Part B

1. Suppose a logic circuit needs to be implemented for a digital system that has three inputs A, B and C and one output Z. Its behaviour is as follows:
   - If the input C=1, the output Z has the value of A.
   - If the input C=0, then output Z has the value of B.
   (a) Obtain the truth table for the output Z.
   (b) Write down either a sum of products (SOP) or a product of sums (POS) Boolean expression for Z.
   (c) Simplify the Boolean expression for Z obtained in (b) above.
   (d) Using the simplified expression in (c) above, construct a logic circuit for the system using either 2-input NAND gates only or 2-input NOR gates only.

2. Consider the following scenario.
   The XYZ company has six departments, namely Production, Accounts, Sales, Administration, Maintenance and Information Technology Services (IT). The following table shows the number of computers available in each of the departments.

<table>
<thead>
<tr>
<th>Department No.</th>
<th>Department</th>
<th>Number of Computers</th>
</tr>
</thead>
<tbody>
<tr>
<td>D01</td>
<td>Production</td>
<td>25</td>
</tr>
<tr>
<td>D02</td>
<td>Accounts</td>
<td>30</td>
</tr>
<tr>
<td>D03</td>
<td>Sales</td>
<td>18</td>
</tr>
<tr>
<td>D04</td>
<td>Administration</td>
<td>30</td>
</tr>
<tr>
<td>D05</td>
<td>Maintenance</td>
<td>25</td>
</tr>
<tr>
<td>D06</td>
<td>IT Services</td>
<td>28</td>
</tr>
</tbody>
</table>

Each department needs to have their own local area network. Network administrator has received a class C IP address block 192.248.154.0/24. It is required to subnet the IP address block to satisfy the requirements of each department and allocate IP addresses to them.

(a) (i) How many addresses are available in the IP address block?
(ii) What are the first and the last addresses of the IP address block?
(iii) How many host bits are required to create the required subnets?
(iv) After subnetting, write the relevant network address, subnet mask and allocated range of IP addresses for each department.

Note: Use the following table format to present your answer.

<table>
<thead>
<tr>
<th>Department No</th>
<th>Network Address</th>
<th>Subnet Mask</th>
<th>IP Address Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>D01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D06</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(b) The XYZ Company links the five departments Production, Accounts, Sales, Administration and Maintenance to the IT Services department and connects those departments to the Internet through the IT Services department. The network has been completed by laying the cables and installing six switches, a router and a firewall. All six departments are situated in six separate buildings.

The administrator allows all subnets to access the Internet through a proxy server. The proxy server and the DNS server are located in the IT Services department.

Draw the labelled network diagram to show the logical arrangement of the computer network of the XYZ company by identifying suitable devices and required cables for all the locations.

(c) After setting up the network any employee of any department was able to access the URL http://www.nie.lk through a web browser in a computer in his/her department. However, one day an employee finds that he cannot access that website from a computer in his department. Write three possible reasons for the above problem.

3. (a) A business sells handicraft items such as wooden masks, handmade souvenirs, and batik and handloom cloths for tourists in a certain city of Sri Lanka. At present customers walk to the shop and buy goods with cash. The owner plans to start selling his products online through his own web portal.

(i) State the type of e-business model the owner plans to start.

(ii) Assume that a certain tourist hotel situated nearby is willing to publicize the planned online shop in their hotel web site.
   
   (1) What type of e-business model can be established in the above scenario between the handicraft business and the hotel?

   (2) Briefly explain one possible e-business revenue model each, for the hotel and the proposed online shop of the handicraft business.

(iii) State two methods that can be used by the planned e-business for processing online payments.

(iv) Briefly explain one e-marketing method that you would propose to attract customers to the planned e-business web portal.

(v) Explain how the user experience can be improved using intelligent agent technology in the planned e-business web portal

(b) Consider the following figure which shows a simplified view of a multi-agent system.

Answer the following question by studying the above figure.

"A software agent may or may not have a user interface".

Do you agree with the above statement? State a reason referring to the above figure.
4. (a) Assume an input which contains a sequence of positive numbers. The sequence has at most
100 numbers. If the input sequence has n numbers where n < 100, then the end of the
sequence is marked by making (n+1)th number -1.
For e.g., the following input sequence has 8 positive numbers, where the 9th input which is -1
marks the end.

23 12 54 76 89 22 44 65 -1

Draw a flowchart that represents an algorithm to output the largest number in a given sequence
of n positive numbers as described above.

(b) Consider the flowchart given below. The algorithm in the flowchart takes two inputs, the first
input L is a list of numbers, the second input K is a given number.

```
Start
Input List L
Input K

n = Length of L
i = 0

is L[i]=K ?

Yes
Output "True"

No
i = i + 1

is i < n ?

Yes

No
Output "False"

Stop
```

(i) What would be the output if the first input L was 23, 45, 32, 11, 67, 39, 92, 51, 74, 89 and
the second input K was 38?

(ii) Briefly explain the aim of this algorithm.

(iii) Develop a Python program to implement the algorithm in the flowchart.
5. The following two tables CLASS and STUDENT are constructed by using the Entity Relationship (ER) diagram shown in Figure.

**CLASS Table**

<table>
<thead>
<tr>
<th>ClassID</th>
<th>ClassName</th>
<th>ClassTeacher</th>
<th>Stream</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1111</td>
<td>12 - A</td>
<td>A. B. Perera</td>
<td>Physical Science</td>
<td>2017</td>
</tr>
<tr>
<td>1112</td>
<td>12 - B</td>
<td>N. Mohamed</td>
<td>Bio Science</td>
<td>2017</td>
</tr>
<tr>
<td>1113</td>
<td>13 - A</td>
<td>E. Selvadurai</td>
<td>Arts</td>
<td>2017</td>
</tr>
<tr>
<td>1114</td>
<td>13 - B</td>
<td>L. De Silva</td>
<td>Commerce</td>
<td>2018</td>
</tr>
</tbody>
</table>

**STUDENT Table**

<table>
<thead>
<tr>
<th>IndexNumber</th>
<th>ClassID</th>
<th>Initials</th>
<th>Surname</th>
<th>DateOfBirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>8991</td>
<td>1112</td>
<td>E.</td>
<td>Nazeer</td>
<td>1999.12.06</td>
</tr>
<tr>
<td>8993</td>
<td>1111</td>
<td>S.</td>
<td>Sivalingam</td>
<td>1999.02.06</td>
</tr>
<tr>
<td>8995</td>
<td>1112</td>
<td>W.</td>
<td>Fernando</td>
<td>1999.11.11</td>
</tr>
<tr>
<td>8997</td>
<td>1113</td>
<td>U. H.</td>
<td>De Silva</td>
<td>1999.08.06</td>
</tr>
</tbody>
</table>

(a) What is the cardinality of the relationship between the entities STUDENT and CLASS, denoted by A and B above? Note: Write down suitable labels for A and B, respectively.

(b) Explain how a relationship is established between the two tables using primary key(s) and foreign key(s) in the above example.

(c) (i) Are the two tables STUDENT and CLASS, in second normal form (2NF)? Explain a reason for your answer referring to tables.

(ii) Briefly explain one key advantage of normalization.

(d) Write an SQL statement to insert the following record to the CLASS table:

<table>
<thead>
<tr>
<th>ClassID</th>
<th>ClassName</th>
<th>ClassTeacher</th>
<th>Stream</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1115</td>
<td>13 - C</td>
<td>A.B. Jinasena</td>
<td>Technology</td>
<td>2018</td>
</tr>
</tbody>
</table>
6. (a) The school admission process of a certain country is explained using the description and the data flow diagram given below.

The applicant sends the application to the respective school. The school sends an acknowledgment to the applicant. The school then verifies the information in the application by checking the following.

- Eligibility of applicant: by using the eligibility criteria taken from the data store 'Eligibility Criteria'
- Registration in the electorate: by requesting the electoral list from the Election Authority (Election Authority sends the Electoral list to the school)
- Residential status: by requesting the confirmation of residence from the Divisional Secretariat (Divisional Secretariat sends the confirmation of residence to the school)

After verification of information, the applicant is informed whether the application has been accepted or rejected which is noted in the application and stored in the data store "Applications". The school obtains the valid applications from the data store "Applications" and schedules the qualified applicants for interviews. Then it calls the applicants for interviews and sends the interview schedule to the Education Authority. The interview schedule is stored in the data store "Interview Schedule".

![Level 1 DFD Diagram](image)

The Level 1 Data Flow Diagram for the above scenario with some data flows labelled as A-E is given in figure. Identify and write down the relevant data flows against the labels A-E.
(b) (i) Briefly explain the key difference between functional and non-functional requirements as used in the system development life cycle.

(ii) The following list includes some functional and non-functional requirements of a proposed e-commerce web portal that plans to sell products on a catalogue:

A – Enable user to find products based on a variety of item characteristics
B – The system should work on any web browser
C – The system should be easy to use
D – Enable user to submit his/her comments on products and read other users’ comments on items
E – Data in the system should be preserved even in the case of a system failure
F – Enable user to create and maintain a wish list of desired products
G – Enable user to browse through products on catalogue
H – The system should be available for use 24 hours a day, 7 days a week and 365 days a year
I – The system should authenticate users through usernames and passwords
J – The system should have versions customized for global users, e.g., French, Japanese, German, etc.

Identify and write down the labels of the non-functional requirements in (i) - (j).

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