4. A block of flats has several software-controlled lifts to access all eight floors of the building. Users of the lifts have complained about waiting times. The developers of the existing control software have been asked to update the software to reduce waiting times for lift users.

  (a)   (i)   Time estimates for the analysis and design stages of this project are listed below:

- carry out feasibility study — 2 days
- produce requirements specification — 3 days
- design of data structures — 2 days
- design of software logic — 4 days.

        Both stages of design should take place at the same time.

        Draw a Gantt chart for the analysis and design stages of the project.   **2**

    (ii)   Explain why economic and technical feasibility must be considered before proceeding with any project.   **2**

  (b)   Lifts in the building may be descending, ascending or stationary. In the example below, Lift 1 is ascending, Lift 3 and Lift 4 are descending and Lift 2 is stationary.

	Lift 1	Lift 2	Lift 3	Lift 4
7th Floor				
6th Floor				
5th Floor	A		D	
4th Floor				
3rd Floor				
2nd Floor				D
1st Floor				
Ground		S		

A = Ascending

D = Descending

S = Stationary

One possible implementation of the updated control software would make use of a 2-D array.

    (i)   Using a programming language of your choice, declare a 2-D array called `lifts` to store the lift details.   **2**

    (ii)   Write code to assign the lifts to the four locations indicated above.   **1**

[Turn over

4. (b) (continued)

(iii) Code will be used to find the nearest lift for any floor whenever the up or down button is pressed by the user.

The user inputs will be stored in two variables, `floor` and `direction`. Details of these variables are provided in the table below.

Variable Name	Possible Values	Purpose
floor	0 to 7	indicates floor user is on when the button is pressed
direction	UP or DOWN	indicates whether the user wants to go up or down

The software will calculate how far away all suitable lifts are from the user's floor and store these results in a 1-D array called `distance`. Unsuitable lifts will be assigned the value 99.

Using the lift details in part (b), when a user on the third floor presses the DOWN button the following logic is applied.

Lift	Suitability	Reason	Assigned value
1	Unsuitable	above the user and travelling upwards	99
2	Suitable	three floors below the user and stationary	−3
3	Suitable	two floors above the user and descending	2
4	Unsuitable	below the user and travelling downwards	99

These results would be stored in a 1-D array called `distance`, as shown below.

distance	99	−3	2	99

Using pseudocode, design an algorithm to calculate and store the correct results in the `distance` array for a single user, on any floor, travelling in either direction. **4**

(iv) Using pseudocode, design an algorithm that will find and display the number of the nearest lift using the values in the `distance` array. **2**

(c) Describe the difference between usability testing with prototypes and end-user testing. **2**