here, the leftmost bit of the register is used as a sign bit.
- a) -102 b) -96 c) -6 d) 58

Q13. When a color image is stored in video memory at a tonal resolution of 24 bits per pixel, approximately how many megabytes (MB) are required to display the image on the screen with a resolution of 1024×768 pixels? Here, 1 MB is 10^6 bytes.

- a) 0.8 b) 2.4 c) 6.3 d) 18.9

Q14. How many memory cells (or latches for holding 1 bit each) are implemented in SRAM with 24 address lines and 16 data lines?

a) 2^{16}

b) 2^{24}

c) 24×16

d) $2^{24} \times 16$

Q15. There is a hard disk drive that has the specifications shown in the table below. When a record of 10,000 bytes is read out from this disk, approximately how long (in milliseconds) does it take to access the disk and to complete the data transfer? Here, the data is stored contiguously from the beginning of one track, and the entire data on the track can be read and transferred per revolution.

Capacity per track	12,000 bytes
Rotation speed	3,000 rpm
Average seek time	15 milliseconds

- a) 17 b) 27 c) 32 d) 42

Q1. When the equation " $100_n - 34_n = 44_n$ " holds, which of the following represents 26_n ? Here, each number is written in radix notation; that is, each subscript " n " indicates the radix. In addition, when there is no subscript, the radix 10 is implied.

a) 18

b) 20

c) 22

d) 38

Q4. When the resulting value of the expression “ $13 \times 16^3 + 11 \times 16^2 + 9 \times 16 + 3$ ” is represented in binary, how many “1” bits are included in the binary value?

a) 6

b) 10

c) 13

d) 16

Q5. When the simultaneous equations shown below hold for the Boolean variables w, x, y , and z , which of the following is the correct solution? Here, “+” stands for the logical sum operation, and “.” for the logical product operation.

$$x \cdot y = 0$$

$$x \cdot z + w = 1$$

$$x \cdot y + w = 0$$

	w	x	y	z
a)	0	0	1	0
b)	0	1	0	0
c)	0	1	0	1
d)	1	1	0	1

Q16. When a memory chip has 8 data lines and 9 address lines, what is the maximum number of bytes that can be stored in the chip? Here, chip select signals are implemented independent of those address lines, and no parity bit is considered.

- a) 128 b) 256 c) 512 d) 1024

Q1. Which of the following represents the hexadecimal fraction 3A.5C as a decimal fraction?

a) $\frac{939}{16}$

b) $\frac{3735}{64}$

c) $\frac{14939}{256}$

d) $\frac{14941}{256}$

Q2. Which of the following hexadecimal numbers, representing signed 16-bit binary numbers, results in overflow when multiplied by 4? Here, a negative number is represented in 2's complement.

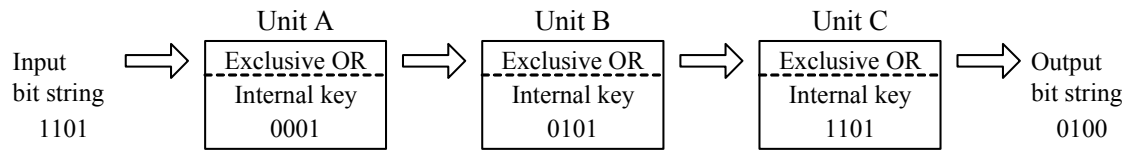
a) 1FFF

b) DFFF

c) E000

d) FFFF

- Q8.** There is a device consisting of Unit A, Unit B, and Unit C. Each unit can execute the “exclusive OR” operation in units of 4 bits. When an input bit string 1101 is given, an output bit string 0100 is obtained. In this device, if the internal key for Unit B is changed and the output bit string 1111 is generated, which of the following is the newly changed internal key for Unit B?



- a) 1011 b) 1100 c) 1101 d) 1110

Q18. When a certain RISC processor has a 5-stage instruction pipeline, how long (in nanoseconds) does it take to continuously execute 7 instructions excluding branch/jump instructions? Here, it takes 1.5 nanoseconds to complete each stage. In addition, any delay, such as pipeline stall and bubble, does not occur during the execution of those instructions.

- a) 7.5 b) 10.5 c) 16.5 d) 52.5

Q19. At least how many bits are required for the register identification field of a machine instruction code in order to specify one of 16 general purpose registers in the machine?

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

Q26. When an image is read with a scanner at a resolution of 600 dpi and printed with a printer at a resolution of 300 dpi, how many times as large as the area of the original image is the area of the printed image?

a) $\frac{1}{4}$

b) $\frac{1}{2}$

c) 2

d) 4

Q28. Which of the following combinations of access time and hit ratio for cache memory and access time for main memory results in the shortest effective access time to main memory?

	Cache memory		Main memory
	Access time (nanoseconds)	Hit ratio (%)	Access time (nanoseconds)
a)	8	60	40
b)	8	70	40
c)	10	70	30
d)	10	80	30

Q1. Which of the following arithmetic expressions is correct? Here, a number is written in radix notation; that is, a decimal subscript following the number (i.e. number_{radix}) is used to indicate the radix.

a) $1010_2 + 10_8 = 17_{10}$

b) $1101_2 + 4_{16} = 17_{10}$

c) $14_8 + 11_2 = 16_{10}$

d) $B_{16} + 10_2 = 14_{10}$

Q2. When the binary fraction 11101.110 is subtracted from the binary fraction 101101.101, what is the correct result?

a) 111.001

b) 111.111

c) 1111.001

d) 1111.111

Q3. When a certain natural number x can be represented by a $2n$ -digit binary number consisting of 1 and 0 arranged alternately, i.e. 1010...10, which of the following equations holds for x ?

a) $x + \frac{x}{2} = 2^{2n}$

b) $x + \frac{x}{2} = 2^{2n} - 1$

c) $x + \frac{x}{2} = 2^{2n+1}$

d) $x + \frac{x}{2} = 2^{2n+1} - 1$

Q4. There is an 8-bit numerical value, where a negative number is represented in two's complement. When this value is represented in decimal, it becomes -100. When this value is regarded as an unsigned number, which of the following is the correct value in decimal?

- a) 28 b) 100 c) 156 d) 228

Q7. Which of the following operations does not change the lower 4 bits of an 8-bit string?

- a) A logical product (i.e. AND) with a bit string 0F in hexadecimal
- b) A logical sum (i.e. OR) with a bit string 0F in hexadecimal
- c) A negative logical product (i.e. NAND) with a bit string 0F in hexadecimal
- d) An exclusive logical sum (i.e. exclusive OR) with a bit string 0F in hexadecimal

Q23. There is a hard disk drive that has the following specifications.

[Specifications]

Capacity: 512 GBytes

Number of cylinders: 1024

Number of platters: 5 (10 surfaces)

Number of heads: 2 per platter

How many bytes can be stored in one track of this hard disk drive? Here, each track has the same capacity. 1 GByte is 10^9 bytes, and 1 Mbyte is 10^6 bytes.

- a) 50 Kbytes b) 100 Kbytes c) 50 Mbytes d) 100 Mbytes

Q27. A color video clip is displayed in full-screen mode on a PC at 30 frames/second, with each screen comprising 300,000 pixels and 256 colors displayed at the same time. Under these conditions, which of the following is the approximate amount of data (in megabytes) that can be displayed in one minute? Here, the data is not compressed.

- a) 77 b) 270 c) 540 d) 2,300

Q1. Which of the following decimal fractions becomes a finite fraction when converted to an octal number?

a) 0.3

b) 0.4

c) 0.5

d) 0.8

- Q2.** A register stores a numerical value representing a binary number. After a positive integer x is entered in the register, the following operation is performed: “shift the register value two bits to the left and add x .” How many times as large as x is the new value of the register? Here, the shift does not cause an overflow.
- a) 3 b) 4 c) 5 d) 6

Q3. Which of the following is the appropriate way to check whether or not an 8-bit unsigned binary number x is a multiple of 16?

- a) The bit-by-bit logical product between x and the binary number 00001111 is 0.
- b) The bit-by-bit logical product between x and the binary number 11110000 is 0.
- c) The bit-by-bit logical sum between x and the binary number 00001111 is 0.
- d) The bit-by-bit logical sum between x and the binary number 11110000 is 0.

- Q4.** In the single precision of “IEEE Standard for Binary Floating-Point Arithmetic” (IEEE 754), the value “V” is represented as follows:

S: Sign (1 bit)	E: Exponent (8 bits)	F: Fraction (23 bits)
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If $0 < E < 255$ then $V = (-1)^S \times 2^{(E-127)} \times (1.F)$

where “1.F” is intended to represent the binary number created by prefixing F with an implicit leading 1 and a binary point.

When the hexadecimal value C1E00000 is represented in IEEE 754, what is the correct value converted to decimal?

- a) -59 b) -44 c) -28 d) 26

Q19. When a CPU can perform a multiplication in 12 nanoseconds (ns), an addition in 1 ns, and a subtraction in 1.5 ns, which of the following is the minimum CPU time, in nanoseconds, for the calculation of “ $a \times a - b \times b$ ”?

- a) 12.5 b) 13.5 c) 14.5 d) 25.5

Q23. A processor with a 256-Mbyte address space is using the address “35E3C03” to access a 16-Mbyte memory device. What are the highest and lowest addresses in the memory map of the 16-Mbyte memory device? Here, the memory addresses are expressed in hexadecimal.

	Highest address	Lowest address
a)	3FFFFFFF	00000000
b)	3FFFFFFF	30000000
c)	40000000	00000000
d)	FFFFFFFF	00000000

Q25. A system has a main memory access time of 60 nanoseconds (ns) and a cache memory access time of 10 ns. When the effective access time for accessing the main memory via the cache memory is 15 ns, what is the hit ratio of the cache memory?

- a) 0.1 b) 0.17 c) 0.83 d) 0.9

Q1. Which of the following is equal to the hexadecimal fraction 2A.4C?

a) $2^5 + 2^3 + 2^1 + 2^{-2} + 2^{-5} + 2^{-6}$

b) $2^5 + 2^3 + 2^1 + 2^{-1} + 2^{-4} + 2^{-5}$

c) $2^6 + 2^4 + 2^2 + 2^{-2} + 2^{-5} + 2^{-6}$

d) $2^6 + 2^4 + 2^2 + 2^{-1} + 2^{-4} + 2^{-5}$

Q2. In what radix does the following equation hold?

$$131 - 45 = 53$$

a) 6

b) 7

c) 8

d) 9

Q17. How many memory cells (or latches for holding 1 bit each) are implemented in SRAM with 24 address lines and 16 data lines?

a) 2^{16}

b) 2^{24}

c) 24×16

d) $2^{24} \times 16$

Q1. What range of decimal numbers can be represented with an 11-bit two's-complement number?

- a) -2048 to 2047
- b) -2048 to 2048
- c) -1024 to 1023
- d) -1024 to 1024

Q2. Which of the following decimal fractions becomes a finite fraction in an octal representation?

a) 0.3

b) 0.4

c) 0.5

d) 0.8

Q3. When a certain natural number x is expressed as a $2n$ -digit binary number “1010...10” consisting of 1 and 0 arranged alternately, which of the following equations can be formulated in terms of the number x ?

a) $x + \frac{x}{2} = 2^{2n}$

b) $x + \frac{x}{2} = 2^{2n} - 1$

c) $x + \frac{x}{2} = 2^{2n+1}$

d) $x + \frac{x}{2} = 2^{2n+1} - 1$

Q4. An integer m is stored in a register as a binary value. If this value is shifted to the left by three bits and m is added to the shifted value, how many times as large as m is the resulting number? Here, no overflow occurs.

a) 4

b) 7

c) 8

d) 9

Q11. There are three 7-bit character codes: 30, 3F, and 7A. When an even parity bit is added to the front of each character code, which of the following shows the correct result? Here, the character codes are expressed in hexadecimal.

- a) 30, 3F, 7A
- c) B0, 3F, FA

- b) 30, 3F, FA
- d) B0, BF, 7A

Q22. The instruction pipeline is a technique used in order to improve the CPU performance. Instructions are divided into stages and moved through the processor. An RISC processor has five-stage pipeline (Instruction fetch, Instruction decode, Execute, Memory access, Register write back) and can accept a new instruction at every clock cycle. How many clock cycles does this processor take for completion of the execution of 10 instructions? Here, there are no pipeline stalls, such as branch stall, load stall, and so on.

- a) 13 b) 14 c) 15 d) 16

Q23. There is a processor with a clock frequency of 1 GHz. When the instruction set of this processor is composed of two types of commands as shown in the table below, what is the approximate processing performance in MIPS?

Command type	Execution time (clocks)	Execution frequency (%)
Command 1	10	60
Command 2	5	40

a) 34

b) 100

c) 125

d) 133

Q28. How many tracks are required to store a sequentially organized data file including a total of 10,000 records on the hard disk drive under the following conditions? Here, each track can contain multiple blocks, but each block cannot be stored across multiple tracks.

[Conditions]

Record length:	300 bytes/record
Track capacity:	30,000 bytes/track
Inter-block gap:	400 bytes
Blocking factor:	20 records/block

- a) 100 b) 106 c) 107 d) 125

Q29. The head of a hard disk drive is currently positioned at cylinder number 100, and the cylinder numbers 120, 90, 70, 80, 140, 110, and 60 are lined up in the I/O request queue. What is the total number of cylinders that the head moves under the following conditions?

[Conditions]

- (1) The seek optimization method reorders the I/O requests so that the head can move as much as possible in a single direction, and the requests are processed in order of cylinder number.
- (2) The requests so far are in the direction where the cylinder numbers increase.
- (3) When there are no more requests in the current direction, the direction of head movement is reversed.
- (4) The results are unaffected by the processing order of the requests.
- (5) New requests do not occur during the process.

a) 80

b) 120

c) 160

d) 220

Q1. Which of the following is the correct decimal fraction equal to hexadecimal fraction 0.248?

a) $\frac{31}{32}$

b) $\frac{31}{125}$

c) $\frac{31}{512}$

d) $\frac{73}{512}$

Q2. Which of the following is the correct value of the quadruple of hexadecimal fraction 0.FEDC?

- a) 1.FDB8 b) 2.FB78 c) 3.FB70 d) F.EDC0

- Q4.** The decimal value “-72” is stored in an 8-bit register using 2’s complement. If the data in the register is logically shifted two bits to the right, which of the following is the correct result that is represented in decimal?
- a) -19 b) -18 c) 45 d) 46

Q5. By definition of the IEEE754 standard, 32-bit floating point numbers are represented as follows:

S (1 bit)	E (8 bits)	M (23 bits)
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S: Sign bit

E: Exponent

M: Mantissa

Which of the following is the correct “mask bits” in hexadecimal to be used for extracting only the exponent part of the above format? Here, “mask bits” means a bit pattern which is logically ANDed with the 32-bit floating point value.

- a) 107FFFFFFF b) 7F800000 c) FF100000 d) FF800000

Q20. A computer is designed to enable pipeline control so that each instruction can be completed in five cycles. How many cycles are needed to execute 20 instructions? Here, all instructions can be executed without being stopped halfway.

a) 20

b) 21

c) 24

d) 25

Q23. There are two systems A and B whose access times of cache and main memory are shown in the table. When a certain program runs on these systems, the cache hit ratio and the effective access time are the same on both systems. What is the cache hit ratio in this case?

Unit: nsec.

	System A	System B
Cache memory	15	10
Main memory	50	70

a) 0.2

b) 0.3

c) 0.5

d) 0.8

Q25. There is a hard disk drive with specifications shown below. When a record of 15 Kbytes is processed, which of the following is the average access time in milliseconds? Here, the record is stored in one track.

[Specifications]

Capacity: 25 Kbytes/track

Rotation speed: 2,400 revolutions/minute

Average seek time: 10 milliseconds

- a) 22.5 b) 37.5 c) 40.0 d) 50.0