

# **THE BCS PROFESSIONAL EXAMINATION**

## **BCS Level 5 Diploma in IT**

**March 2017**

### **Systems Analysis and Design**

#### **EXAMINERS' REPORT**

##### **Case Study for both Sections A and B - Medical Appointments System**

More than 2000 patients are registered with a local health centre. The centre employs a number of general practitioners (i.e. doctors) and a few receptionists. Patients are officially registered with one doctor but can arrange appointments with any available one. These appointments may subsequently be cancelled. Some appointments result in one or more prescriptions.

New patients are registered by a receptionist. When a patient is registered he/she provides his/her details such as name, date of birth, address, etc., and receives a unique patient number.

To book an appointment a patient should contact a receptionist. The patient provides his/her number (or date of birth) and the receptionist provides a list of available time slots for appointments. The appointment is booked with the patient's doctor or if the patient's doctor is not available with any available doctor. The date and time of the booked appointment are given to the patient as a confirmation.

Patients can cancel booked appointments by contacting a receptionist who will cancel appointments on behalf of patients.

A patient who attends an appointment should check in first using a special terminal located in the waiting area of the Health Centre. The patient inputs his/her number (or date of birth). The system checks the details and confirms that the patient has been checked in.

Doctors record appointment outcomes and details of prescriptions (if any) during the appointments i.e. all prescriptions issued by doctors are recorded on the patient's record.

Patients who leave the area where the Health Centre is located are de-registered by receptionists.

#### **Section A**

##### **General Comments**

A reasonable range of marks for this section with most candidates obtaining a pass. None of the three questions attracted consistently low or high marks.

##### **Question Number A1**

Learning Outcomes:

4. Use appropriate methods and techniques to produce an analysis of a given scenario
6. Provide suitable documentation for systems analysis and design activities.

### Question

- a) Produce a context diagram of the Medical Appointments system described in the scenario above.

(6 marks)

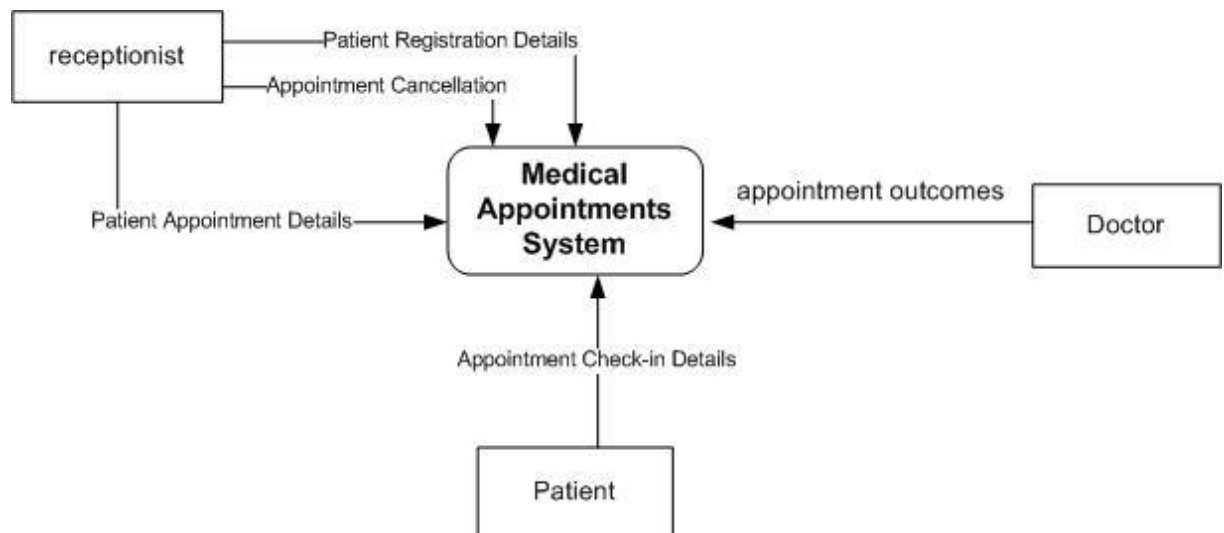
- b) Produce a logical top level data flow diagram of the Medical Appointments system.

(19 marks).

### Answer Pointers

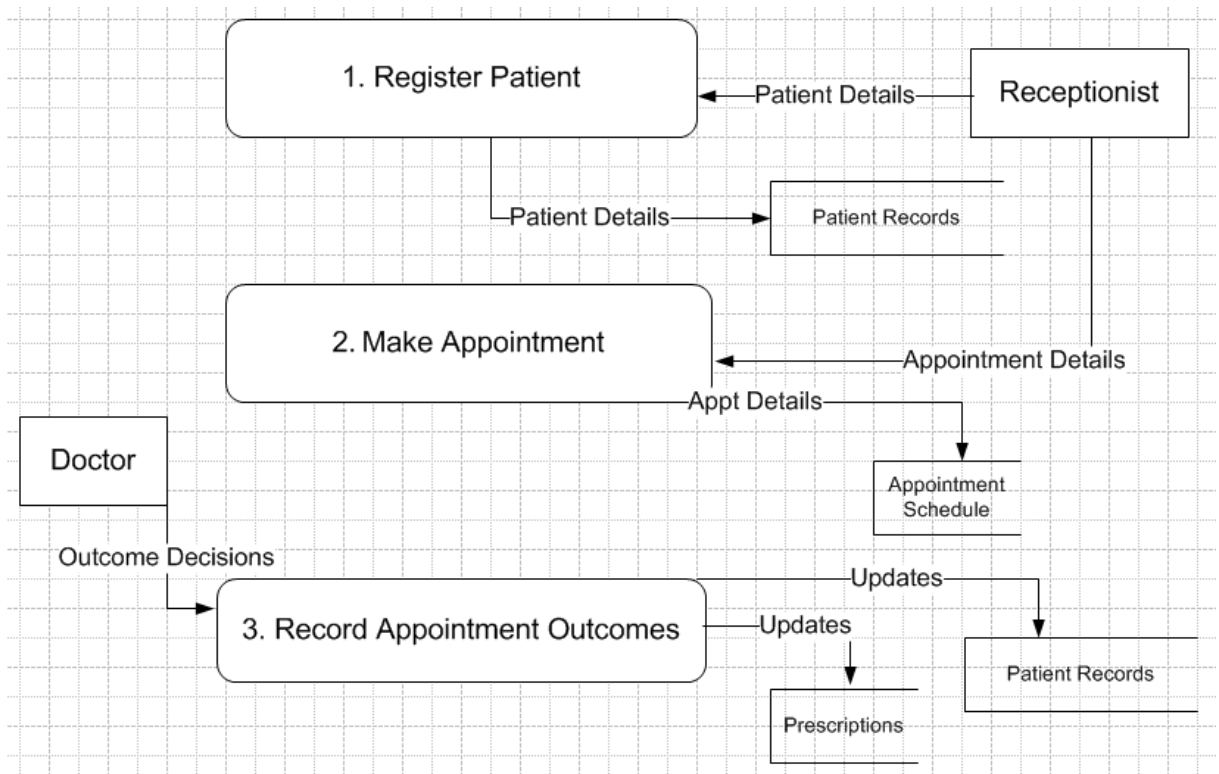
a)

The context diagram should represent the system as a single process with all external entities and dataflows in and out of the system identified.

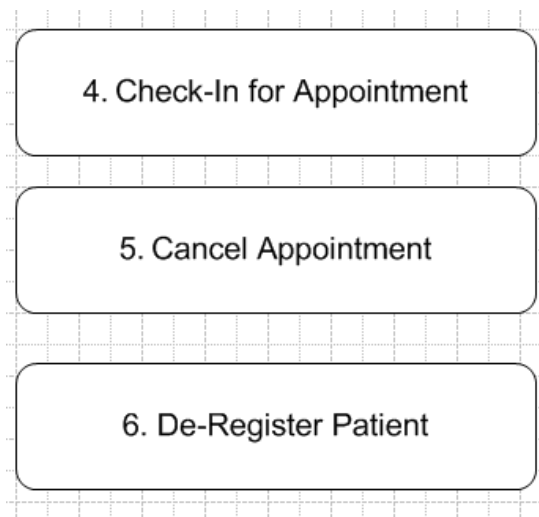


b)

The top level dataflow diagram needs to show how the dataflows in the context diagram are dealt with inside the system. The processes in this diagram might be explained in more detailed lower level diagrams so they do not need to be functionally cohesive. Three of the processes are identified in the following diagram:



A complete solution would have to include the following processes too:



### Examiners' Guidance Notes

This question was attempted by 62% of candidates, most of whom obtained a pass mark for the question. The average mark for this being 13/25. Most answers for part (a) were quite good but a significant number of candidates did not attempt this part or attempted it by presenting something other than a context diagram – usually some type of activity diagram. Since many of these candidates made a good job of Part B the problem seems to be that they simply did not recognise the term “context diagram”. In Part B a significant minority of candidates made the mistake of representing some dataflows as processes usually connecting process boxes that look more like data stores.

## Question Number A2

Learning Outcomes:

2. Discuss various approaches to systems analysis and design and explain their strengths and weaknesses.
3. Evaluate the tools and techniques of systems analysis and design that may be used in a given context.

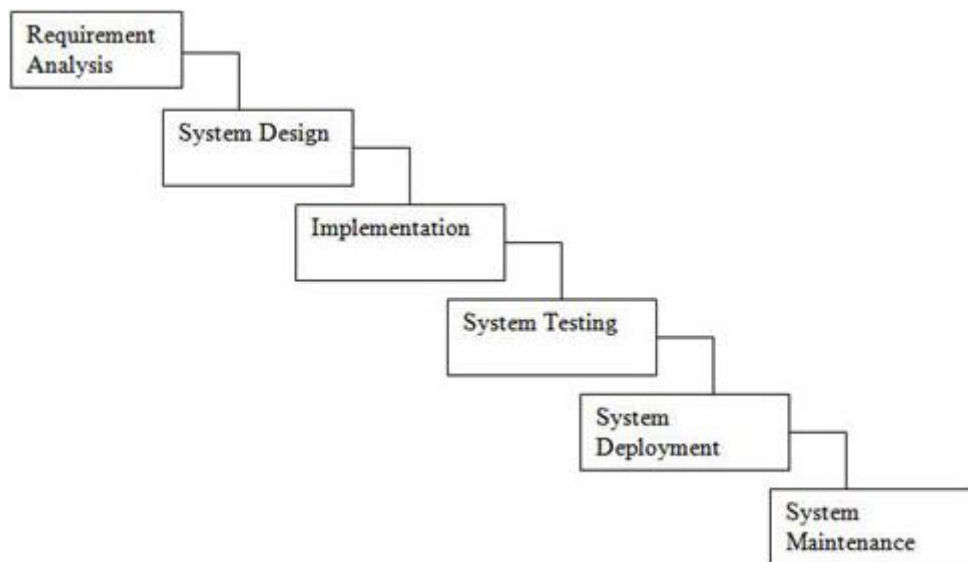
### Question

- a) Explain the difference between a waterfall and an iterative/incremental System Development Life Cycle (SDLC). Illustrate your answer with diagrams. **(15 marks)**
- b) Which approach would you recommend for developing the system for a medical appointments similar to the one described in the case study above? Justify your recommendation. **(10 marks)**

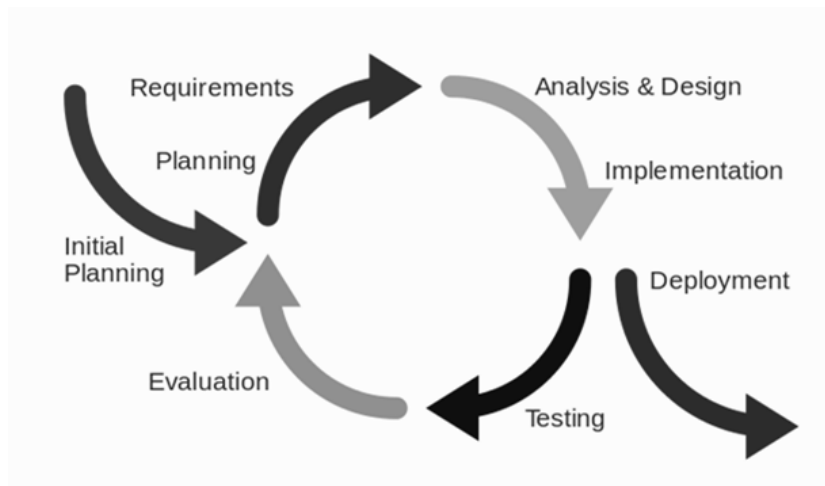
### Answer Pointers

a)

A suitable diagram for the Waterfall model might look like this:



The following diagram captures the idea behind iterative approaches:



**b)**

It is most common to choose the iterative approach because of its greater flexibility and the way it fits with prototyping which would surely be appropriate in this context. Some candidates might suggest the Waterfall model because the requirements are unambiguous and unlikely to change. Either answer provided it is well-defended was accepted.

### **Examiners' Guidance Notes**

This question was attempted by 70% of candidates, most of whom obtained a pass mark for the question. The average mark was 15/25. In part (a) most candidates provided a clear explanation of the waterfall model with a suitable diagram but far fewer were able to explain the iterative/incremental lifecycle. A significant number of candidates did not present a diagram for the iterative/incremental approach and many talked vaguely about the approach being "agile" without explaining how iteration and incremental delivery relate to agility. The answers to part (b) were generally good although it was surprising to see that many recommended the waterfall model (usually because the requirements of the case study were judged to be clear) rather than favouring the more modern approach.

### **Question Number A3**

Learning Outcomes:

2.4 Categorisation of requirements including the difference between function and quality requirements.

2.5 Gap analysis.

a) A company has decided to purchase 'off the shelf' (OTS) software to handle the financial aspects of its business. Describe at least 10 general criteria that should be used to decide which OTS software applications are suitable for the company.

**(19 marks)**

b) If no OTS software can be found that exactly matches the required criteria, what other options does the company have to obtain suitable software?

**(6 marks)**

## Answer Pointers

a)

A range of criteria could be given in response to this question – the examiner used discretion in deciding how relevant the criteria. Broadly speaking they were expected to fall under the following headings. The questions associated with each heading are examples of appropriate criteria:

**Does the package meet our current requirements:** How much configuration / customisation would be required and how easy would this be to do? Would the software require us to make changes to our existing business processes?

**Does it meet our future requirements:** Will the package meet requirements that we can anticipate having in the future?

**Implementability:** What platform does the package require? Will we be able to integrate it with our existing systems?

**Support:** What is available in terms of training? Consulting? Documentation? Community? How stable is the supplier?

**Cost:** How much will it cost to implement (license, hosting, customisation), maintain, upgrade, modify?

**Deliverability:** Will customisation be done through APIs (good) or will it need to be done by modifying the source code (bad)? How difficult is it to test the package (especially in an automated fashion)?

b)

These options relate to bespoke software which may be developed in-house or contracted out. Some candidates also considered the use of Open Source solutions as an alternative to the use of commercial packages.

## Examiners' Guidance Notes

This question was attempted by 53% of candidates, most of whom obtained a high mark for the question. The average mark being 17/25. Most candidates were able to provide 10 appropriate criteria for Part A – with many candidates providing more than 10. The answers to Part B were generally good too with candidates considering various means of developing bespoke software.

## Section B

### General Comments

Questions 4 and 5 were much more popular than Question 6. The best results were achieved for Question 4. The Question 5 and Question 6 results were substantially worse.

### Question Number 4

Learning outcomes:

5. Use appropriate methods and techniques to produce a design for a given scenario
6. Provide suitable documentation for systems analysis and design activities

## Question

- a) This question refers to the case study described above – the Medical Appointments system. The table below shows an example of a list of appointments arranged with doctors.

<b>Doctor no.: 1</b>	Doctor name: Smith J	Doctor room no.: G5			
	Appointment code: 2016/702	Appointment date: 2/9/16	Appointment time: 10.20	Patient No.: 217	Patient name: Jones J
	Appointment code: 2016/717	Appointment date: 3/9/16	Appointment time: 9.40	Patient No.: 357	Patient name: Patel J
		.....	.....	....	.....
<b>Doctor no.: 3</b>	Doctor name: Mills D	Doctor room no.: G2			
	Appointment code: 2016/726	Appointment date: 3/9/16	Appointment time: 13.40	Patient No.: 87	Patient name: Brown G
		.....	....	....	
<b>Doctor no.:4</b>	Doctor name: Fitzgerald J	Doctor room no.: G3			
	Appointment code: 2016/705	Appointment date: 2/9/16	Appointment time: 11.20	Patient No.: 412	Patient name: Wilson P
		.....	.....	.....	.....
		.....	.....	.....	.....

Normalise the table to produce a set of relations in the third normal form (3NF). You must show all of your working explaining each step. **(16 marks)**

- b) Draw an entity relationship diagram (ERD) based on the relations produced in part (a). **(9 marks)**

## Answer Pointers/Model answer

a)

The steps of normalisation are shown below:

UNF	1NF	2NF	3NF	Relations
Doctor no. Doctor name Doctor room no.  Appointment code Appointment date Appointment time Appointment detail	<u>Doctor no.</u> Doctor name Doctor room no.  <u>Doctor no.</u> <u>Appointment code</u> Appointment date	<u>Doctor no.</u> Doctor name Doctor room no.  <u>Doctor no.</u> <u>Appointment code</u>	<u>Doctor no.</u> Doctor name Doctor room no.  <u>Doctor no.</u> <u>Appointment code</u>	Doctor       Appointment/D octor

Patient No. Patient name	Appointment time Appointment detail Patient No. Patient name	<u>Appointment code</u> Appointment date Appointment time Appointment detail Patient No. Patient name	<u>Appointment code</u> Appointment date Appointment time Appointment detail Patient No.*  <u>Patient No.</u> Patient name	Appointment       Patient
-----------------------------	---	--	---	--

For correct 1NF with explanation (remove repeating groups) **4 marks**

For correct 2NF with explanation (remove part key dependencies) **4 marks**

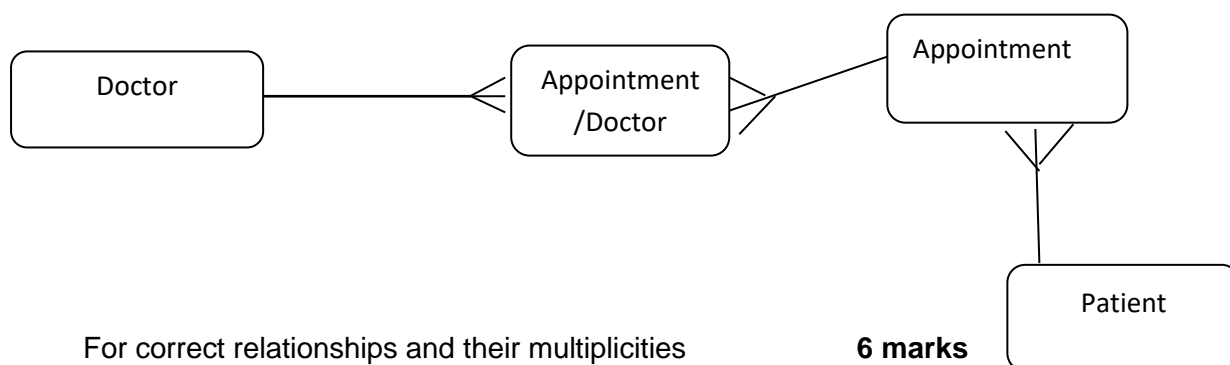
For correct 3NF with explanation (remove non-key dependencies) **4 marks**

For correct relations

**4 marks**

**Question 4a - 16 marks**

**b)**



For correct relationships and their multiplicities  
For correct entities

**6 marks**

**3 marks**

**Question 4b – 9 marks**

### Examiners' Guidance Notes

Nearly 92% of candidates attempted this question and the majority of them achieved a pass mark for their answers. Many answers for part (a) were good and the majority of candidates were able to practically demonstrate the normalisation process. Some candidates however did not provide proper explanations. Part (b) was answered generally well. Some candidates had problems with relationships (with cardinalities of relationships in particular). Some candidates produced ERDs which were inconsistent with the normalised relations/tables.



## Question Number 5

Learning outcomes:

2. Discuss various approaches to systems analysis and design and explain their strengths and weaknesses.
5. Use appropriate methods and techniques to produce a design for a given scenario
6. Provide suitable documentation for systems analysis and design activities

### Question

- a) Consider the following extra information about the Medical Appointments system described above:

“There are two types of patients: fully registered patients and visiting patients. The following data should be stored about each fully registered patient: *Patient no.*, *Patient name*, *Patient address*, *Patient date of birth*, *Patient tel no.*, The attributes of each visiting patient are: *Patient name*, *Patient address*, *Patient date of birth*, *Patient doctor details*.

An object of class Prescription consists of a Header, a number prescription lines, a doctor's signature”

Explain the following relationships between classes using examples from the Medical Appointments system to illustrate your answers:

- (i) Association,
- (ii) Aggregation or Composition, and
- (iii) Generalisation/Inheritance.

The examples should show relevant fragments of a class diagram **(15 marks).**

- b) Explain briefly how you would map an inheritance hierarchy in a class diagram to relational database tables. Consider THREE possible approaches. **(10 marks)**

### Answer Pointers/Model answer

a)

Explanation of association **2 marks**

Example of association (e.g. between Patient and Appointment) **3 marks**

Explanation of aggregation **2 marks**

Example of aggregation (e.g. object of class

Prescription ‘consists’ of Header, iteration of prescription lines, signature)

**3 marks**

Explanation of inheritance/generalization

**2 marks**

Example of inheritance/generalization (e.g. Patient– superclass with two subclasses: Fully Registered and Visiting)

**3 marks**

Proper class diagrams fragments should be drawn.

**Question 5a – 15 marks**

**b)**

There are three approaches to mapping:

- Only the superclass is implemented as a table. Attributes of subclasses become attributes of the superclass table and have null values when they are not used. This approach is in particular useful when subclasses differ from their superclass more in behaviour (operations) than in attributes.
- Only the subclasses are implemented as tables. The attributes of the superclass are kept in the subclass tables. This works if the superclass is *abstract* (i.e. there are no instances of it).
- All the classes (both the subclasses and the superclass) are implemented as separate tables. To retrieve the data for a subclass, both its own table and the table of its superclass must be accessed.

**Question 5b – 10 marks**

**Examiners' Guidance Notes**

This question was attempted by appr. 87% of candidates. Part (a) was answered reasonably well. Some candidates however were unable to give proper and correct examples of relationships between classes. A small number of candidates also had problems with definitions/explanations of relationships between classes (association and aggregation in particular). Also a small number of candidates did not draw relevant fragments of class diagrams.

Part (b): Some candidates provided good answers, but there were also completely irrelevant answers. Generally, the results are below average.

**Question Number 6**

Learning outcomes:

3. Evaluate the tools and techniques of systems analysis and design that may be used in a given context.
5. Use appropriate methods and techniques to produce a design for a given scenario
6. Provide suitable documentation for systems analysis and design activities

## Question

- a) Give a brief explanation of 'object interaction and collaboration' in object-oriented systems.

Discuss the similarities and differences between sequence and communication/collaboration diagrams. **(6 marks)**

- b) Produce a sequence diagram for the use case 'Check in' in the Medical Appointments system described above. A brief description of this use case is given below.

*"The patient enters his/her date of birth. The system searches the patient's and appointment's details and displays the patient's name, the appointment details (date, time) and the doctor's details (name, room no.)."*

**(10 marks)**

- c) Produce a state machine/chart for the class Appointment in the Medical Appointments system described above. You may assume that objects of this class are affected by the following 'events' (listed below in alphabetical order):

- archive an appointment – to remove an appointment from the system
- arrange an appointment -to create a new appointment
- check in for an appointment
- complete an appointment – for a doctor to record any information about completed appointment

**(9 marks)**

## Answer Pointers/Model answer

a)

Proper and brief explanation of the meaning of object interaction and collaboration.

**2 marks**

At least two similarities should be identified.

**2 marks**

At least two differences should be identified.

**2 marks**

**Question 6a – 6 marks**

b)

The sequence diagram should have the following elements:

Actor – Patient

**2 marks**

Classes/Objects: Appointment, Patient, Doctor

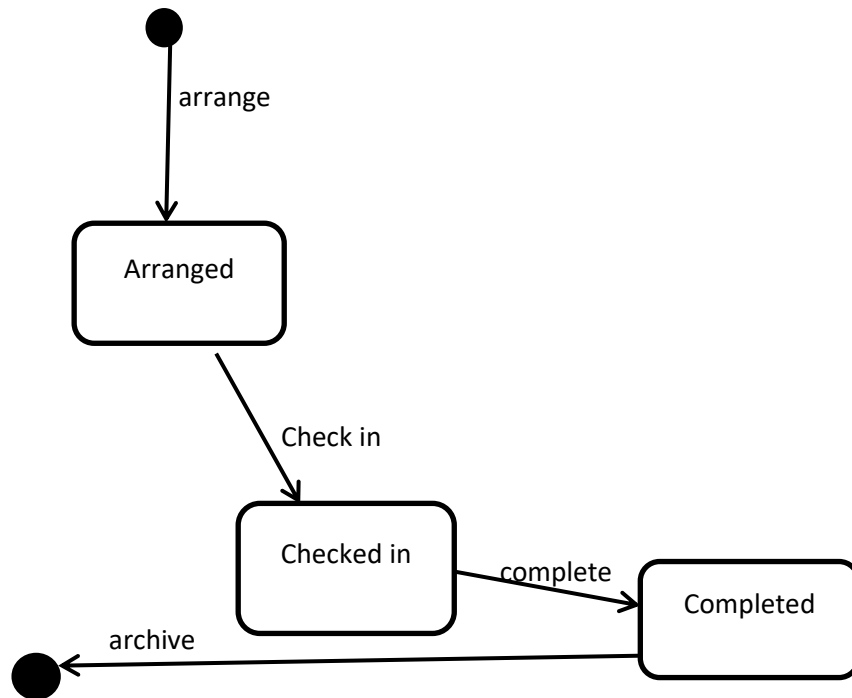
**4 marks**

Right messages/operations

**4 marks**

**Question 6b – 10 marks**

c)



correct state nodes  
initial and final states  
correct transitions

**3 marks**  
**2 marks**  
**4 marks**  
**Question 6c- 9 marks**

### Examiners' Guidance Notes

Only a small number of candidates ( 26%) attempted this question, and the results are worse than the results of Question 4. Part (a) was answered reasonably well. Most candidates who answered part (b) identified the right actor, but only a few candidates identified the right classes/objects and messages. Part (c) : a substantial number of candidates produced reasonable state charts/state machines.