1 As part of the Smart Nation initiative, the Singapore Government leverages technology to provide online citizen-related services.

These digital services abide by the existing Personal Data Protection Act (PDPA) which restricts the sharing of personal data between Government agencies. This may result in the users having to provide their personal information repeatedly whenever they access the agencies' portals. They may also be required to submit physical documents for verification.

To enhance the users' experience for these online services, the Government intends to roll out a new web application service, *MyData*, that enables citizens and residents to manage the use of their personal data for simpler online transactions.

MyData will store and manage all the personal data in a common back-end system for the Government agencies to retrieve while users perform online transactions.

The users can update their personal particulars, control how their data are to be used and choose to be notified of any transaction on *MyData*.

The project team from the Government Technology Agency (GovTech) is tasked to design and implement *MyData*.

(a) **(i)** Describe the purpose of a project proposal. [2]

(ii) In the project proposal, a section is dedicated to the problem statement which discusses the benefits brought about by the proposed *MyData*.

State two other **topics** that you are expected to find in this project proposal. [2]

The initial work of the project team involves an investigation process.

(b) Describe two examples of people whom the team consulted. For each example, state:

- the fact finding technique used
- the nature of the information that the team obtained.

Each fact finding technique should be different. [4]

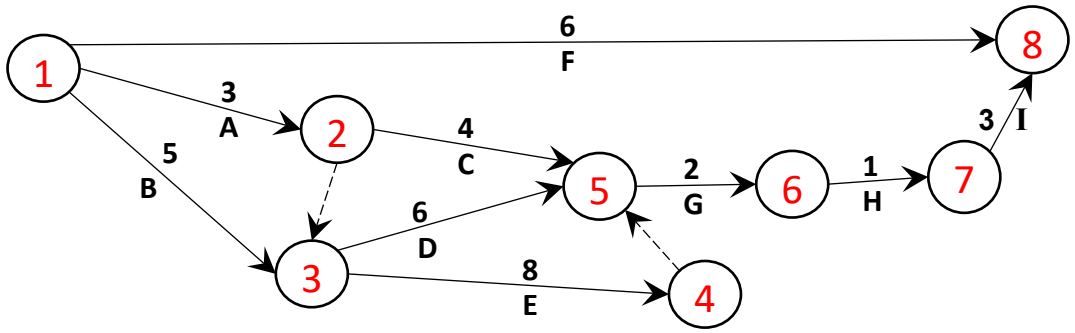
(c) A member of the project team had the task of ensuring that social and ethical issues were considered.

Describe one example of each of these issues that this member of the team might have considered. [4]

Following the investigation, the system analyst draws up the following activities which make up the system development cycle:

Activity	Activity Description	Time (weeks)
A	Design of database	3
B	Design of web interface	5
C	Transfer of data from files into database	4
D	Initial testing	6
E	Development	8
F	Documentation	6
G	Alpha testing	2
H	Acceptance testing	1
I	Implementation	3

The project manager produces the following Program Evaluation and Review Technique (PERT) chart from the activity table.



(d) **(i)** State and explain the significance of the dashed lines. [2]

(ii) State the critical path. [1]

(iii) State the minimum time in which the project could be completed. [1]

The Gantt chart below is based on the information in **part (d)**.

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A - Design of database																				
B - Design of web interface																				
C - Transfer file to database																				
D - Initial testing																				
E - Development																				
F - Documentation																				
G - Alpha testing																				
H - Acceptance testing																				
I - Implementation																				

(e) **(i)** The timing of three activities is missing and also the timing of one of the activities shown is incorrect.

Draw a sketch of the Gantt chart to show the correct version. [4]

(ii) Explain how the Gantt chart can help the software developers in carrying out their work. [2]

Testing is conducted during Activity **D** to assess the behaviour of *MyData* for the immediate retrieval of personal particulars by government agencies. Upon query, personal particulars of a user are released immediately to the agencies if the user's consent is given and the user is not classified as a special case. If the user's consent is not given, the transaction will be denied. If the user is classified as a special case, approval is needed. *MyData* will also assess the nature of the digital services and will only release data immediately if these services are classified as basic, else, approval would be needed.

(f) **(i)** Create a decision table showing all the possible conditions and actions. [4]

(ii) Simplify your decision table by removing redundancies. [2]

The following paragraph regarding the privacy policy is to be included on the website:

"To safeguard your personal data, all electronic storage and transmission of personal data are secured with appropriate security technologies. The Website may contain links to sites whose data protection and privacy practices may differ from ours. We are not responsible for the content and privacy practices of these other websites and encourage you to consult the privacy notices of those sites."

(g) **(i)** Describe two suitable security measures that could be adopted. [4]

(ii) Explain why it is important for users to consult the privacy policy before transacting at any website. [2]

(h) After the system is implemented, maintenance will be required.

Name and describe two types of maintenance. For each type, give an example for *MyData*. [6]

2 SkyBnB is a company that rents apartments to customers for lodging during their vacations.

Customers usually pay a deposit when booking an apartment before their vacation, and the balance amount will be paid one week before the start of the rental. Each apartment has a unique identification number (ID) and the rental rate depends on the type of apartment.

At the time of booking, the company records the following data:

- customer name and email address, if the customer has not made a booking before
- customer ID
- booking date
- check-in date
- check-out date
- apartment ID
- type of apartment
- deposit paid

The apartment types are coded as follows:

- Small apartment – SA
- Large apartment – LA
- Deluxe apartment – DA

Customers may make more than one booking.

The document below is an example of an invoice emailed to the customer after they have paid the deposit.

INVOICE

Annabelle Dallas
annabelledallas@gmail.com

Customer ID:	SB31245
Booking Date:	15/05/2019
Apartment ID:	YIJC123
Apartment Type:	DA

Check-in date	Check-out date	Nights charged	Rate	Total
20/06/2019	24/06/2019	4	$110.55	$442.20
			Deposit Paid:	$100.00
			Amount Due:	$342.20

(a) The company wants to model this application using a relational database.

(i) A database needs a number of tables to store the data for this application.

Draw an Entity-Relationship (E-R) diagram showing the tables and the relationships between them. [6]

(ii) A table description can be expressed as:

`TableName (Attribute1, Attribute2, Attribute3,...)`

The primary key is indicated by underlining one or more attributes. Foreign keys are indicated using a dashed underline.

Write table descriptions for the tables you identified in **part (i).** [6]

(b) The company implements the relational database using a Database Management System (DBMS) and develops an application for recording a new booking.

Describe three validation checks that the booking form could use. [3]

3 **(a)** Explain what is meant by *an object* in object-oriented programming. [2]

A linked list is an Abstract Data Type (ADT) that holds a collection of nodes that are linked together via pointers and these nodes can only be accessed in a sequential way. Linked list does not provide random access to a node. A linked list contains an array of `Node` objects, and a start pointer, `StartPtr` which gives the index of the starting `Node` in the array. There are operations to insert a new node, delete an existing node, display contents of the Node array and traverse through the linked list.

A Stack ADT is a Last-in-First-Out (LIFO) data structure that have operators `push` and `pop` to insert and remove an item from the stack respectively.

A Queue ADT is a First-in-First-Out (FIFO) data structure that contains a `Head` pointer and a `Tail` pointer which give the index of the starting and the index of the ending `Node` in the array respectively. The ADT has operations `enqueue` and `dequeue` to insert a new node to the tail and remove an item from the head of the queue respectively.

The linked list, stack and queue data structure can be implemented using object-oriented programming language.

(b) **(i)** Draw a class diagram, with base class `LINKEDLIST`, showing the following:

- appropriate sub-class(es)
- inheritance
- properties required
- associated methods [6]

(ii) Explain why inheritance is an important feature of object-oriented programming. [2]

4 A university intranet can be accessed by all students, both locally and remotely, via the Internet. The network administrator has installed a firewall in the intranet.

(a) Describe two benefits that the intranet might provide for the students. [2]

(b) Describe one threat and how it could compromise the university servers. Explain how the servers and the data stored on them could be protected and identify any limitation of the protection. [4]

(c) Most of the students save their work in their laptops. Identify two possible dangers which may lead to the accidental loss of data in the local drives. Describe appropriate strategies to prevent such situations. [4]

(d) The existing network infrastructure is due for replacement and the University plans to provide cloud-based services to the students. Describe three benefits and two risks to the University if the cloud-based approach is adopted. [5]

5 **(a)** The pseudocode for a sorting algorithm is given as follows:

```
01    FOR k ← 1 TO ArraySize
02        MinIndex ← k
03        FOR j ← k+1 TO ArraySize
04            IF Array[MinIndex] > Array[j]
05                THEN
06                    MinIndex ← j
07            ENDIF
08        ENDFOR j
09        Temp ← Array[k]
10        Array[k] ← Array[MinIndex]
11        Array[MinIndex] ← Temp
12    ENDFOR k
13    OUTPUT "The sorted array is ", Array
```

(i) Complete the trace table provided. [4]

(ii) State and explain the order of growth for this sorting algorithm. [2]

(iii) Explain whether this sorting algorithm is stable. [1]

(b) **(i)** Write the pseudocode for the insertion sort algorithm. [5]

(ii) Arrange the array `[12,11,13,5,6]` in an ascending order using the insertion sort algorithm. Write down the array after performing each swap in the algorithm. [3]

6 Singapore celebrated her 54th National Day this year and the greeting "**Happy 54th Birthday**" was transmitted very frequently through digital messages and information on webpages. They are transmitted as 0's and 1's in the digital world of binary codes.

Copy **only the rows with empty cells** and fill in the correct values. [5]

Character	ASCII Code	Binary	Hexadecimal
H		01001000	
a	097	01100001	61
p	112	01110000	70
p	112	01110000	70
y	121	01111001	79
<space>	032	00100000	20
5	053		
4			
t	116	01110100	74
h	104	01101000	68
<space>	032	00100000	20
B	066		42
i			
r			72
t	116	01110100	74
h	104	01101000	68
d			64
a	097	01100001	61
y	121	01111001	79

~ END OF PAPER ~