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 தரப்) 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**

පැය තුනයි
மூன்று மணித்தியாலம்
Three hours

අමතර කියවීම් කාලය - මිනිත්තු 10 යි
மேலதிக வாசிப்பு நேரம் - 10 நிமிடங்கள்
Additional Reading Time - **10 minutes**

Use additional reading time to go through the question paper, select the questions you will answer and decide which of them you will prioritise.

Index No: ....

Important:

* *This question paper consists of* **16** *pages.*

* *This question paper comprises of two parts,* **Part A** *and* **Part B.** *The time allotted for* **both parts** *is* **three hours.**

* *Use of calculators is* **not allowed**

PART A – Structured Essay:
(pages 2-8)

* *Answer* **all** *the questions* **on this paper itself.** *Write your answers in the space provided for each question. Note that the space provided is sufficient for your answers and that extensive answers are not expected.*

PART B – Essay:
(pages 9-16)

* *This part consists* **six** *questions, of which,* **four** *are to be answered. Use the papers supplied for this purpose.*

* *At the end of the time allotted for this paper, tie the* **two parts together** *so that* **Part A** *is* **on top** *of* **Part B** *before handing them over to the Supervisor.*

* *You are permitted to remove* **only** **Part B** *of the question paper from the Examination Hall.*

For Examiner's Use Only

For the Second Paper		
Part	**Question No.**	**Marks**
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
	8	
	9	
	10	
Total		

Final Marks

In numbers	
In words	

Code Number

Marking Examiner 1	
Marking Examiner 2	
Marks checked by :	
Supervised by :	

[See page two

Part A – Structured Essay
*Answer **all four** questions on this **paper itself***

1.(a) A form that a user can use to enter a complaint regarding a good or a service that he/she received is shown in Figure 1.1. The HTML source that was used to make the form is shown in Figure 1.2 with **seven** blanks (----------------------).

Central Province

Public concerns form

Concern

District: Kandy

Types: ○ Goods ○ Services

Description:

Complainant details

Name:

Email: Phone:

Submit

Central Province Consumer Affairs

Figure 1.1

(i) Fill the **seven** blanks of Figure 1.2 to make the code complete.

(04 *marks*)

```html
<html>
    <h1>Central Province</h1>
    <h2>Public concerns form</h2>
    <hr style="width:30%;text-align:left;margin-left:0">

      <form method="post" ------------------- ="./action_page.php">
      <h3>Concern</h3>
      <label for="district">District: </label>

      < ------------------- name="district" id="district">
          <option value="kandy">Kandy</option>
          <option value="matale">Matale</option>
          <option value="nuwaraeliya">Nuwara Eliya</option>

      < ------------------- ><br><br>
      <label for="ctype">Type:</label>

      <input type=" ------------------ " name="ctype" id="goods" value="goods">
      <label for="goods">Goods</label>

      <input type=" ------------------ " name="ctype" id="services" value="services">
      <label for="services">Services</label><br><br>

      <label for="description">Description:</label>
      <input type="text" name="description" size="25"><br><br>
    <hr style="width:30%;text-align:left;margin-left:0">

    <h3>Complainant details</h3>
      <label for="name">Name:</label>
      <input type="text" name="name"><br><br>
      <label for="email">Email:</label>
      <input type="email" name="email">
      <label for="phone">Phone:</label>
      <input type="tel" id="phone" name="phone" size="10" pattern="[0-9]{10}"
      title="Invalid telephone number"required><br><br>

      <input type=" ------------------ " value=" ------------------ ">
  </form>
  <br>
  <img src="flag.jpg" alt="Central province flag" width="50" height="40">
  <a href="http://www.cpca.lk" title="10, Hill street, Kandy">Central Province Consumer
  Affairs</a>
  </html>
```

Figure 1.2

(ii) What happens when the user presses the 'Submit' button on the form?

....

....

(01 *marks*)

(iii) What is the benefit of using *input type="email"* for the email address entry field instead of *input type="text"*?

....

....

(01 *marks*)

(iv) What can you guess about the purpose of *pattern="[0-9]{10}"* with respect to the Phone entry field?

....

....

(01 *marks*)

(v) What is the purpose of the use of *title="10, Hill street, Kandy"* in the *<img src* code line?

....

....

(01 *marks*)

(b) Explain the **main** purpose of the HTML code extract shown in Figure 1.3.

```php
<?php
  $host = "localhost";
  $db_user = "student_user";
  $db_password = "student_pass";
  $db_name = "studentDB";
  $conn = mysqli_connect ($host, $db_user, $db_password, $db_name);
  if (!$conn) {
    die("<tr><td colspan='3'>Connection failed:" .
    mysqli_connect_error () . "</td></tr>");
    }
  $sql = "SELECT student_id, first_name, last_name FROM stu-dents";
  $result = mysqli_query ($conn, $sql) ;
  if (mysqli_num_rows ($result) > 0) {
    while ($row = mysqli_fetch_assoc ($result) ) {
      echo "<tr>
            <td>" . $row["student_id"] . "</td>
            <td>" . $row["first_name"] . "</td>
            <td>" . $row["last_name"] . "</td>
            </tr>";
    }
  } else {
    echo "<tr><td colspan='3'>No students found .</td></tr>";
  }
  mysqli_close ($conn);
?>
```
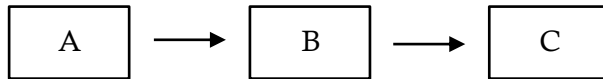
Figure 1.3

....

....

....

....

(02 *marks*)

2.(a)(i) Following diagram shows the *abstract model of information creation*:

```
┌─────┐      ┌─────┐      ┌─────┐
│  A  │ ───→ │  B  │ ───→ │  C  │
└─────┘      └─────┘      └─────┘
```

Identify the A, B and C above.

A : ………………….. B : ………………….. C : …………………..

(01 *marks*)

(ii) Write down the A, B and C components of the above model for each of the following online activities:

Activity 1 : Successfully logging in to your favourite online bookshop to buy stationery.

Activity 2 : Selecting the items to purchase and adding them to your shopping trolley.

Activity 3 : Successfully paying for your order using your debit card.

<u>Activity 1:</u>

A : ……………………………………………………………………………………………

B : ……………………………………………………………………………………………

C : ……………………………………………………………………………………………

<u>Activity 2:</u>

A : ……………………………………………………………………………………………

B : ……………………………………………………………………………………………

C : ……………………………………………………………………………………………

<u>Activity 3:</u>

A : ……………………………………………………………………………………………

B : ……………………………………………………………………………………………

C : ……………………………………………………………………………………………

(03 *marks*)

(iii) At a later date, after successfully logging in to this system to purchase the same **items**, you decide to use the 'Repeat Previous Order' option given at the site. Write down any changes to your answer for Activity 2 of part (ii) above.

<u>Activity 2:</u>

A : ……………………………………………………………………………………………

B : ……………………………………………………………………………………………

C : ……………………………………………………………………………………………

(01 *marks*)

(b) *Open source software* require the users to be technically skilled in setting up and configuring them. Briefly explain how the setting up and configuration are usually done in *proprietary software*.

....

....

....

(01 marks)

(c) While Information and Communication Technology (ICT) allows us to create and disseminate our intellectual ideas in more efficient and impactful ways, it also contributes to a higher level of plagiarism than in traditional (non-ICT) methods. Briefly explain the reason for this observation.

....

....

....

(01 marks)

(d) Some argue that the increasing use of Information and Communication Technology as an indirect contributor to global warming. Briefly explain a major reason for this view.

....

....

....

(01 marks)

(e) You browse an online product catalogue in an e-commerce website looking for a product purchase and the website collects your product browsing history without obtaining your consent. What is the security related concern that you face in this situation?

....

....

....

(01 marks)

(f) Fill the two blanks of the following statement:

In a reverse auction, from sellers and buyers, . ……………......... do the bidding and usually the ………………………… bid wins.

(01 marks)

3.(a) Draw a flow-chart to input the name of a text file and to count and print the number of words in that file. Assume that the file exists in the computer. (**Hint**: Go on reading each character in the file. Stop when EOF [end of file] character is encountered.)

(03 *marks*)

(b) Write down the output of the following Python code.

```python
def check_values (n) :
        result = []
        for i in range(1, n + 1):
                if i % 2 == 0 and i % 3 == 0:
                        result.append (i)
        return result
output = check_values (12)
print (output)
```

....

(02 *marks*)

(c) Fill the **five** blanks (----------------------) of the following Python code which has been written to find the prime numbers from 2 upto a given number.

Note: A prime number is any whole number greater than 1 that is divisible only by 1 and itself. e.g., Prime numbers from 2 up to number 5 are 2, 3 and 5.

```python
upper = _____ (input ('Enter end of range:'))
if upper > 1:
        print ("Prime numbers between 2 and ", upper, "are:")
        for num in range (2, _____ ) :
                for i in range (2, _____ ) :
                        if ( _____ ) == 0 :
                                _____
                else:
                        print (num)
```

(05 *marks*)

4.(a)   List in proper order, the **three** stages of the System Development Life Cycle (SDLC) covered by the Structured System Analysis and Design Methodology (SSADM).

(1) : ....

(2) : ....

(3) : ....

(01 *marks*)

(b)   Write down **one** benefit of *prototyping*.

....

....

....

....

(01 *marks*)

(c) (i) A guest billing system for a hotel is required. The following information is given by the hotel client to the system analyst.

The hotel has different types of rooms with different rates. Hotel also has a restaurant and a health center. A guest can take one or more rooms. Once a guest checks-in to the hotel all his transactions at the restaurant and the health center should be entered to the system. When the guest checks-out by giving his name, his final bill should be made considering his period of stay, rooms occupied and his transactions at the restaurant and the health center. When the guest is given the final bill, he makes the payment for which a receipt is given.

Draw the data flow diagram for the **check-out process in** the above description <u>containing only the following entity and processes</u> and <u>including the necessary data stores and data flows.</u>

Entity   : Guest
Process : 1. Prepare cost of rooms
         : 2. Make final bill
         : 3. Accept guest payment

(03 *marks*)

(ii) When making the final bill, a 10% service charge is added to the total amount that the guest has to pay. Write down the process description for '2. Make final bill'.

....

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(02 *marks*)

(d) Fill in the blank of the following statement:

*A good user interface makes it easy for a user to understand and …………………………………………
a system.*

(01 *marks*)

(e) Fill in the blank of the following statement:

*Pilot deployment is a/an ……………………….. scale implementation that is used to prove the
validity of a project idea.*

(f) A shop manager needs a stock control system. There are three options. He can either select and buy one from two off-the-shelf stock control systems (named A and B) or he can develop his own stock control system (named C).

The manager wants the final stock control system to contain two important features (named F1 and F2).

Suggest a method that the manager can use to choose one from A, B and C. (**Hint**: Give marks to each option.)

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(01 *marks*)

**

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:
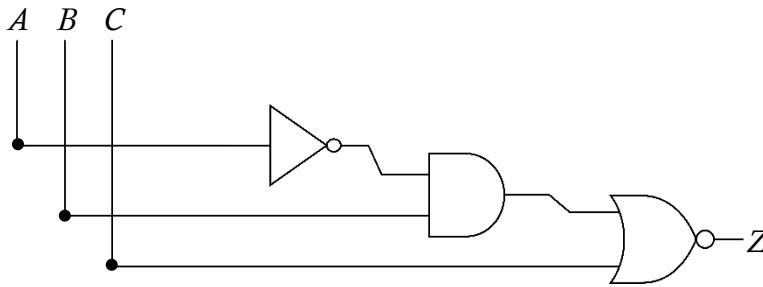
(02 *marks*)

(b) Write down the following Boolean expression in the 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:

(02 *marks*)

   (iii) Using the Karnaugh map, derive the most simplified sum-of-product (SOP) expression for the output Z. Show the loop 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 *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.

   (ii) 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*)

   (iii) Give the reasons for the placement of these devices in their respective locations. (01 *mark*)

   (iv) 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.

   (i) Write the subnet mask of the above given IP address block in dotted decimal notation. (01 *mark*)

   (ii) 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:

   (i) maintaining a smooth connection between the application and the user

   (ii) sending and receiving data in binary form

   (iii) specifying the path that the data packets will use for transmission

   (iv) 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.

   (i) Write down the encryption key used by Kamal in this communication. (01 *mark*)

   (ii) If Nimal receives ECD from Kamal in a separate communication using the same security scheme, what is the original message from Kamal? (01 *mark*)

7. (a) Figure 7.1 shows the Arduino circuit that Saman implemented to detect a door opening.
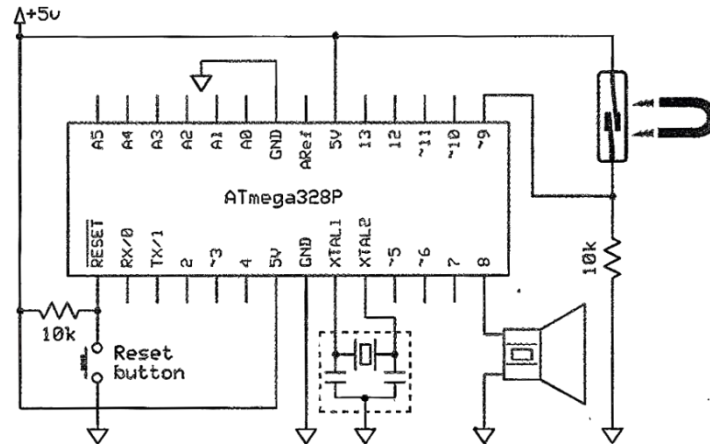
Figure 7.1

(i) Explain the behaviour and operation of the sensor used in this circuit. (02 *marks*)

(ii) To operate this setup Saman wrote the firmware code shown in Figure 7.2. However, the setup failed to operate as expected due to defects in the code. Write down the corrections that you would do to the code. (02 *marks*)

```
const  int  SensorP  =  9;
const  int  BuzzerP  =  8;

void  setup()  {
        pinMode  (SensorP,  INPUT);
        pinMode  (BuzzerP,  OUTPUT);
}
void  loop()  {
        int  senState  =  digitalRead(SensorP);
        if  (senState  ==  HIGH)
                tone(SensorP,262);
        else
                noTone(BuzzerP,0);
}
```

Figure 7.2

(iii) Saman hopes to extend this circuit to indicate the door openings only at night time. What does he need to modify in this circuit to add that feature? If any item(s) must be connected to the ATmega328P, indicate the relevant pin(s). (02 *marks*)

(b) *SuperMobile* is an online mobile phone shop where customers can purchase mobile phones through its *e-Commerce* site. *SuperMobile* uses the third-party courier service *DeliverToday* as its delivery partner. The customers who purchase mobile phones from *SuperMobile* become members of the loyalty program. They can upload their reviews, feedback, and creative content related to their mobile phone usage to the online site and receive beneficial loyalty points in return.

(i) Write down the e-Business transaction types that are possible with *SuperMobile*. (01 *mark*)

(ii) *SuperMobile* owners speculate that establishing their own delivery team for customer deliveries can be cost-effective and more profitable than using the *DeliverToday* service. Analyse this speculation by giving **one reason each** for and against this view.
(**Note:** Consider the financial aspects only.) (02 *marks*)

(iii) Mobile phones are not perishable and thus don't indicate expiry dates. However, they often have a finite shelf life beyond which the customers are reluctant to purchase them. Give a reason for this observation. (01 *mark*)

(iv) Suggest a suitable business strategy that *SuperMobile* can use **both** to reduce the environmental damage due to e-waste and also to increase its sales. (02 *marks*)

(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.

```python
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 [Csname]) 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 [Sqty] 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 the 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.

Student_ ID	Student_ Name	Subject_ ID	Subject_ Name	Teacher_ ID	Teacher_ Name	Exam_Date	Mark
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. (01 *mark*)

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

  (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 won't 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*)

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