

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව  
 இலங்கைப் பரீட்சைத் திணைக்களம்  
 Department of Examinations, Sri Lanka

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2024  
 கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2024  
 General Certificate of Education (Adv. Level) Examination, 2024

තොරතුරු හා සන්නිවේදන තාක්ෂණය I  
 தகவல், தொடர்பாடல் தொழினுட்பவியல் I  
 Information & Communication Technology I

20 E I

පැය දෙකයි  
 இரண்டு மணித்தியாலம்  
 Two hours

### Instructions:

- \* Answer all the questions.
- \* Write your **Index Number** in the space provided in the answer sheet.
- \* Instructions are also given on the back of the answer sheet. Follow those carefully.
- \* In each of the questions 1 to 50, pick one of the alternatives from (1), (2), (3), (4), (5) which is **correct or most appropriate** and mark your response on the answer sheet with a **cross (X)** in accordance with the instructions given on the back of the answer sheet.
- \* Use of calculators is not allowed.

### 1. Consider the following data:

- A – temperature values given by a sensor
- B – creator's name and the date of creation of a file saved in a computer
- C – collection of posts and responses shared on a social media platform

Which of the following correctly categorizes the above data?

- (1) A – big data, B – continuous data, C – metadata (data about data)
- (2) A – continuous data, B – big data, C – metadata
- (3) A – continuous data, B – metadata, C – big data
- (4) A – metadata, B – big data, C – continuous data
- (5) A – metadata, B – continuous data, C – big data

### 2. Which of the following are good examples for *batch processing*?

- A – a system that outputs the presently vacant vehicle parking space closest to a user ×
  - B – a system that automatically backs up the files in a computer at the end of each day ✓
  - C – a system that sorts the customer orders received during a day according to value ✓
- (1) A only
  - (2) A and B only
  - (3) A and C only
  - (4) B and C only
  - (5) All A, B and C

### 3. Select the answer containing the correct replacements for (A) and (B) in the following paragraph:

Although ..... (A) ..... is very old, it still plays a central role in the daily operations of the world's largest corporations. In addition to its power, the other main reason for its popularity is its ..... (B) .....

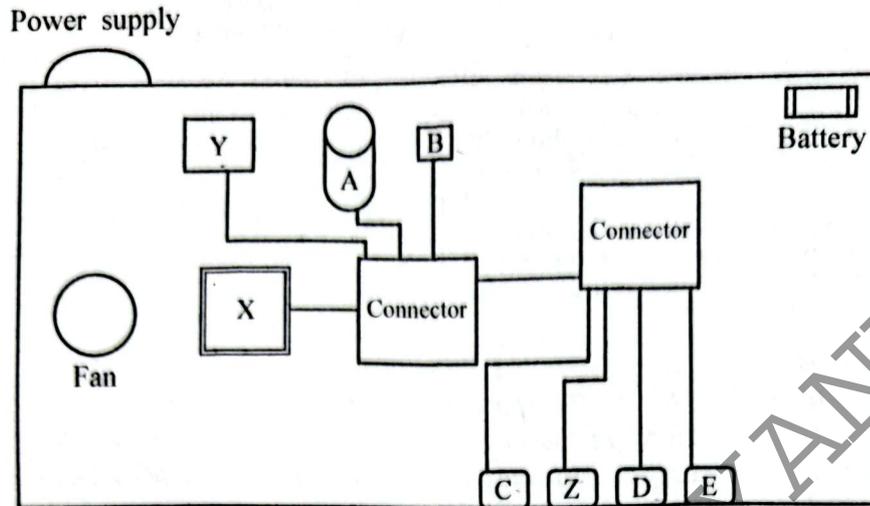
- (1) A – cloud computing B – non-reliance on the Internet
- (2) A – cloud computing B – non-reliance on service providers
- (3) A – the main frame computer B – low cost
- (4) A – the main frame computer B – reliability ✓
- (5) A – the main frame computer B – small size

### 4. A village of houses constructed mainly with the aid of a *special equipment* is nearing completion in the United States of America. This equipment has been used to construct the walls of the houses with the foundations and the roofs constructed in the traditional way. This equipment reduces the number of workers required for the construction process and has made the process faster and cheaper with minimized construction waste. What could be this special equipment?

- (1) a digitizer
- (2) a large 3D printer
- (3) a plotter
- (4) a pointing device
- (5) a joystick



5. The figure below shows some components and connections on a computer motherboard.



The labels A-E indicate the following:

- A - hard disk
- B - ROM BIOS
- C - connector for audio port
- D - connector for network port
- E - connector for USB port

What are indicated by the labels X, Y and Z respectively?

(1) X - connector for video port	Y - CPU	Z - memory
(2) X - connector for video port	Y - memory	Z - CPU
(3) X - CPU	Y - memory	Z - connector for video port
(4) X - CPU	Y - connector for video port	Z - memory
(5) X - memory	Y - connector for video port	Z - CPU

6. A person notes that a desktop computer was booting very fast from the hard disk after the computer was repaired. Which of the following would have been done during the repair?

- (1) decreasing RAM and reinstalling the operating system
- (2) formatting the hard disk only
- (3) installing a new CD drive only
- (4) replacing the small fan inside the computer only
- (5) replacing the hard disk with a Solid-state Drive (SSD) and reinstalling the operating system

7. What is the correct binary equivalent of decimal  $14.25_{10}$ ?

- (1) 1001.10
- (2) 1010.11
- (3) 1011.01
- (4) 1110.01
- (5) 1111.10

8. What is the correct decimal equivalent of octal  $120_8$ ?

- (1) 10
- (2) 17
- (3) 80
- (4) 136
- (5) 640

9. Which of the following are correct?

- I :  $EB7_{16} = 1110\ 1011\ 0111_2$
- II :  $84_{10} = 1010100_2$
- III :  $753_8 = 1001011_2$

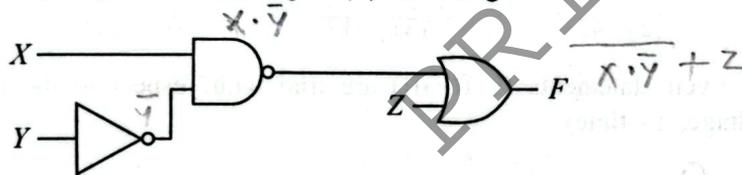
- (1) I only
- (2) I and II only
- (3) I and III only
- (4) II and III only
- (5) All I, II and III

10. The second and third rows of the following table contain two English words and their binary representations according to the ASCII code. The binary representation of No! is kept blank.

Word	Binary representation
no	1101110 1101111
N!	1001110 0100001
No!	

What is the correct replacement for the blank?

- (1) 0100001 1001110 1101111<sup>+</sup>  
 (2) 1001110 0100001 1101111<sup>+</sup>  
 (3) 1001110 1101111 0100001<sup>✓</sup>  
 (4) 1101110 0100001 1101111<sup>✗</sup>  
 (5) 1101110 1101111 0100001<sup>✓</sup>
11.  $11001_2 + 10001_2 =$   
 (1) 101010<sub>2</sub> (2) 101011<sub>2</sub> (3) 101100<sub>2</sub> (4) 111001<sub>2</sub> (5) 111010<sub>2</sub>
12. Which of the following expresses the output ( $F$ ) of the given circuit?



- (1)  $(X + \bar{Y})Z$  (2)  $\overline{(X + \bar{Y})} + Z$  (3)  $\overline{(X + \bar{Y})}Z$  (4)  $X\bar{Y} + Z$  (5)  $\overline{(X\bar{Y})} + Z$
13. Applying *Double complement* and *De Morgan's laws* to  $\bar{x} + yz$  results in  
 (1)  $xy + \bar{z}$ . (2)  $x\bar{y} + z$ . (3)  $\bar{x}\bar{y}z$ . (4)  $\overline{x(yz)}$ . (5)  $\bar{x}\bar{y} + yz$ .
14. What is the most simple Boolean expression that can be obtained through the given Karnaugh map?

		xy			
		00	01	11	10
z	0	0	1	1	1
	1	0	1	1	0

- (1)  $y$  (2)  $xz$  (3)  $x\bar{z}$  (4)  $\bar{x}z$  (5)  $y + x\bar{z}$
15. Which of the following are correct regarding the *Process Control Block (PCB)*?
- A - It is a data structure used by the operating system to manage information about a process.  
 B - It is created during the compilation of a program.  
 C - The *program Counter* values of two PCBs can be the same. ✓
- (1) A only (2) A and B only (3) A and C only  
 (4) B and C only (5) All A, B and C

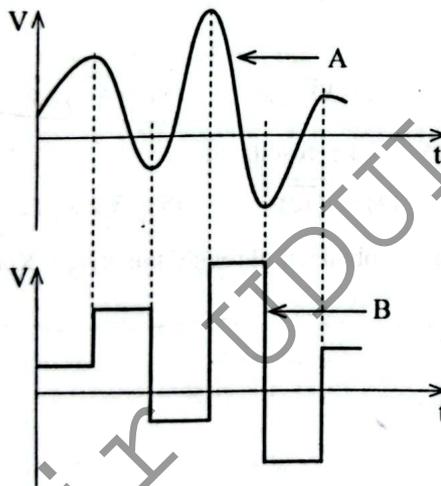


16. Amara switches on a multi-user computer system. After it has booted, Sama logs on to the computer from a terminal and starts a web browser. After sometime, Sama starts a text editor also to work on her Python program. Then Rani also logs on to the computer from another terminal and starts a web browser.

Which of the following are possible execution sequences on the processor of this computer?

- (1) BIOS → OS → Sama's web browser process → OS → Sama's text editor process → OS → Rani's web browser process → OS → Sama's text editor process → ...
  - (2) BIOS → OS → Sama's web browser process → Sama's text editor process → OS → Rani's web browser process → OS → Sama's web browser process → ...
  - (3) BIOS → Sama's web browser process → Sama's text editor process → OS → Rani's web browser process → OS → Sama's text editor process → ...
  - (4) OS → BIOS → Sama's web browser process → OS → Sama's text editor process → OS → Rani's web browser process → OS → Sama's web browser process → ...
  - (5) OS → BIOS → Sama's web browser process → Sama's text editor process → OS → Rani's web browser process → OS → Sama's web browser process → ...
17. Each block of a disk is 512 bytes. When a file of size 1959 bytes is stored on that disk, how many bytes allocated to the file would be wasted?
- (1) 89                      (2) 423                      (3) 512                      (4) 601                      (5) 1447

18. Which of the given statements (I, II, III) are true with respect to the following two diagrams?  
(Note: V - Voltage, t - time)



- I - A depicts an analog signal.  
II - B depicts a digital signal.  
III - B is a digitized version of A.

- (1) I only                      (2) II only                      (3) III only  
(4) II and III only                      (5) All I, II and III
19. Which of the following is correct regarding parity bits?
- (1) The parity bit in a set of bits is adjusted after that set of bits is communicated.
  - (2) The parity bit for a set of bits is selected to ensure the total number of 1-bits in the set is either even or odd.
  - (3) The transmission speed of a communication is increased by parity bits.
  - (4) Parity bits are added after a communication to correct errors.
  - (5) Encryption needed in a data transmission is provided by parity bits.
20. What is done by a modem when it receives an analog signal from a PSTN (Public Switched Telephone Network) line?
- (1) It amplifies the signal for better clarity.
  - (2) It compresses the signal for storage.
  - (3) It demodulates the signal back into digital form.
  - (4) It encrypts the signal for security.
  - (5) It modulates the signal further for transmission.

[See page five

21. Which of the following best describes a *switch* in a network?
- (1) It amplifies data signals for clearer transmission.
  - (2) It always broadcasts all incoming data to every device in the network.
  - (3) It compresses data for more efficient transmission.
  - (4) It directs data only to the specific device for which the data is intended.
  - (5) It stores data for future processing.
22. How many usable host addresses are available in the 192.168.100.0/27 IP address block?
- (1) 16
  - (2) 30
  - (3) 32
  - (4) 62
  - (5) 64
23. Which of the following are properties of the Transmission Control Protocol (TCP)?
- A – detection and correction of any errors in a communication  
 B – receiver acknowledging to the sender about the receipt of a data packet  
 C – ensuring data packets are received in order
- (1) A only
  - (2) A and B only
  - (3) A and C only
  - (4) B and C only
  - (5) All A, B and C
24. A new system must be delivered completely to the client by a given date. There should not be any partial deliveries. Further, the system architecture and design must be fully defined before any coding began.
- Which of the following are suitable models to develop this system?
- A – waterfall      B – spiral      C – agile
- (1) A only
  - (2) A and B only
  - (3) A and C only
  - (4) B and C only
  - (5) All A, B and C
25. During the feasibility analysis of a software development project, it was discovered that the development team does not have the knowledge and the skills to develop the software. Which component of the feasibility study would have identified this issue?
- (1) economic feasibility
  - (2) legal feasibility
  - (3) operational feasibility
  - (4) schedule feasibility
  - (5) technical feasibility
26. Which of the following shows the correct order of stages in the System Development Life Cycle?
- (1) Feasibility study → Requirements analysis → System design → Implementation → Testing → Deployment
  - (2) Feasibility study → System design → Requirements analysis → Implementation → Testing → Deployment
  - (3) Requirements analysis → Feasibility study → System design → Testing → Deployment → Implementation
  - (4) Requirements analysis → System design → Feasibility study → Deployment → Testing → Implementation
  - (5) System design → Requirements analysis → Feasibility study → Implementation → Testing → Deployment
27. Which of the following is **not true** regarding the *prototyping* technique used in system development?
- (1) Prototypes need to be approved by the users, during the 'system testing' phase.
  - (2) Prototyping is neither necessary nor appropriate in every project.
  - (3) Successful prototyping helps to develop a system that better addresses user needs and expectations.
  - (4) Successful prototyping helps to eliminate costly late changes to a system.
  - (5) To get the benefits of prototyping, user feedback on the prototypes is extremely important.



28. Which of the following statements regarding *software tests* are correct?

- A – *White-box tests* involve testing the internal structures and workings of a software.  
 B – *Unit tests* are usually performed after the *system test*.  
 C – System developers should take every effort to make the *acceptance test* successful.

- (1) A only (2) A and B only (3) A and C only  
 (4) B and C only (5) All A, B and C

● Read the following description to answer questions 29 and 30.

A *playground reservation system* is needed for students and others to reserve the school playground (which is adjoining the school) for team sports. Each reservation is for two hours. All non-students will need to pay for their reservations. The reservations are to be made using the National Identity Card (NIC) numbers. The NICs are to be verified at the playground gate before a team is let in.

The algorithm that could be used for the reservation process is shown below with blanks labelled A – D.

```

BEGIN
  A
  IF user interested to make a reservation THEN
    B
    C
    IF user is not a student THEN
      D
    ENDIF
    Confirm booking and update reservation database
  ENDIF
END.
```

29. Which of the following contains the suitable replacements for the above blanks?

- (1) A – DISPLAY existing bookings B – GET date/time C – GET NIC number D – Complete user's credit/debit card payment  
 (2) A – DISPLAY existing bookings B – GET date/time C – Complete user's credit/debit card payment D – GET NIC number  
 (3) A – DISPLAY existing bookings B – GET NIC number C – Complete user's credit/debit card payment D – GET date/time  
 (4) A – GET date/time B – DISPLAY existing bookings C – GET NIC number D – Complete user's credit/debit card payment  
 (5) A – GET NIC number B – DISPLAY existing bookings C – GET date/time D – Complete user's credit/debit card payment

30. Which of the following suggestions about the above system is **not** suitable?

- (1) The list of reservations for a given date should be provided when needed.  
 (2) Each time a student is making a reservation he/she should be required to enter his/her home address.  
 (3) It is suitable to check the validity of the NIC number.  
 (4) Reservations should not clash with school times.  
 (5) For fairness, the number of reservations that a particular NIC number is allowed per day should be limited.

[See page seven

31. Consider the following relation about a student who is registered in a programme at an institute:  
STUDENT(Sno, Snic, Sname, Sphone, Prog\_number)
- Note: Sno - the unique registration number of the student  
Snic - the national identity card number of the student  
Sname - the name of the student  
Sphone - a phone number of the student  
Prog\_number - the unique number of the programme for which the student has registered
- Which of the following are correct?
- A - Sno can be the primary key.  
B - Snic can be a candidate key.  
C - Prog\_number can be a foreign key.
- (1) A only (2) A and B only (3) A and C only  
(4) B and C only (5) All A, B and C
32. Which of the following are true?
- A - A table can have multiple candidate keys.  
B - A primary key is always a candidate key.  
C - A candidate key of one table can be used as a foreign key in another table.
- (1) A only (2) A and B only (3) A and C only  
(4) B and C only (5) All A, B and C
33. Which of the following are examples of *one-to-many relationships*?
- A - A customer can place many orders, but each order is placed by only one customer.  
B - An employee can be assigned to multiple projects, and each project can have multiple employees. ✗  
C - One department has one manager, and each manager manages multiple departments.  
D - A supplier can supply only one item and an item can be supplied by only one supplier.
- (1) A and B only (2) A and C only (3) A and D only  
(4) B and C only (5) C and D only
34. Match the Normal forms labelled from 0 to 3 to the corresponding Descriptions labelled from A to D.
- | Normal form            |
|------------------------|
| 0 - Zero normal form   |
| 1 - First normal form  |
| 2 - Second normal form |
| 3 - Third normal form  |
- | Description                   |
|-------------------------------|
| A. single valued attributes   |
| B. full functional dependency |
| C. repeating data             |
| D. transitive dependency      |
- (1) 0 - A, 1 - B, 2 - C, 3 - D  
(2) 0 - A, 1 - C, 2 - B, 3 - D  
(3) 0 - B, 1 - C, 2 - A, 3 - D  
(4) 0 - C, 1 - A, 2 - D, 3 - B  
(5) 0 - D, 1 - B, 2 - C, 3 - A
35. What is the primary purpose of database *normalization*?
- (1) eliminating data redundancy and anomalies  
(2) increasing the number of tables in the database  
(3) organizing data into logical structures and relationships  
(4) simplifying database queries  
(5) speeding-up database queries

36. Which of the following will change all occurrences of 'Mahawa' in the 'City' attribute of USER in relation to 'Maho'?

- (1) MODIFY USER SET City = 'Maho' WHERE City = 'Mahawa';  
 (2) MODIFY USER SET City = 'Mahawa' INTO City = 'Maho';  
 (3) UPDATE USER SET City = 'Mahawa' INTO City = 'Maho';  
 (4) UPDATE USER SET City = 'Maho' WHERE City = 'Mahawa';  
 (5) UPDATE USER SET City = 'Maho' WHERE City != 'Mahawa';

37. Which of the following lists the given SQL statement clauses in the correct order?

- (1) SELECT, FROM, WHERE, GROUP BY, HAVING  
 (2) SELECT, GROUP BY, HAVING, FROM, WHERE  
 (3) SELECT, HAVING, FROM, WHERE, GROUP BY  
 (4) SELECT, WHERE, GROUP BY, HAVING, FROM  
 (5) SELECT, WHERE, HAVING, GROUP BY, FROM

38. What would be the execution output of the following Python code if a = 5, b = 3, c = 2 and d = 6?

```
x = (a - b) ** c + d % c
print(x)
```

- (1) -22            (2) 0            (3) 1            (4) 4            (5) 7

39. What is the execution output of the following Python code?

```
qns = ["a", "b"]
for x in range(1,3):
    for y in qns:
        print(x,y, end='')
```

- (1) 0 a 2 b            (2) 1 a 3 b            (3) 1 a 1 b 2 a 2 b  
 (4) 1 a 1 b 3 a 3 b            (5) 1 a 3 a 1 b 3 b

40. What is the execution output of the following Python code?

```
def list_operation(nlist):
    for i in range(len(nlist)):
        if i % 2 == 0:
            nlist[i] = nlist[i] ** 2
        else:
            nlist[i] = nlist[i] + 3
    return nlist
numbers = [1, 2, 3, 4, 5]
output = list_operation(numbers)
print(output)
```

- (1) [1, 2, 3, 4, 5]            (2) [1, 5, 9, 7, 25]            (3) [2, 5, 6, 7, 10]  
 (4) [4, 4, 6, 16, 8]            (5) [4, 6, 16, 8, 36]

41. What is the execution output of the following Python code?

```
marks = [(1, "amara", 96), (2, "rajah", 34),
         (3, "rani", 49), (4, "fahim", 68)]

i = -1
while i < (len(marks) - 1):
    i += 1
    if marks[i][2] < 50:
        continue
    print(marks[i][1], end=" ")
```

- (1) 1 4            (2) 1 amara 4 fahim            (3) amara fahim  
 (4) rajah            (5) rajah rani

[See page nine]



47. Which of the following statements are correct regarding *website publishing*?

- A – One has to obtain a *domain name* to publish a website. ✓
- B – Before deciding to host a website on one's own computer, one has to do a good cost-benefit analysis on the same. ✓
- C – *Shared hosting* will provide faster access to the site's users all the time compared to either *Virtual Private Server (VPS) hosting* or *dedicated server hosting*. ✓

- (1) A only (2) A and B only (3) A and C only  
(4) B and C only (5) All A, B and C

48. Which of the following is correct?

- (1) Arduino Uno is the protocol used for setting up simple IoT applications. ✓
- (2) LDR and LED are sensors used in Arduino Uno based IoT applications.
- (3) Serial.begin(9600) provides a valid baud rate to initiate the serial communication between the Arduino Uno board and the computer.
- (4) Since Arduino Uno does not have a hard disk it is not subjected to unauthorized data access.
- (5) An ethernet shield must be connected to the four pins between A0 – A5 of the ATmega328P microcontroller.

49. Which of the following statements are true?

- A – Generative Artificial Intelligence (AI) tools can produce new content or data, according to their learned patterns. ✓
- B – The use of Generative AI tools such as GPT with user prompts is an example of machine-to-machine coexistence. ✓
- C – Although AI is used today, *strong AI* (machines possessing general intelligence and capabilities that are similar to human cognition) still remains a theoretical concept. ✓

- (1) A only (2) A and B only (3) A and C only  
(4) B and C only (5) All A, B and C

50. Consider the following statements P and Q:

- P – A *qubit* of a quantum computer can have a higher number of states than a bit of a traditional computer.
- Q – Quantum computing promises to perform calculations, currently beyond traditional computer's reach, at incredible speeds.

Which of the following is valid regarding the above two statements?

- (1) Both statements P and Q are correct and statement P gives the reason for statement Q.
- (2) Both statements P and Q are correct but the points presented in the two statements are not related.
- (3) Statement P is correct but statement Q is incorrect.
- (4) Statement P is incorrect but statement Q is correct.
- (5) Both statements P and Q are incorrect.

\*\*\*

සියලුම හිමිකම් ඇවිරිණි/முழுப் பதிப்புரிமையுடையது/All Rights Reserved]

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව  
 இலங்கைப் பரீட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம் இலங்கைப் பரීட்சைத் திணைக்களம்  
 Department of Examinations, Sri Lanka  
 ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව  
 இலங்கைப் பரීட்சைத் திணைக்களம்  
 Department of Examinations, Sri Lanka Department of Examinations, Sri Lanka

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2024  
 கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2024  
 General Certificate of Education (Adv. Level) Examination, 2024

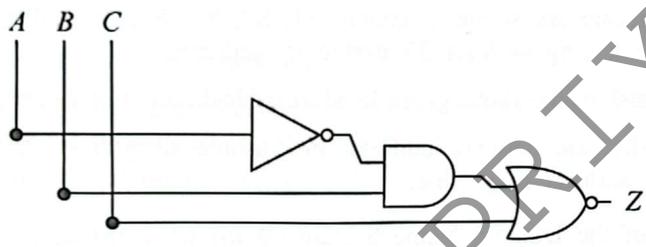
තොරතුරු හා සන්නිවේදන තාක්ෂණය II  
 தகவல், தொடர்பாடல் தொழினுட்பவியல் II  
 Information & Communication Technology II

20 E II

Part B

\* Answer any four questions only.

5. (a) Draw the complete truth table for the following circuit:



(02 marks)

(b) Write down the following Boolean expression in its simplest form.

$$(A + B) \cdot (A + \bar{B}) + A\bar{B}$$

(01 mark)

(c) In a circuit with three inputs A, B and C the output (Z) should be 1 when each of two or three inputs is 1. If none or only one of the inputs are 1 then the output should be 0.

(i) Draw the complete truth table for the above circuit. (02 marks)

(ii) Complete the Karnaugh map relevant to the above circuit according to the following format:

		AB			
		00	01	11	10
C	0				
	1				

(02 marks)

(iii) Using the Karnaugh map, derive the most simplified sum-of-products (SOP) expression for the output Z. Show the loops clearly on the Karnaugh map. (02 marks)

(iv) Draw a logic circuit for the most simplified expression derived in above (iii) by only using AND, NOT and OR gates. (01 mark)

(d) (i) Explain the use of a the half adder in digital circuits. (01 mark)

(ii) Describe how a flip-flop works as a memory element in digital circuits. Explain how it differs from combinational logic gates. (02 marks)

(iii) Draw the truth table for a full adder circuit. (02 marks)

6. (a) Draw a sketch to show how a computer and a printer should be connected in a *point-to-point topology* using a twisted pair Ethernet cable. (01 mark)
- (b) Consider a network consisting of two separate local area networks (LANs) of two departments A and B. Each department's LAN has four computers (named C1 to C4 in A, and C5 to C8 in B respectively). In addition, a common server (SVR) for the use of these two departments is also included.
- Draw the diagram of this network. Clearly indicate on it the network devices that are used to establish the two local area networks and to connect the entire network to the Internet. (01 mark)
  - Give the reasons for the placement of these devices in their respective locations. (01 mark)
  - Suppose a unit of data is being sent from C1 to C6. Indicate that data flow in the above network diagram using dotted lines. (01 mark)
- (c) Suppose an organization is assigned the 192.168.100.0/24 IP address block. Assume that the organization needs to create six subnets, namely S1, S2, S3, S4, S5 and S6 from this address block with each subnet having at least 25 usable IP addresses.
- Write the subnet mask of the above given IP address block in dotted decimal notation. (01 mark)
  - For each subnet, list the network address, first usable IP address, last usable IP address and the broadcast address in a table. (03 marks)
- (d) (i) What is the role of the Domain Name System (DNS) when the user enters a web address (e.g., *http://www.gmail.com*) into the URL field of a web browser? (01 mark)
- (ii) What is meant by the 'hierarchical and distributed structure' of the DNS? (02 marks)
- (e) Write down the name of the TCP/IP model layer responsible for each of the following tasks:
- maintaining a smooth connection between the application and the user
  - sending and receiving data in binary form
  - specifying the path that the data packets will use for transmission
  - dividing data into packets (02 marks)
- (f) Suppose Kamal wants to send the secret message ADD to Nimal. Kamal converts ADD to CEE before sending it to Nimal.
- Write down the encryption key used by Kamal in this communication. (01 mark)
  - If Nimal receives ECD from Kamal in a separate communication using the same security scheme, what is the original message from Kamal? (01 mark)



- (c) Consider a multi-agent system where agents (mobile robots) are designed to collaborate in a warehouse package moving task.

Each package is to be moved from its storage point (A) to its assigned delivery point (B) across the warehouse floor area. Each agent is tasked with moving the assigned goods from point A to point B in an optimum manner. Each agent has its own utility function that helps the agent to make optimum decisions based on the given set of parameters.

- (i) Highlighting the key characteristics, write down how the concept of 'agents' in this multi-agent system differs from a standard software program. (01 mark)
- (ii) Write down one **positive** (reward) and one **negative** (punishment) factor that could be considered in the utility function definitions of the agents (robots). (02 marks)

8. (a) Write the output of the Python code given in Figure 8.1.

```
def calculate(n):
    result = 0
    for i in range(1, n+1):
        for j in range(i):
            result += i * j
    return result

print(calculate(4))
```

**Figure 8.1**

(02 marks)

- (b) Figure 8.2 contains a labeled Python code to print the binary equivalent of an input decimal whole number. Write down the suitable replacements for the labels P–U to complete the code.

```
reversed_binary = ''

n = float(input("Enter a whole number: "))
if (n%1 != P):
    exit("Please enter a whole number.")
n = Q(n) #convert n to an integer
if (n == P):
    print(n)

while n >= 1:
    reversed_binary = reversed_binary + R (S)
    n = T

binary = U[::-1]
print(binary)
```

**Figure 8.2**

(03 marks)

- (c) There is a limit imposed on the maximum weight of an airline passenger's bag. Thus when a person is flying, s/he should select the items which are most important for him/her for the trip.

From three items, a labeled Python code written to help a person decide on the 'highest value' items that s/he should choose for a bag, is shown in Figure 8.3. The total weight of the bag should be within the airline's capacity limit for a bag which is 50 Kg. The weights, values and the names of the three items are in the relevant arrays. The output of the code is given in Figure 8.4.

```
def item_selector(remainder, weights, values, names):
```

```
    A = len(B)
```

```
    merged = [(values[i], weights[i], names[i], i) for i in range(n)]
```

```
    print("Merged:", merged)
```

```
    merged.sort(reverse=True, key=lambda x: x[0])
```

```
    print("Sorted records:", merged)
```

```
    res = ''
```

```
    for value, weight, name, index in merged:
```

```
        if remainder >= weight:
```

```
            C = D + name + ''
```

```
            E = F - G
```

```
    return res
```

```
# Input:
```

```
bag_capacity = 50
```

```
weights = [49, 10, 35]
```

```
values = [60, 100, 120]
```

```
names = ["Laptop", "Book", "Clothes"]
```

```
selected = H(bag_capacity, weights, values, names)
```

```
print("Selected items:", I)
```

Figure 8.3

```
Merged: [(60, 49, 'Laptop', 0), (100, 10, 'Book', 1), (120, 35, 'Clothes', 2)]
```

```
Sorted records: [(120, 35, 'Clothes', 2), (100, 10, 'Book', 1), (60, 49, 'Laptop', 0)]
```

```
Selected items: Clothes Book
```

Figure 8.4

- (i) Write down the suitable replacements for the **nine** labels (A-I) in the Python code given in Figure 8.3.

Notes:

- The Python sort() method could be used to sort a list.

*Syntax* : list.sort(reverse=True|False, key=myFunc)

- When 'reverse=True', the list is sorted into descending order.

- How the sorting is to be done could be indicated through the 'key'.

e.g., 'key=lambda x: x[0]' in the above code indicates that the sorting is to be done based on the numbers in the 'values' array. (09 marks)

- (ii) Describe the changes that should be done to the code to increase the number of items from three to five. (01 mark)

9. (a) Consider the following description relevant to a database that is to be developed for a fuel station to manage the details of customer transactions:

- Each customer [Customer] has a unique identifier [Cid], a name [Cname] (consisting of a first name [Cfname] and a surname [Csurname]) and a phone number [Cphone]. Each customer may have multiple phone numbers. Each customer owns [owns] one or more vehicles.
- Each vehicle [Vehicle] has a unique vehicle number [Vno] and a model [Vmodel]. Each vehicle is owned by only one customer.
- The fuel station sells several petrol types [Petrol]. Each petrol type has a unique Identifier [Pid] and a price per liter [Pprice].
- Different petrol types can be purchased for a vehicle [purchases], and each petrol type may be purchased for multiple vehicles.
- Each petrol purchase is recorded with a vehicle number [Vno], a petrol type identifier [Pid], the quantity of petrol sold [Qty] and the date of sale [Sdate].
- Each employee [Employee] has a unique number [Eno], a name [Ename], a position [Eposition] and a type [Etype] (which could be either full-time or part-time). An employee may sell [sells] multiple petrol types. Each petrol type can be sold by many employees.

(i) Draw an ER Diagram for this application showing the entities, attributes and relationships. Underline the key attributes. **Note:** Use **only** the terms given within square brackets in the above description for the entities, attributes and relationships. Use upper case letters for entities and relationships. (04 marks)

(ii) Write the relational schema for the ER diagram.

**Note:** List **only** the tables with their attribute names. Underline primary keys. Draw an arrow from each foreign key to the table it references with the arrow head pointing to the primary key of the referenced table. (04 marks)

(b) Consider the following **Result** table containing the details about students, their subjects, the teachers of those subjects, the exam dates and the marks.

<u>Student_ID</u>	<u>Student_Name</u>	<u>Subject_ID</u>	<u>Subject_Name</u>	<u>Teacher_ID</u>	<u>Teacher_Name</u>	<u>Exam_Date</u>	<u>Mark</u>
101	Arun	SU101	ICT	2001	Smith	2024-09-20	85
102	Kamal	SU102	Physics	2002	Johnson	2024-09-21	78
103	Fernando	SU101	ICT	2001	Smith	2024-09-20	90
104	Haran	SU103	Maths	2003	Williams	2024-09-19	88
105	Bob	SU101	ICT	2001	Smith	2024-09-20	65
101	Arun	SU102	Physics	2002	Johnson	2024-09-21	68
103	Fernando	SU103	Maths	2003	Williams	2024-09-19	76

(i) In which normal form does the **Result** table exist? Justify your answer. (02 marks)

(ii) Describe how you would convert the **Result** table to its next normal form. (02 marks)

(c) Consider the following **Product** table.

Product_No	Product_Type	Product_Name	Retail_Price	Wholesale_Price
P1	Food	Milk	850.00	800.00
P2	Food	Tea	825.00	815.00
P3	Food	Sugar	900.00	800.00
P4	Stationery	Book	700.00	650.00
P5	Stationery	Paper	725.00	700.00

(i) Write down the output of the following SQL statement:

```
SELECT Product_Name, Wholesale_Price
FROM Product
WHERE Retail_Price - Wholesale_Price > 50;
```

(01 mark)

(ii) Write the required SQL statement to insert the following record to the **Product** table:

Product_No	Product_Type	Product_Name	Retail_Price	Wholesale_Price
P6	Stationery	Bag	755.00	750.00

(01 mark)

(iii) Write down the SQL statement to display *Product\_Type*, *Product\_Name* and *Wholesale\_Price* of the products whose *Product\_Name* is not *Bag*. (01 mark)

10.(a) Consider the following python statement:

```
answer = height + width
```

There will be multiple binary instructions that the CPU will have to execute with respect to the above statement. The **first** is to load the value of variable 'height' into a register. The **fourth** would be to store the result of the addition in 'answer' variable.

What would be the **second** and **third** instructions?

(02 marks)

(b) Show that the answer for  $1100_2 - 1010_2$  could be obtained by adding the 2s complement of  $1010_2$  to  $1100_2$  and ignoring the carry. (03 marks)

(c) Amal starts a single processor computer and starts a *web browser*. After sometime he starts a *spreadsheet* application too on the same computer.

(i) **READY**, **RUNNING** and **BLOCKED** are three states of a process. When the operating system of the computer temporarily stops the above *web browser process* in order to let the *spreadsheet process* run on the processor, to which of the above three states will the *web browser process* transit? (01 mark)

(ii) Write down the **state transition** that the *web browser process* will undergo, when it has to wait for some data from the web server. (01 mark)

(iii) Explain the use of 'Program counter' of the *Process Control Blocks* during a *web browser process* → *spreadsheet process* context switch. (02 marks)

(d) A computer uses 16-bit virtual addresses. This computer has a 32 KB physical memory and a 4 KB page size.

(i) Write down the number of frames in physical memory. (01 mark)

(ii) A user runs a program having a size of 64 KB on this computer. A few selected fields of the first few rows of the *page table* of that process at a particular time are shown in the figure.

	Frame	Validity
0	111	1
1	100	1
2	110	1
3	101	1
4	000	0
5	000	0
6	000	0

Notes:

- The page number is used as the index into the page table.
- The frame number is indicated in binary. **Validity** bit being 1 indicates that the relevant page is in physical memory.

Assume that in the above process the virtual address 0010 0000 0000 0100 is wanted. Write down the 15-bit physical address that the above address would get mapped to.

(01 mark)

(iii) Assume that in the above process given in (ii), the virtual address 0100 0000 0000 0001 is wanted. Write down **one** reason why the operating system will not decide frame 011 of memory as the frame for that page. (01 mark)

(iv) In addition to the above fields of the page table, a **Modified** bit may also exist. It will be set to 1 when data in a page is changed. Why is that information important for the operating system? (01 mark)

(e) (i) The data of the *average.py* file is stored in blocks 100, 125, 150 and 175 on a disk that uses an *indexed allocation* scheme. In this allocation scheme, what important information is needed by the operating system to find the blocks of this file? (01 mark)

(ii) When *contiguous allocation* is compared with *indexed allocation*, which one can cause the *external fragmentation* of a disk? (01 mark)

\*\*\*