



Systems Modelling Techniques using UML

Sample Exam Questions

Sample Examination Questions

The following exam scenario and questions have been prepared to give you practice in tackling typical exam-style questions.

A question has been prepared for each possible exam topic with content and marking similar to that topic in a real exam. For this reason the scenario below is a bit longer than you might expect in the real exam, since only 3 of the topics are usually examined in any 1 exam.

The 3 topics examined are *usually* a Use Case question, a Domain Class Model question and 1 of either an Activity Diagram, a State Machine or an Interaction Diagram. However please note any combination of techniques is permitted within the confines of the syllabus.

The real exam will have 50 marks available with 25 marks as the pass mark. Obviously the marking points shown below add up to more than 50.

The exam is open book. At the start of the exam you are given 15 minutes to read the scenario and questions, during which time you may not write at all or highlight any material. You will then have 60 mins to complete the exam questions.

Scenario

TravelTrades.com

Many airline, train and cruise companies (“Travel Providers”) have a policy whereby bookings that have been booked and purchased cannot be cancelled and refunded, although the names of the passengers and certain other details can be changed for a fee. Of course many travellers buy insurance to cover certain contingencies, but the insurance is expensive and doesn’t cover all eventualities.

Bearing all this in mind an established travel agency, Exdepia, has decided to trial a website dedicated to the trade through resale of travel bookings that cannot be refunded. The website will be known as ***TravelTrades.com (TT)***.

A web development software house has been engaged to write the software, and will use standard web development tools wherever possible. The software will be entirely self-contained, accessed over the internet, and will be hosted by Exdepia’s usual service provider. A business analyst working for the software house on this project has gathered initial information from the sponsor, which is summarised as follows.

The website puts together sellers and purchasers of travel bookings for flights, train journeys and cruises which cannot be refunded. The bookings, which may be for 1 or more passengers, are expected to be offered at less than 50% of their original purchase price. Such bookings must allow changes of name, dates and ports of departure and arrival – usually there is a charge levied for this by the original travel provider. This charge must be quoted in the data related to the booking offer, and the cost will be borne by the purchaser. All bookings must be ‘e-bookings’ i.e. no physical documents are issued by the provider, so that the traveller has to print them to undertake the journey. There is always a unique booking code that identifies the original booking with the travel provider.

If a traveller wishes to re-sell their booking, they must first register their details on the site, which signs them up for the service. They are then able to advertise their booking, by creating a ‘booking offer’ advertisement in the format provided by the website. The booking offer is considered ‘Active’ at this point.

The basic selling service is free, but there will be a premium service for which there will be a charge. The premium service positions the advert above others, and pushes the advert periodically to social media and bulletin boards. A seller can upgrade their account at any time.

As long as a trade is not in progress, a seller can suspend a booking offer, in which case the offer is not visible to any potential purchasers. A suspended booking offer can be re-instated at any time.

Persons looking for bookings to buy do not have to register themselves initially, but can search the website freely for suitable booking offers. Once they find a suitable booking offer, they can make an offer to buy the booking, but in that case they must first register as a purchaser with the website, if they haven't already done so.

The seller's booking on offer will contain 1 or more journey legs. Each journey leg is for 1 named person and has a date of travel from 1 specific port to another specific port. The offer must be purchased as 1 'job lot' and can't be broken up.

A couple of other features are contemplated, but might not make it into the first release:

- The current Exdepia booking agents will have their own access to the system as booking offers may be of use to their clients. They will have the same access as a 'normal' booking purchaser, but could have additional facilities, yet to be defined.
- The site will offer registration for a tax refund service, for those sellers whose bookings have expired because the journey date has passed. The tax refund process itself is out of scope.

Making a Trade

Once a purchaser has made an offer for a booking, which includes recording a bid price, a trade is created in a provisional state, and the rest of the trade will be conducted as follows.

The seller is contacted by an automated email from TT, triggered by the purchaser's bid. If they wish to accept the offer price, they will reply to TT, via a link, with further booking details, in particular the booking reference number from the original travel provider. The seller is not obliged to sell if the bid price is below the posted price. Once the offer has been accepted though, the booking offer is reserved and must not be offered elsewhere, unless the trade falls through for some reason.

If the seller does not respond within 48 hours, or rejects the bid, the trade is automatically cancelled, and the system notifies both parties by email. Otherwise a TT agent will attempt to confirm the trade by checking out the details of the booking on the original travel provider's website, and if everything seems as advertised on TT, an email will be generated to the purchaser requesting the transfer of the agreed purchase price to a TT account. The trade itself will be marked as 'in progress'. If the details don't check out the trade is cancelled by the TT Agent and the parties are advised by email.

If the funds are not remitted within 48 hours, the trade is to be cancelled automatically, and the system notifies each party of this fact. The details of cancelled trades should remain in the system for audit and statistical purposes.

The TT bank account will be set up to notify the system immediately when the purchaser funds have arrived. The trade is then completed automatically by sending the

travel provider and booking code information by email to the purchaser and remitting the purchase funds to the seller's nominated account, less a fixed charge and a 15% commission. The seller is advised by email that the trade is complete and therefore to expect the funds. It is then up to the purchaser to change the booking details, and pay the relevant fees. This will generate a revised booking code from the original provider, making the seller's original code invalid.

A booking offer subject to a completed trade will remain visible on the site to the seller, but not to purchasers, with a status of 'traded'. It is thought that offers traded in this way should remain in the system for 2 years before being purged, along with all the related trade information. Active and Suspended booking offers are purged automatically, with any trades' information, when their first journey date is passed, unless the seller has registered for the tax refund service.

Annex A

Short Use Case Description for '**Create Seller Booking Offer**'

Title: Create Seller Booking Offer

Description: As a Seller I want to create a Booking Offer that offers my travel booking open to bids from Purchasers.

Pre-conditions: Seller is logged in

Narrative:

1. Seller: selects option to 'Create Booking Offer'

System: shows Booking Offer creation form

2. while {journeys to register}

system: prompts for means of travel, journey date, from/to ports, number of pax

Seller: enters the information

System: validates the information entered, including ports

3. Seller: indicates no more journeys to register

System: displays data entered, prompts confirmation

4. Seller: confirms

System: prompts for an offer price

5. Seller: enters a price

System: prompts for final confirmation

6. Seller: confirms create offer

System: assigns unique offer ID and creates offer. Display offer summary with ID.

7. Seller: OK

System: ends Use Case

Sample Exam Questions

Question 1 (20 Marks)

Draw up a Use Case Diagram to summarise the functionality required from this new application. One Use Case should be '**Create Seller Booking Offer**'.

Each legitimate Use Case scores 1 Mark; each legitimate Actor scores ½ Mark.

In your answer show 1 example of either Actor Specialisation or Use Case specialisation. (1 Mark).

In your answer show 1 example of either an <<include>> or an <<extend>>. (1 Mark).

Question 2 (21 Marks)

Draw a Domain Class Diagram to capture the business information exposed in the scenario. The diagram should show domain classes, labelled associations between the classes and the multiplicity of each association. Attributes and operations are not required. Any m:n associations should be resolved.

One class on the diagram should be **Travel Booking Offer**, which is the concept of a seller's booking being offered for sale on the website via an advertising service.

Each legitimate Domain Class scores ½ Mark; each legitimate association scores ½ Mark, with an additional ½ Mark for an appropriate multiplicity.

In your answer show 1 example of a specialisation association (1 Mark) and 1 example of either a composition or an aggregation association (1 Mark).

You may make reasonable assumptions concerning multiplicities not explicit in the scenario.

Question 3 (15 Marks)

Draw an Activity Diagram to model the process whereby a trade is made and carried through between a Booking Offer purchaser and a Booking Offer seller. You may make any reasonable assumptions, but only attempt to model the information given explicitly in the scenario.

Partitions are not required in this diagram and only model the actions to be undertaken by TT agents and the new system. Object Flows are not required.

Question 4 (14 Marks)

Draw a State Machine to model the lifecycle of a **Travel Booking Offer** that is traded on this website. Identify suitable states that would be necessary to control a typical object of this class, based on the scenario, making any reasonable assumptions.

Question 5 (12 Marks)

You are given a short Use Case Description for '**Create Seller Booking Offer**' (Annex A).

Draw up a Use Case Realisation diagram for this Use Case, using a UML Sequence Diagram.

You should use only Actor, Boundary, Control and Entity Objects in this diagram, and ensure the Entity objects correspond to classes mentioned in your Domain Model, created in a previous question.

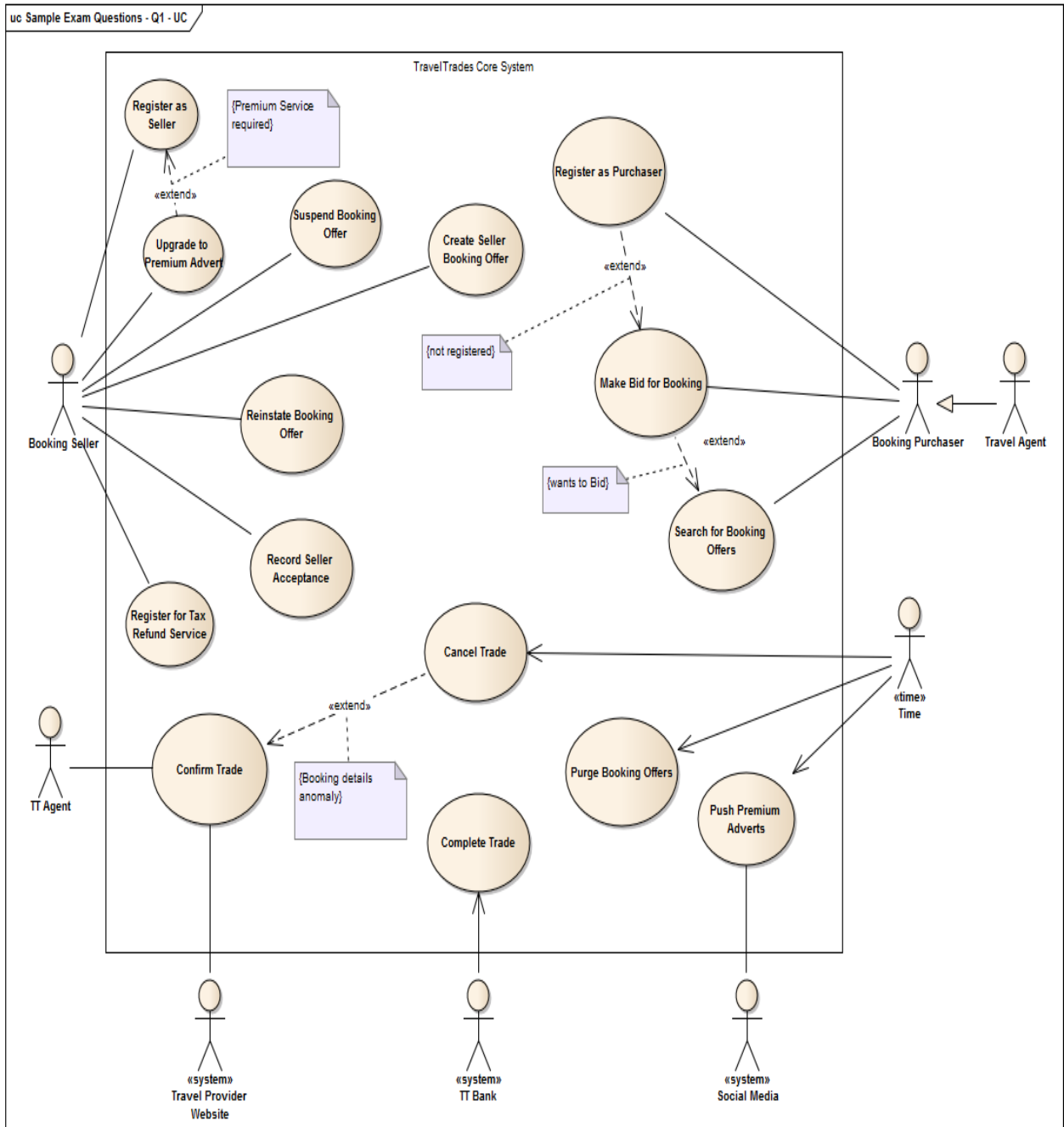
Question 6 (10 Marks)

The exam may contain an Activity Diagram question applying the technique in support of a Use Case rather than a business process.

You are given a short Use Case Description for '**Create Seller Booking Offer**' (Annex A).

Draw an Activity Diagram to represent the logic of the processing implied by the Use Case. The diagram should include a partition for the Primary Actor and another for the 'system'.

Sample Exam Paper Q1 - UCD - Sample Answer



Marking Guidelines

1 mark for each Use Case correctly identified from the scenario, labelled with a verb-noun phrase (14 Marks only – 1 Use Case has been given to the candidate in the question).

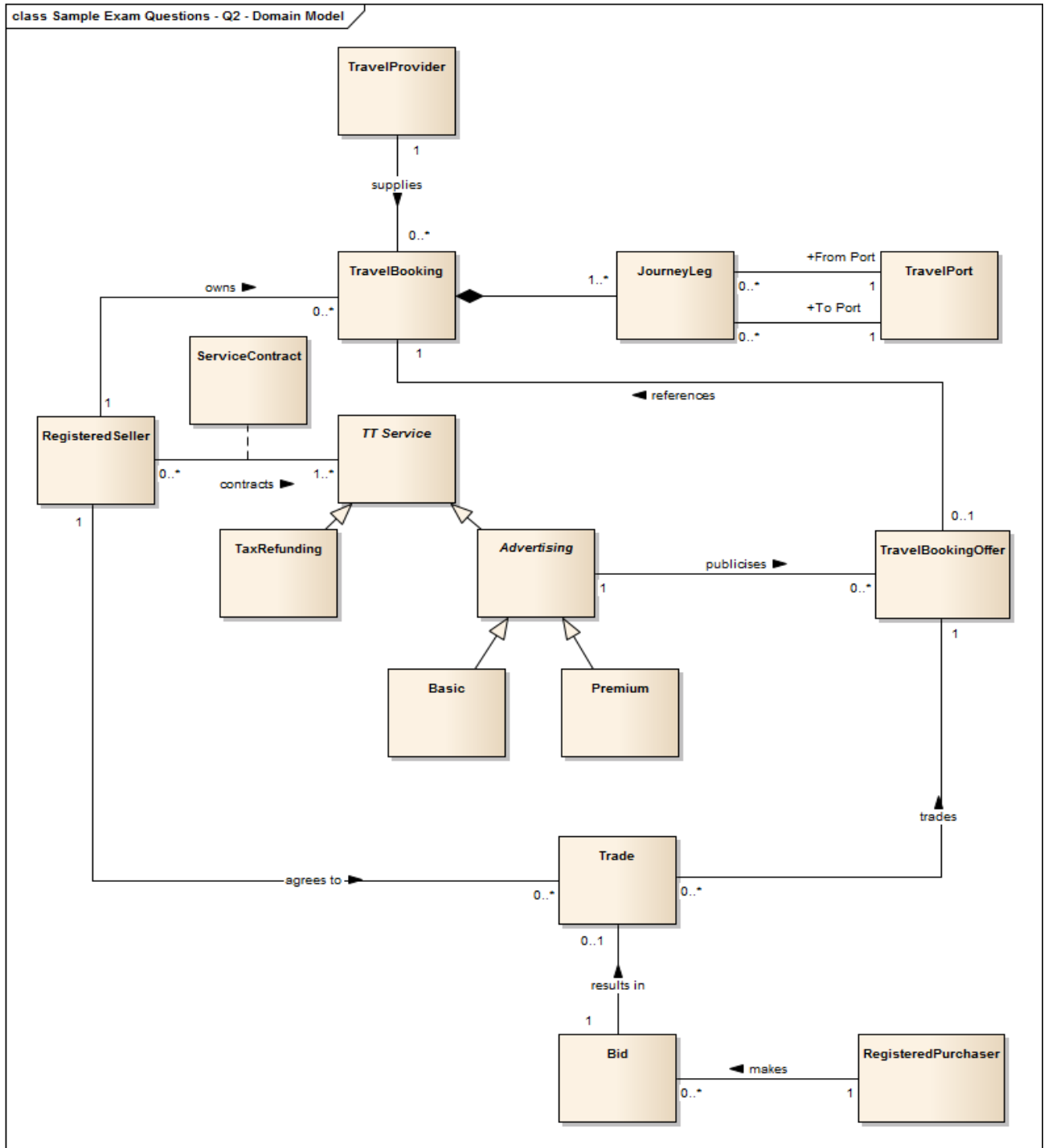
½ mark for each Actor correctly identified from the scenario (4 Marks). The marks may only be awarded if the Actor associations with the Use Cases, as identified by the candidate, are complete, correct and supported in the scenario.

1 Mark for a valid example of an <<include>> or <<extend>> supported by the information in the scenario.

1 Mark for a valid example of Actor or Use Case specialisation supported by the information in the scenario.

20 Marks

Sample Exam Paper Q2 – DCM - Sample Answer



Marking Guidelines

½ Mark for each Class identified. (7 Marks – 1 class is given to the candidate).

½ Mark for each appropriately labelled association between classes, **excluding** composition and inheritance associations. The association class link is excluded too. Additional ½ Mark if the multiplicities are appropriate (some flexibility allowed here).
Max 11 Marks.

1 Mark for representing the specialisation of the *TT Service* concept accurately.

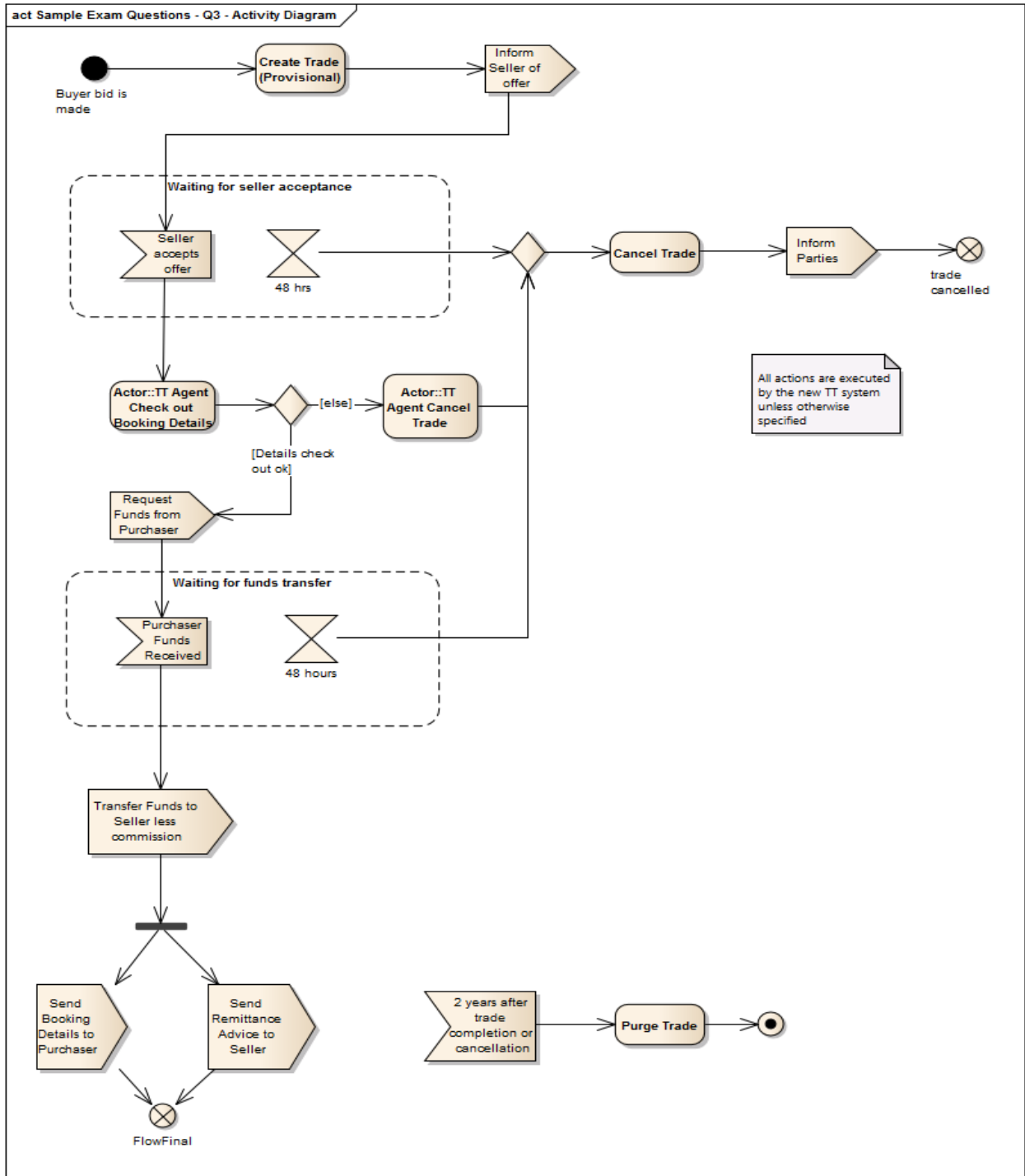
1 Mark for the composition association *Travel Booking* -> *Journey Leg*.

1 Mark (in Total) for the roles 'from Port' and 'to Port'.

NB: the association class *Service Contract* may be represented as the same (or a similar) class with 2 x 1:m associations.

21 Marks in total

Sample Exam Paper Q3 - AD - Sample Answer



Marking Guidelines

Start with 2 Marks and deduce $\frac{1}{2}$ Mark for each significant logic error (i.e. logic incompatible with the scenario description). Min 0 Marks.

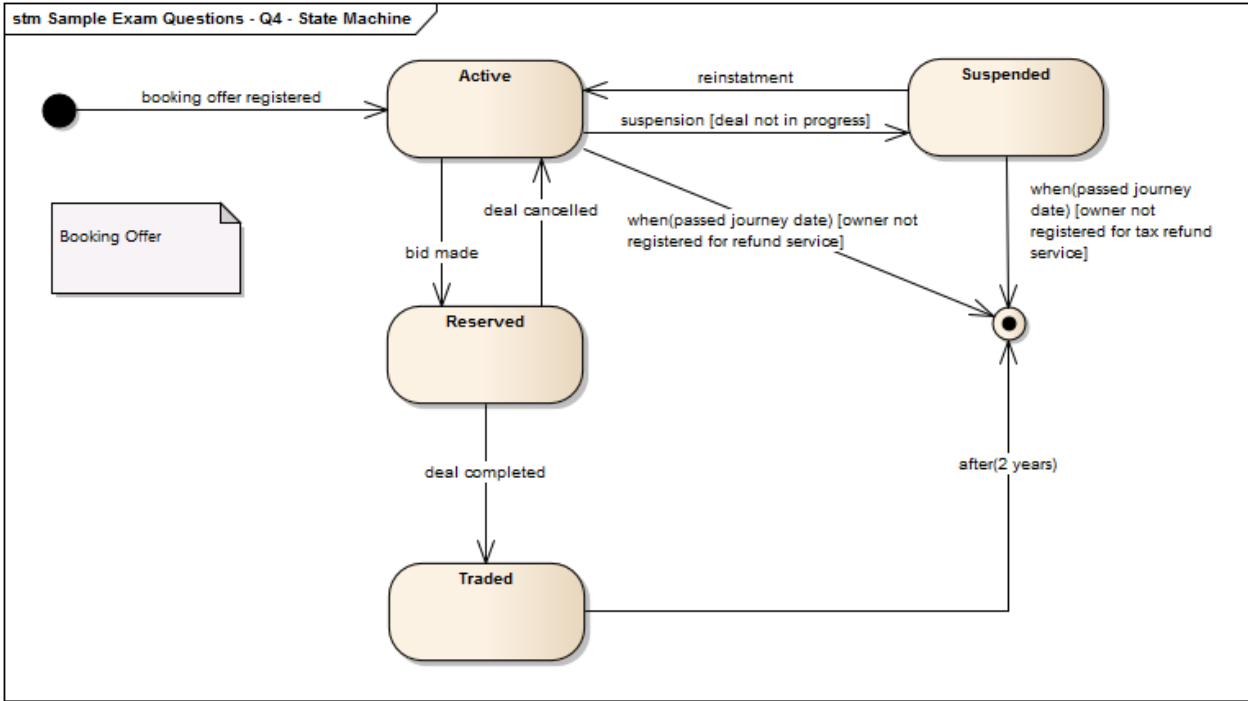
$\frac{1}{2}$ Mark for each control node: initial, flow final, activity final, fork and join, merge and decision. $8 \times \frac{1}{2}$ Mark = 4 Marks. To gain the marks the syntax of the symbol must have been applied correctly.

$\frac{1}{2}$ Mark for each action node: action/activity, signal send/receive, timer. $16 \times \frac{1}{2} = 8$ Marks. To gain the marks the syntax of the symbol must have been applied correctly.

$\frac{1}{2}$ Mark for each interruptable region = 1 Mark

15 Marks

Sample Exam Paper Q4 - SM - Sample Answer



Marking Scheme

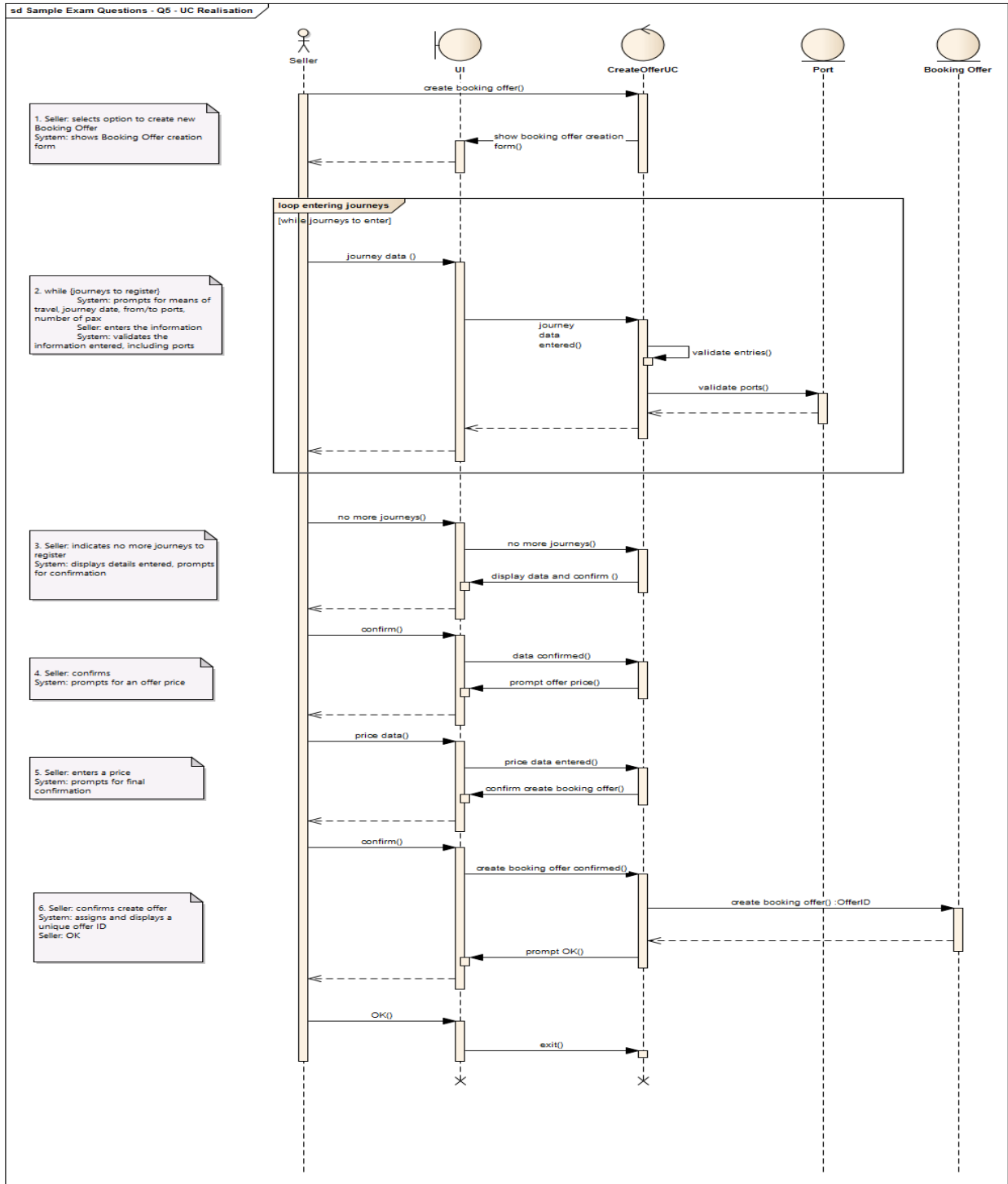
1 mark for showing a Start and an End State.

1 mark for each additional State, similar to those shown, appropriately labelled (max. 4 Marks).

1 mark for each transition comprising $\frac{1}{2}$ mark if the transition is supported in the scenario and $\frac{1}{2}$ mark if the transition is correctly labelled with an event (and guard if appropriate) (max. 9 Marks).

14 Marks in Total

Sample Exam Paper Q5 - SD - Sample Answer



Marking Guidelines

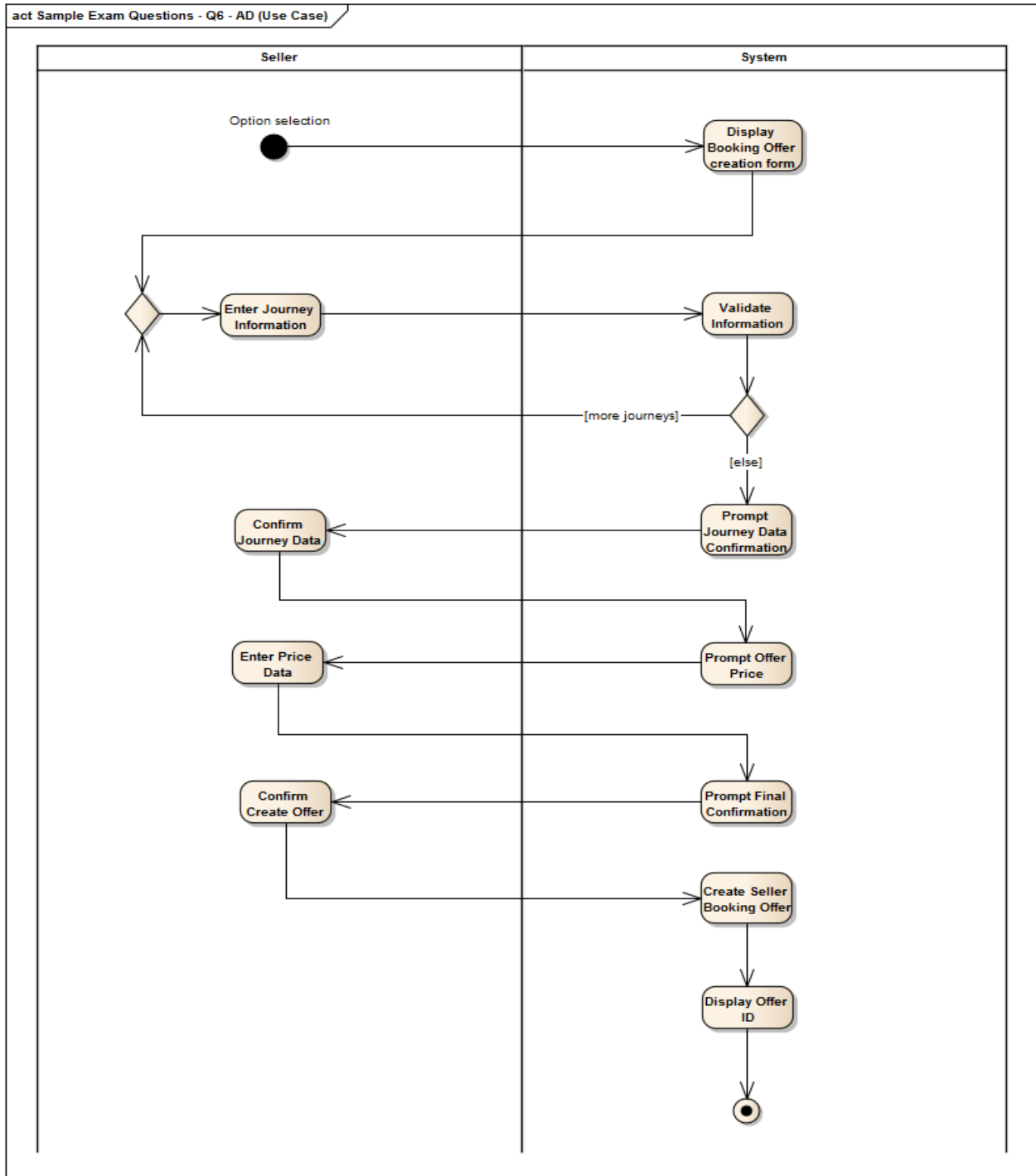
1 Mark for each lifeline, similar to those shown above (max. 5 Marks). Lifelines representing entities should correspond to classes on the DCM. The standard icon representations are not required.

1 Mark for each 'round trip' similar to those shown above (max. 6 Marks). Activation bars are not required. Round trip narratives are not required (candidate has a copy of these). To gain the marks, messages must be named, and the flow of messages must be accurate, but parameters and return types are not required.

1 Mark for the loop fragment with condition.

12 Marks in total

Sample Exam Paper Q6 - AD - Sample Answer



Marking Guidelines

Start with 2 Marks and deduce $\frac{1}{2}$ Mark for each significant logic error (i.e. logic incompatible with the Use Case description). Min 0 Marks.

$\frac{1}{2}$ Mark for each control node: initial, flow final, activity final, fork and join, merge and decision. $4 \times \frac{1}{2}$ Mark = 2 Marks. To gain the marks the syntax of the symbol must have been applied correctly.

$\frac{1}{2}$ Mark for each action node: action/activity, signal send/receive, timer. $12 \times \frac{1}{2} = 6$ Marks. To gain the marks the syntax of the symbol must have been applied correctly.

10 Marks

**British Computer Society
BUSINESS SYSTEMS DEVELOPMENT**

**CERTIFICATE IN
SYSTEM MODELLING TECHNIQUES (UML)**

BCS SMTU Examination Sample Paper 1

DO NOT OPEN THIS EXAMINATION PAPER UNTIL YOU ARE TOLD TO

Time allowed: 1 hour

- **You will have fifteen (15) minutes reading time before the examination starts. Do not write, mark, highlight or underline anything during this time.**
- **This is an open-book examination. This means you can refer to written material in addition to the examination paper itself.**
- **Attempt ALL questions.**
- **START EACH QUESTION ON A NEW PAGE.**
- **You must answer the questions in English using only blue or black ink; pencil or highlighter must not be used.**
- **Answers which are simply copied or quoted from reference material, will receive no credit.**
- **If you think a question is unclear or incorrect, write the reason why you believe the question to be faulty and your interpretation.**
- **If the paper appears incomplete or a question is illegible, please bring this to the attention of the invigilator immediately.**
- **At the end of the examination, you must hand in ALL WRITTEN WORK, plus THE EXAMINATION QUESTION PAPER. (Cross through any written work you do not wish to have marked).**
- **YOUR ANSWER PAPER WILL NOT BE MARKED IF THE EXAMINATION QUESTION PAPER IS NOT RETURNED.**

The total number of marks achievable is 50 – The pass mark is 50%

CANDIDATE NAME: _____

Scenario – FastShop Ltd

FastShop is a traditional catalogue company based in the north-west of England. It sells 'home and garden' products to its customers via orders placed over the phone. FastShop prides itself on the speed and quality of its service to all of its valued customers. FastShop wishes to improve its services further and has asked for a preliminary analysis of its 'Manage Customer Orders' process. The details of the process and the associated business rules follow.

Manage customer orders process

When a customer telephones to place an order, the sales person must first ascertain whether the customer is known to FastShop (i.e. does FastShop hold a record for that customer). If the customer is not known, the sales person checks the customer's credit rating and, if OK, creates a new customer record. If the customer is already known, the sales person checks the details with the customer and updates them where necessary.

Once the customer details are confirmed, the sales person takes the customer's order and asks the customer if they would like to confirm. The customer can decide not to proceed at this point and the call will be ended and the order deleted. If the customer does confirm, the order is marked as confirmed by the sales person and passed to the order handler.

Twice a day, the order handler will service the confirmed orders by picking and then packaging the products. Once all the products for an order are packaged, the order handler notifies the delivery manager that the order is ready for dispatch and marks the order as packaged.

At the end of each day, the delivery manager despatches the packaged orders via the courier service, and marks the orders as despatched. The courier's activities are not of concern here but, once the order has been signed for by the customer, the courier service e-mails the delivery manager notifying him that the order has been delivered. The delivery manager then updates the order status to delivered.

Business rules

- Each order must be for at least one product but not more than 25
- Before confirmation, orders may be edited as required. After confirmation, the order becomes auditable and only the status of the order may be changed
- All changes to the status of an order must be recorded. It must be possible to determine the states the order has been in and the employee that changed the state together with the date and time of each change. Obviously employees can only authorise order changes for which their role permits
- Orders may be cancelled while in progress which is at any point after order confirmation but before delivery confirmation
- Cancelled orders, like delivered orders, are considered complete and will be deleted from the system after 5 years
- An employee may act in several different roles at one time and we need to record when the employee was allocated to which role

Question 1

Produce a draft activity diagram for the 'Manage Customer Orders' process as described on page 2 only (not the business rules on page 3). Derive your answer from the FastShop Ltd Case Study description presented above. You should include:

- Swimlanes
- Actions, Edges, Send and Receive Events (if appropriate)
- Object flows showing the resulting states of order caused by the activities you have drawn

(Total: 20 marks)

Question 2

Draw a business class model to support the 'Manage Customer Orders' process:

- Correctly identifying and naming the classes needed to satisfy the data requirements of the business process and rules
- Correctly identifying and naming the class associations and indicating the appropriate multiplicity at both ends

Marks will be deducted for spurious classes.

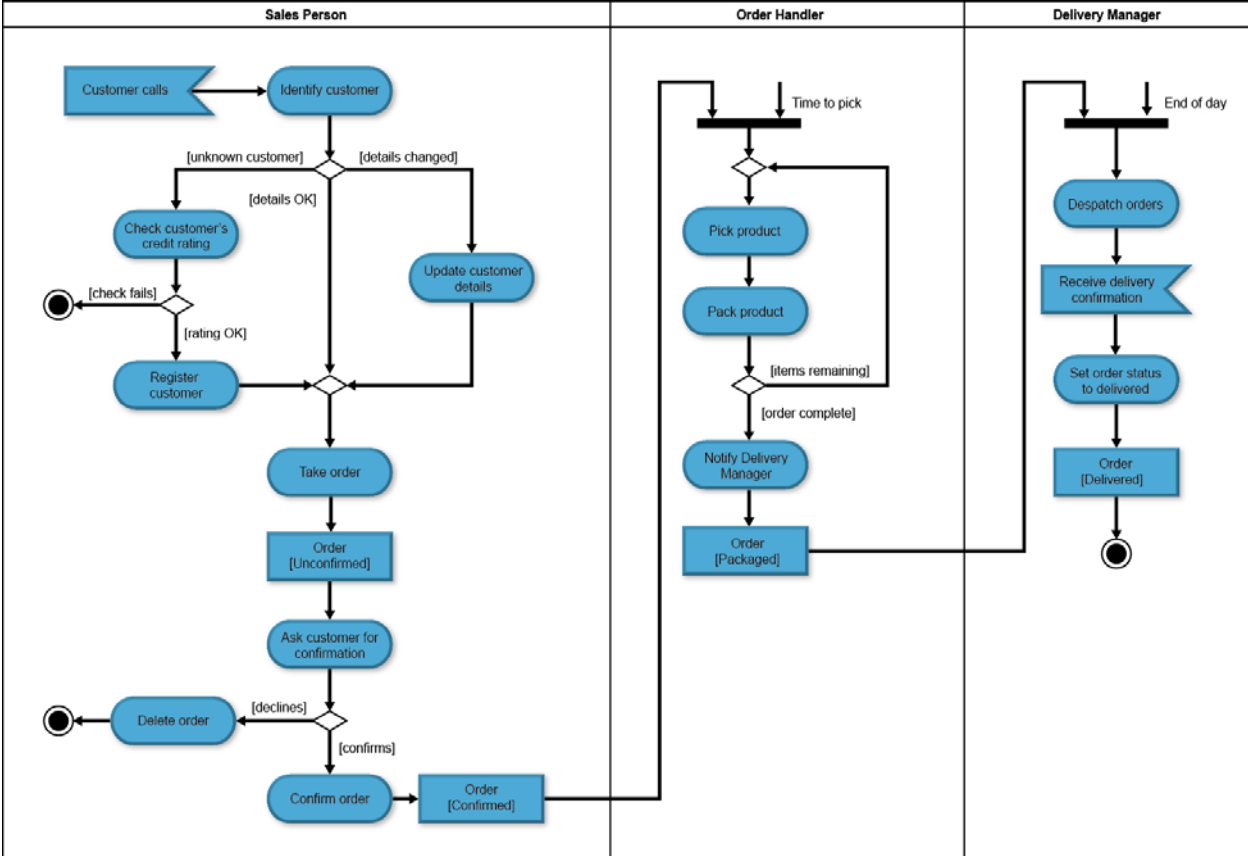
(Total: 20 marks)

Question 3

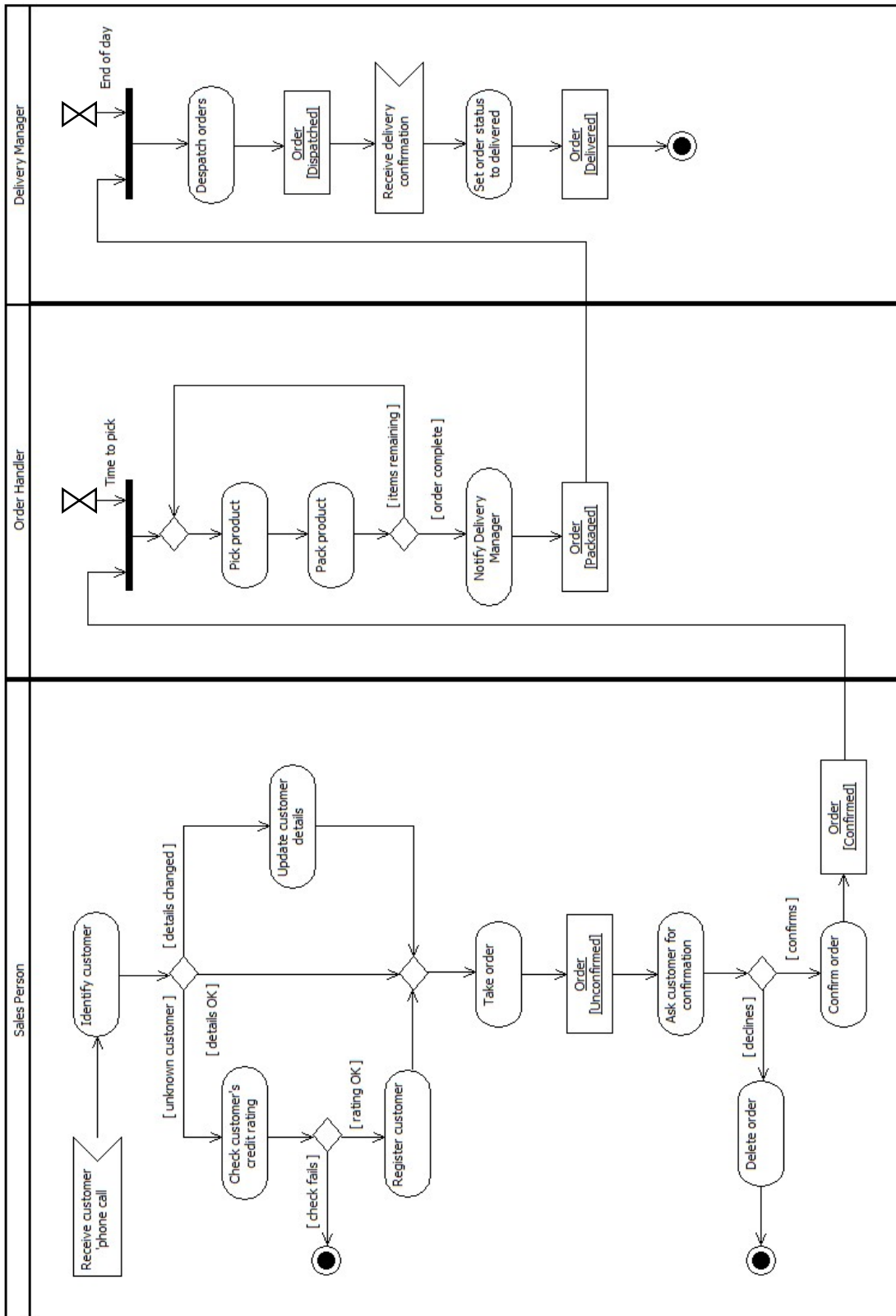
Draft a state machine for the order class showing all of its valid states and events.

(Total: 10 marks)

End of examination paper



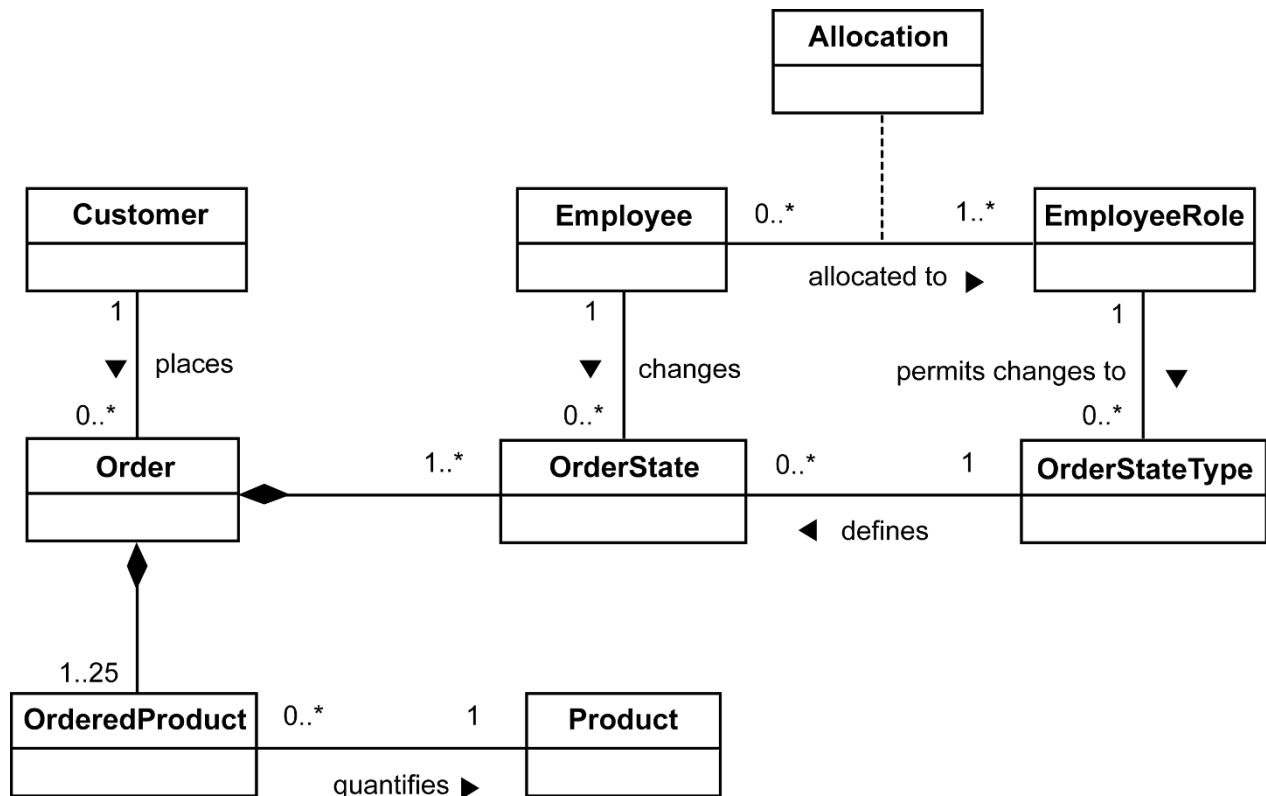
QUESTION 1 - Total: 20 marks



-
- $\frac{1}{2}$ mark for each swim lane 1½ marks
 - $\frac{1}{2}$ mark for each end node 1½ marks
 - $\frac{1}{2}$ mark for each time event 1 mark
 - $\frac{1}{2}$ mark for each action, correctly named (verb noun), with appropriate logic flows and in the correct swim lane 6½ marks
 - Up to 1 mark for each decision point with appropriate guard conditions 4 marks
 - $\frac{1}{2}$ mark for each merge 1 mark
 - $\frac{1}{2}$ mark for each object flow with appropriate state name 2½ marks
 - 1 mark for each receive 2 marks

(Total 20 marks)

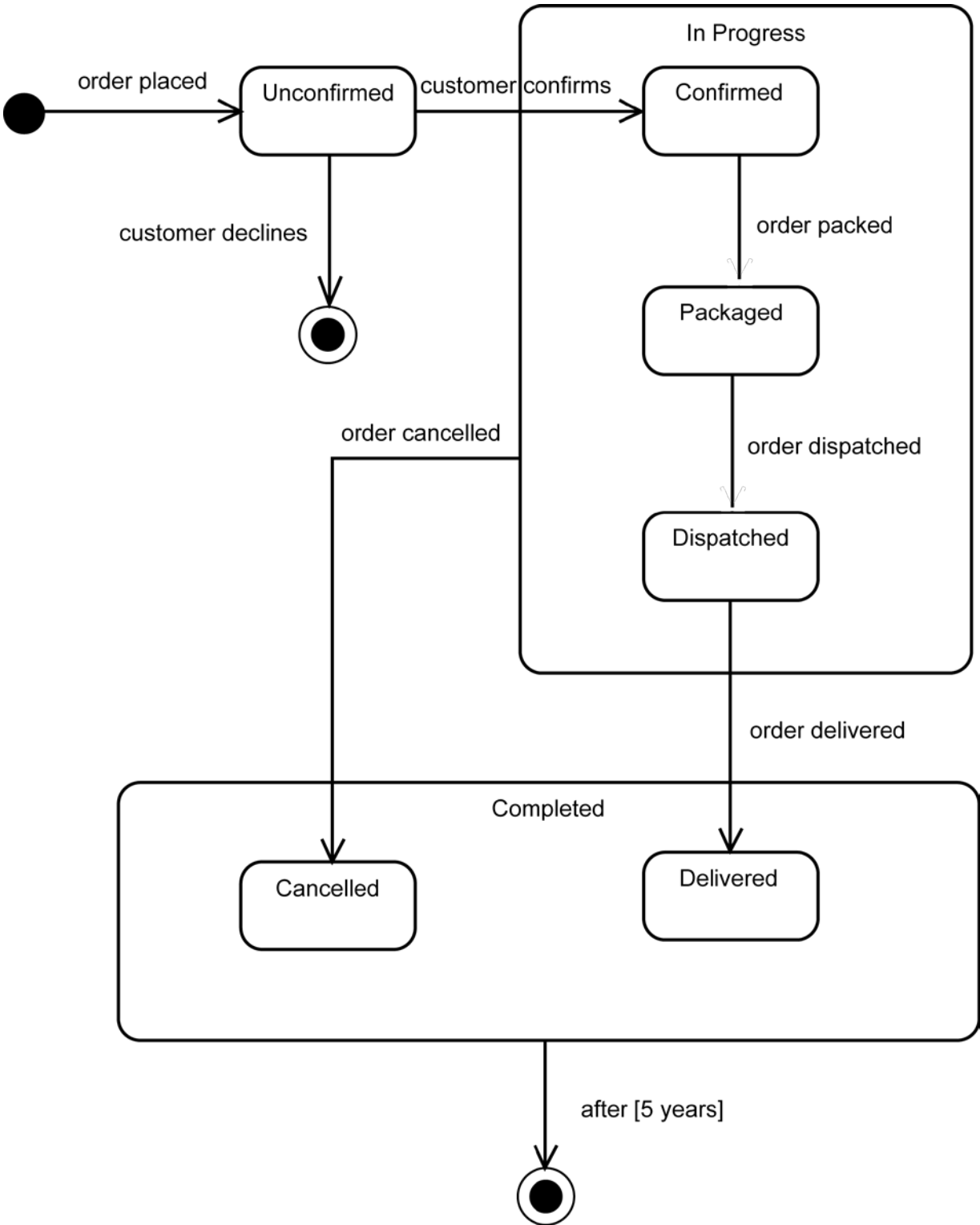
QUESTION 2 - Total: 20 marks



- 1 mark for each class (½ mark if plural name given) 8 marks
deduct ½ mark for each spurious class if more than 2 given (i.e. for 3rd, 4th, etc)
- ½ mark for each appropriately named association (including arrow) 4 marks
- ½ mark for corresponding association multiplicities (both ends) 4 marks
- 1 mark for each composition notation 2 marks
- 1 mark for the association class 1 mark
- 1 mark for appropriate association class name 1 mark

(Total 20 marks)

QUESTION 3 - Total: 10 marks



-
- $\frac{1}{2}$ mark for each state name 3 marks
 - $1\frac{1}{2}$ marks for order cancelled event (or $\frac{1}{2}$ mark in total if composite state omitted) 1 $\frac{1}{2}$ marks
 - 1 mark for 5 years elapsed event (or $\frac{1}{2}$ mark in total if composite state omitted) 1 mark
 - $\frac{1}{2}$ mark each for all other events 3 marks
 - $\frac{1}{2}$ mark for start node $\frac{1}{2}$ mark
 - $\frac{1}{2}$ mark for each end node 1 mark

(Total 10 marks)

BCS Certificate in Systems Modelling Techniques (UML)

NOTE:

These are sample questions, with marking guidelines, for each of the BCS Diploma certificate modules. Each sample question has been written to help candidates prepare for the module examination by providing an example of the general approach adopted by these questions. Therefore, the total marks assigned to the sample questions will vary depending upon the certificate module.

The BCS Examination Providers are accredited to set the examinations for the certificate modules and part of the accreditation process requires Providers to demonstrate their ability to set rigorous examination papers. The sample questions are not intended for use by Examination Providers as a basis for setting their own examination papers and should not be viewed as a template for these examinations.

SYSTEM MODELLING TECHNIQUES (UML)

Use Case Question

Scenario 1

The Northstar Hotel's website allows potential guests to make a room reservation, specifying the dates and type of room. If they have registered with the website previously their stored details are used to speed up the process, otherwise they are required to register as a new customer. Each reservation is given a unique reservation code.

Before the date of their stay they may enter this reservation code into the website to amend or cancel the reservation. Amendments can include altering the dates, changing the room type or the number of guests in each room.

When the guests arrive at the hotel the reservation id is used by the receptionist to quickly find the reservation to check them in with.

At the end of their stay the receptionist checks the guests out, at this point the hotel system validates their payment through the card payment system; a printed invoice may be requested by the guest at this point.

The hotel has many room types available, each with a room-type name, number of guests and additional facility information. Each room in the hotel has a room number and is of one specific type. The maintenance of this data is performed using a separate system out of scope of this exercise.

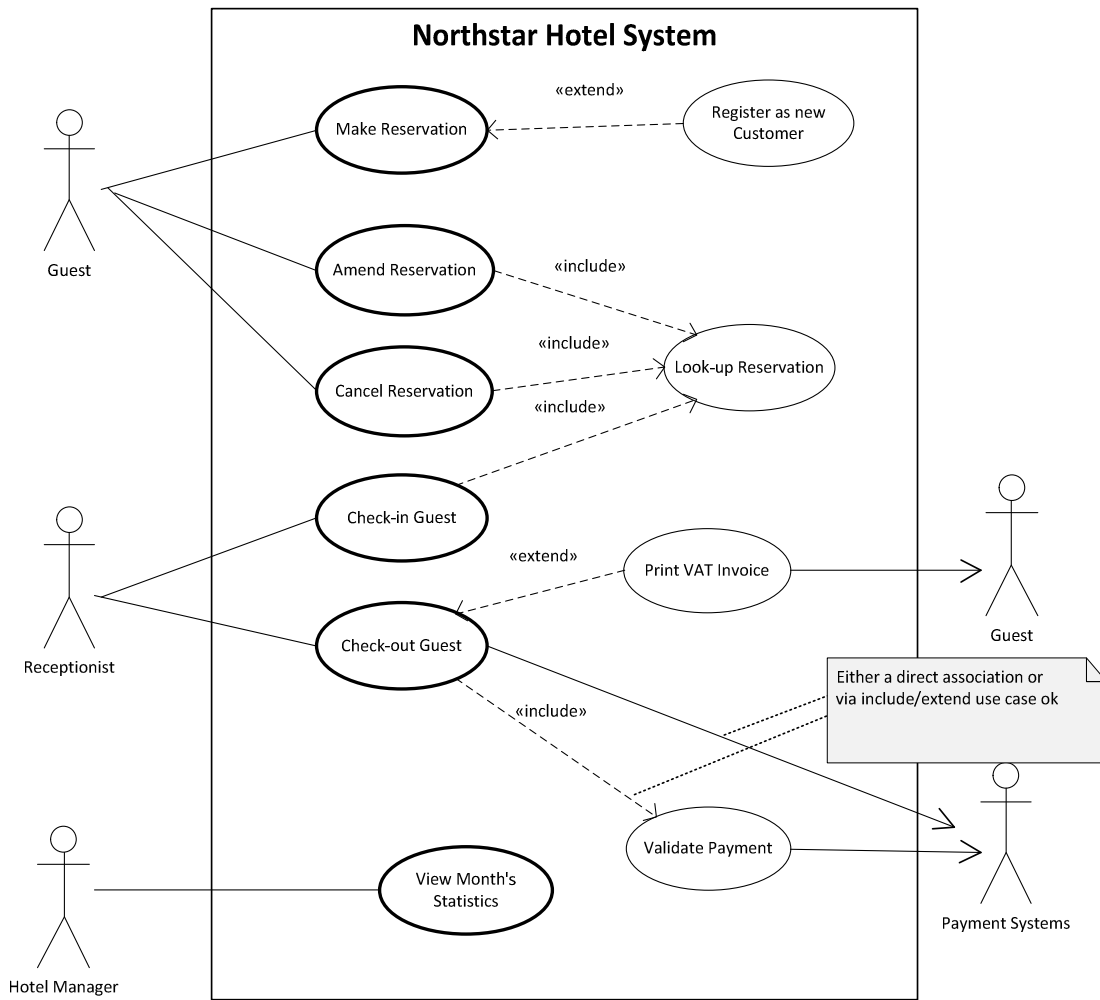
Monthly reports are prepared by the system which may be viewed on request by the Hotel Manager.

Question

Produce a System Use Case diagram for the above scenario.

(18 marks)

Specimen answer and marking scheme



Note: depending on assumptions then some of the extend associations may be represented by include associations, and vice-versa. The only true means of determining this would be to produce full use case descriptions.

Element	Details	Max Marks
System Boundary	1 Mark for displaying and naming the system boundary <ul style="list-style-type: none"> - Another <i>allowable answer is that two boundaries are presented, one representing the website and another the main system. Only one mark though</i> 	1
Actors	1 Mark for each actor, [up to 4] <ul style="list-style-type: none"> - Candidates include Guest/Customer (only 1 mark if both), Receptionist, Hotel Manager, Payment System - Time should not be marked correct; see below 	4
Use Cases	1 Mark for correctly named (verb-object/noun) use cases [up to 6] <ul style="list-style-type: none"> - This includes sub-use cases that are included or extended providing they are reasonable - Functional decomposition should be avoided, as should anything that does not truly represent an interaction across the system boundary 	6
Use Case~Actor Associations	½ (0.5) marks for each correct actor to use case association crossing system boundary[up to 10 ~ 5 marks] <ul style="list-style-type: none"> - A use case's interactions with secondary actors are counted in addition to the primary actor to use case association 	5
Include/extend associations	1 mark for each correct include and extend use case example [up to 2 examples] <ul style="list-style-type: none"> - multiple use cases including same use case counts as single example - Depending on both assumptions made and definition of include/extend allow for various interpretations, however see note above about functional decomposition and truly representing interactions 	2
TOTAL		18 marks

Annotated Scenario

The following highlights where the information required to produce the above use case diagram is presented in the scenario. Some details would be relevant to a data/class related question but are included here to mimic the live exam.

The Northstar Hotel's website allows potential **guests** to **make a room reservation**, specifying the dates and type of room. If they have registered with the website previously their stored details are used to speed up the process, otherwise they are required to **register as a new customer**. Each reservation is given a unique reservation code.

Before the date of their stay they may enter this reservation code into the website to **lookup the reservation to amend** or **cancel**. Amendments can include altering the dates, changing the room type or the number of guests in each room.

When the guests arrive at the hotel the reservation id is used by the **receptionist** to quickly **find the reservation** to **check them in** with.

At the end of their stay the receptionist **checks the guests out**, at this point the hotel system **validates their payment** through the **card payment system**; a **printed invoice** may be requested by the guest at this point.

The hotel has many room types available, each with a room-type name, number of guests and additional facility information. Each room in the hotel has a room number and is of one specific type. The maintenance of this data is performed using a separate system out of scope of this exercise.

Monthly reports are prepared by the system which may be **viewed on request** by the **Hotel Manager**.

Guest->Make Reservation

Guest->Register as new customer

Guest->Amend reservation

Guest->Cancel reservation
Both include ->(lookup/find reservation)

Receptionist->Check-in guest

Also includes->(lookup/find reservation)

Receptionist->Check out guest

Includes or extended by(based on assumption)

Validate payment->Card Payment System

Check out guest also includes or extended by

Print Invoice->Guest

Hotel Manager->View monthly report*

*Note that a time driven use case producing the report is not credited as that is not a true interaction across the system boundary; in this scenario the hotel manager initiates viewing the report at a later time. Had the report been output specifically at the time the report is prepared this may have then represented an interaction.

Class Diagram question

Scenario 2

A company holds the following information about the vehicles it owns.

- Registration number (all vehicles)
- Engine capacity (cc) (all vehicles)
- Next vehicle test date (all vehicles)
- Laden weight (vans and lorries only)
- Unladen weight (Vans only)
- Carrying capacity (Vans only)
- Number of wheels (Lorries only)
- Towing capacity (Lorries only)
- Licence grade required (Lorries only)

The company also holds information about the trailers that can be used on a lorry. Each trailer has a trailer number, a load capacity and a date of last service. The company has 40 lorries and 120 trailers. The company needs to record which trailers can be attached to which lorries. A lorry may not be allocated a certain trailer, or it may be allocated one or more trailers. A trailer may be allocated to more than one lorry, but it has to be allocated to at least one lorry.

The manufacturer of each vehicle has to be recorded. The company may have many vehicles made by the same manufacturer (e.g. Ford), but it does not store information about manufacturers for which it does not have a vehicle. A vehicle (such as a Transit) is only made by one manufacturer.

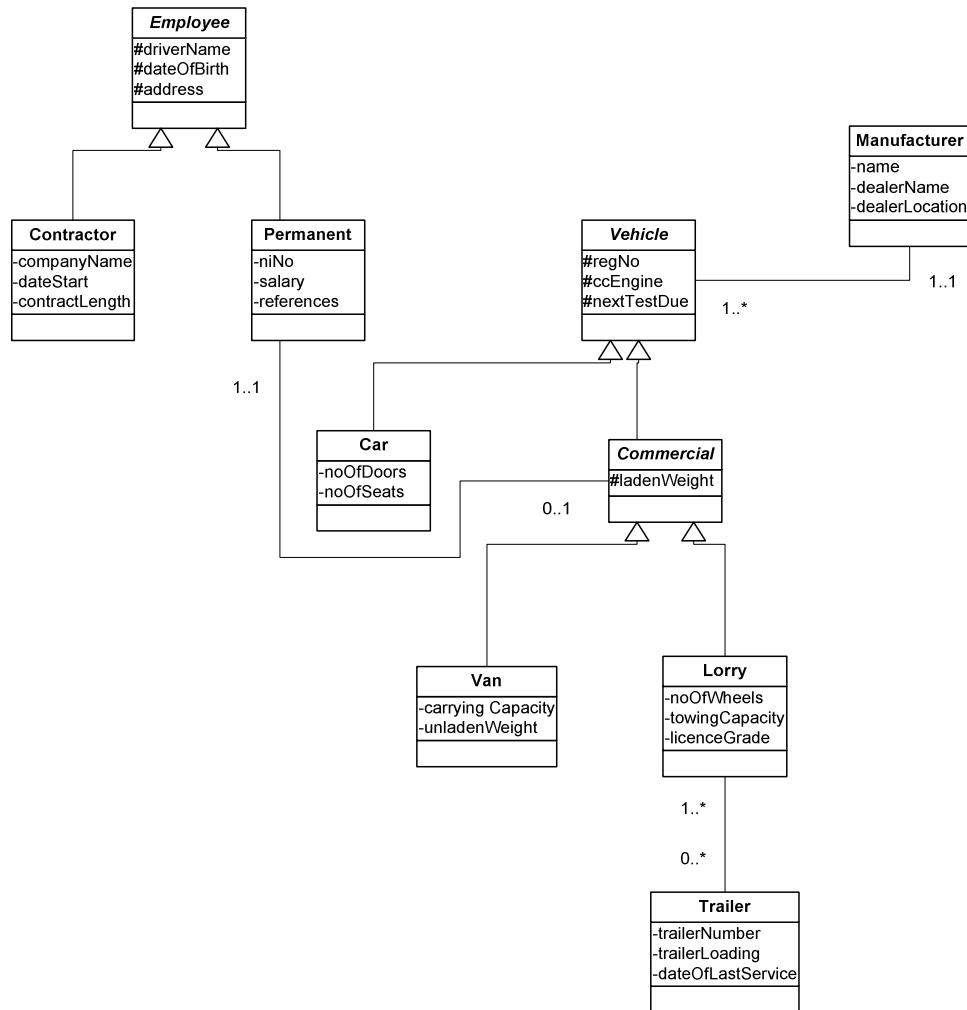
There are two types of employee, contractors and permanent. The attributes driver name, date of birth and address are held for all drivers. The attributes company name, start date and contract length are held for contractors. The attributes national insurance number, salary and references are held for contract staff. Both vans and lorries must be allocated to a permanent employee. Each van or lorry is allocated to just one permanent employee. A permanent employee has a maximum of 1 lorry or van allocated to them. However, there are some permanent employees (office staff) who do not have a lorry or van allocated to them.

Question

Draw a class diagram for this scenario, explicitly showing the data items of each class and sub-class.

(21 marks)

Specimen answer and marking scheme



- 0.5 mark for each class or sub-class up to a maximum of 5 marks
- 0.5 marks for each attribute set up to a maximum of 5 marks
- 1 marks for the Vehicle generalisation
- 1.5 marks for the Commercial generalisation
- 1 mark for the employee generalisation
- 2 marks for the correct association multiplicities between lorry and trailer
- 2 marks for the correct association multiplicities between manufacturer and vehicle

- 2 marks for the correct association multiplicities between permanent employee and commercial
- 0.5 marks for notating abstract classes up to a maximum of 1.5 marks

Total: 21 marks

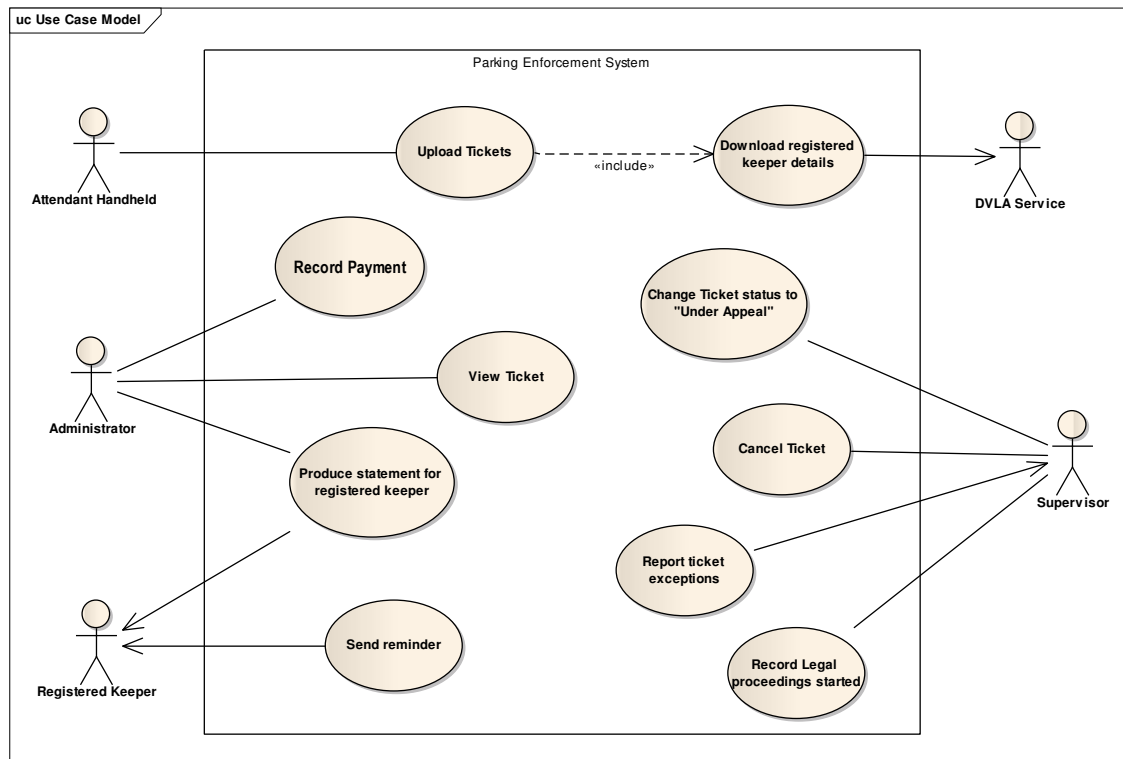
Interaction diagram question

Scenario 3

An application for a Parking Enforcement System (PES) is being built for a number of local authorities to manage their parking enforcement processes. The application receives information about new fines uploaded from the attendant's handsets. Most fines are then paid within the allowed period and that payment recorded against the fine which is then closed. Sometimes only part of the fine is received in which case the outstanding balance should be updated but the fine still active.

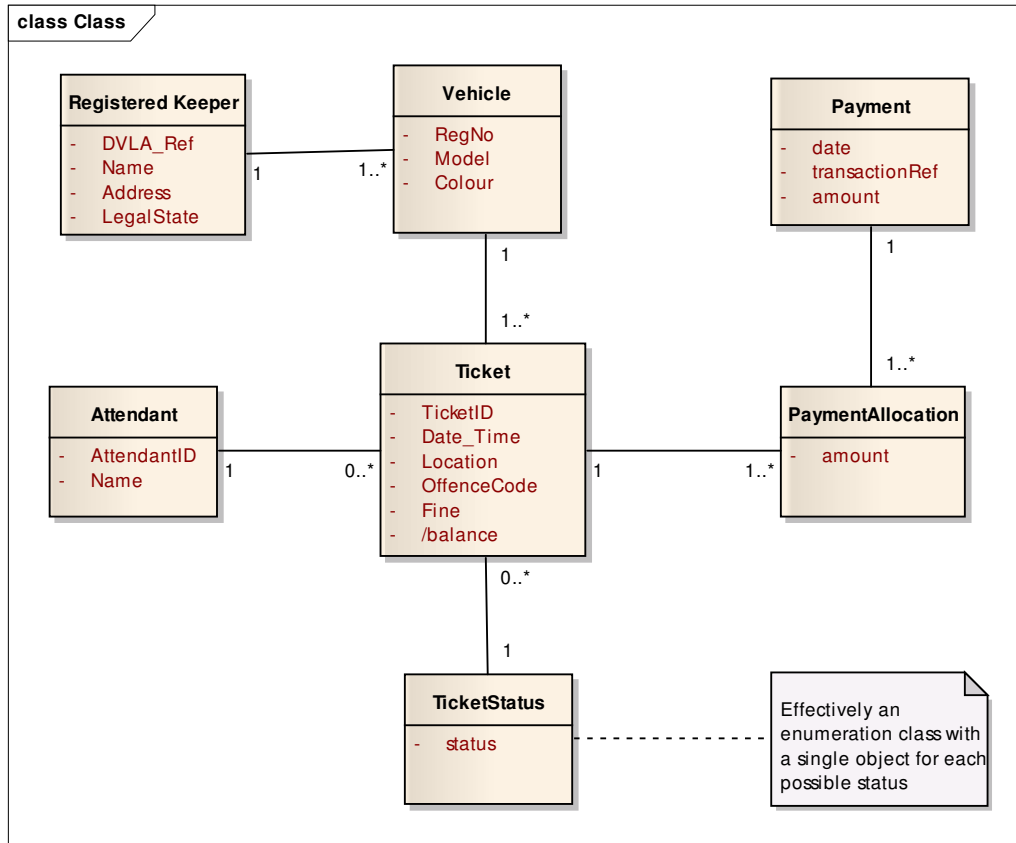
Use case diagram:

[Note: Typically you would have produced a use case diagram similar to this in a previous question based on the same scenario.]



Class Diagram:

[Note: Typically you would have produced a class diagram similar to this in a previous question based on the same scenario.]



Use Case Description

The following use case description is for the “Record Fine Payment”. Not all conditions and scenarios are listed, only those required by the question.

Use Case	Record Fine Payment	Scope	IT System
Actor(s)	Administrator	Goal Level	User
Pre-conditions	Actor is logged into application;		
Post-conditions	A new payment is recorded on the system; One or several fines are updated to either be completely or partially paid off		
Main Success Scenario			
<ol style="list-style-type: none"> 1. The actor enters the first TicketID from the remittance stub 2. The system displays information about the registered owner and the specified ticket including vehicle details <i>and a list of any other outstanding fines by vehicle</i> 3. The actor enters the amount paid which matches the outstanding balance 4. The system displays the updated fine details (same information as step 2) 5. The actor closes the use case 			
Alternate flows			
... 3a: The payment is not for the full outstanding balance 3a1: the actor enters the partial payment amount Return to step 4 ...			
Main Scenario	The payment relates to a single ticket and clears the outstanding balance - [ticket.balance = £0& status = 'paid']		
Scenario 1	The payment relates to a single ticket but is only a part payment - [ticket.balance > £0& status is unchanged]		
<i>Scenario n etc.</i>	<i>Not relevant to this question</i>		

Question

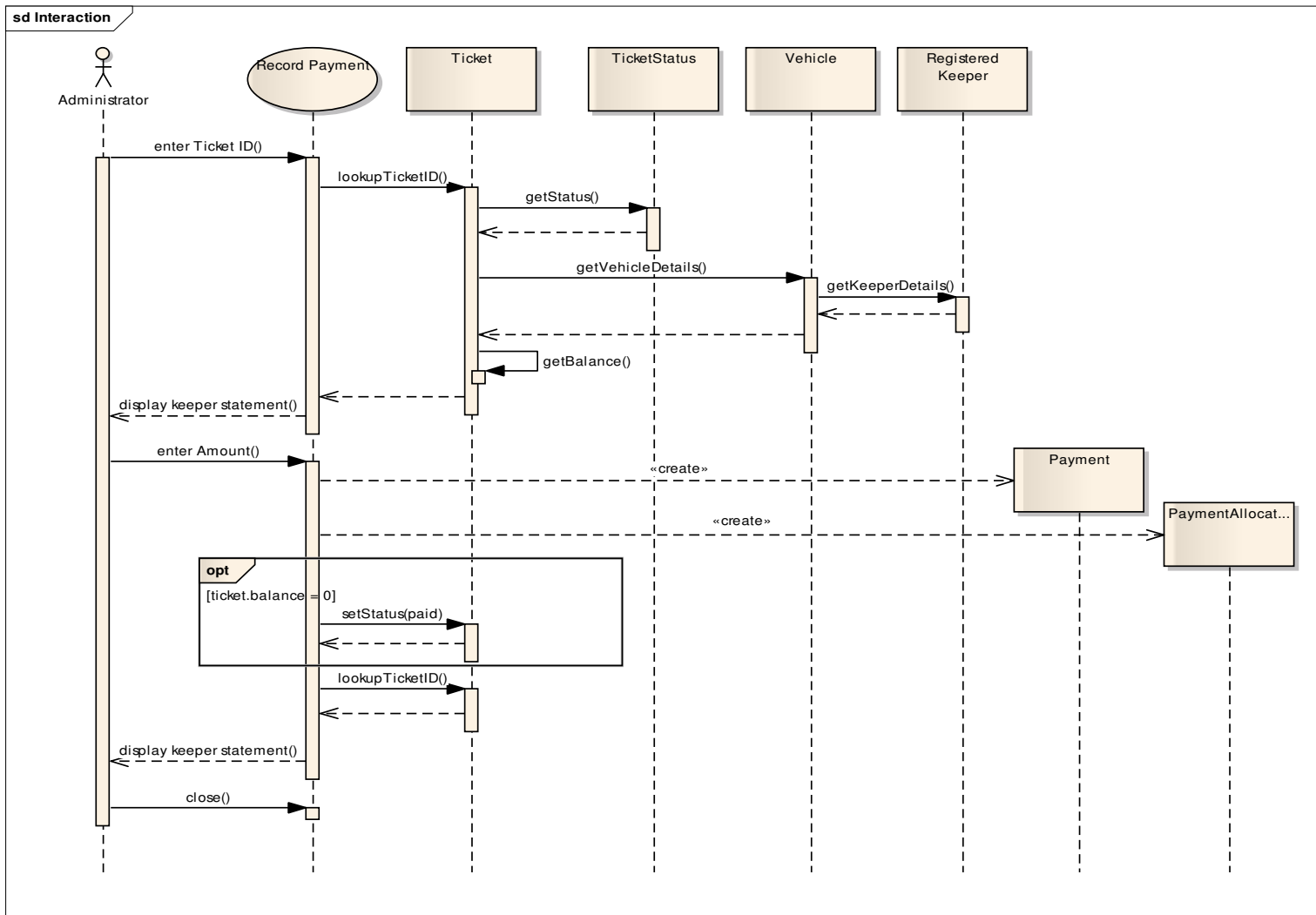
Produce an interaction diagram (i.e. Sequence or Communication diagram) for the "Record Payment" use case.

The diagram **SHOULD** allow for both the main success scenario (single ticket, full payment) and the alternative scenario where only a part payment has been received against a single ticket.

Note: You are NOT required to model any other scenarios, such as payment of multiple tickets being allocated against a single payment or where the payer is not the known keeper; no additional marks will be gained for doing so.

(14 Marks)

Sample Answer and marking scheme



Element	Marks	Notes
Lifeline objects	1 for Actor 1 for Use Case 0.5 for other objects (max 3 marks) 0.5 for correct creates (max 1 mark) [total 5 marks]	<i>Actor may be specifically named or just called 'Actor'</i> <i>Control, Boundary objects (or both) acceptable in place of Use Case</i> <i>Ticket, Vehicle, Keeper, Payment, Ticket Status & Payment Allocation</i> <i>Payment and Payment Allocation should not exist at start (allow for absence of dotted lifeline at start if object placed at top depending on style)</i>
Use Case consistency	2 for reflecting use case sequence [total 2 marks]	<i>Actor<>Use Case Messages and returns match use case steps</i>
Messages	0.5 per message (max 4 marks) [total 4 marks]	<i>Messages should be placed correctly and clear in their purpose</i>
Scenario Coverage	1 for fragment 1 for effect [total 2 marks]	<i>May be an alt or potentially an opt fragment at a suitable level</i> <i>Should reflect coverage of both scenarios</i>
General	1 for clear flow [Total 1 mark]	<i>It should be possible to follow the sequences through the diagram</i>

(Total 14 marks)

This marking scheme refers specifically to a Sequence diagram. If a Communication (aka collaboration) diagram is produced then marks should be awarded for equivalent elements as below

BCS Certificate in Systems Modelling Techniques Syllabus

Version 3.3

September 2012

Change History

Version Number and Date	Changes Made
Version 3.3 September 2012	Updated the Reasonable Adjustments Requirements and removed the Definitions of Terminology. Included a section to cover excerpts from BCS books
Version 3.2 August 2012	Added in details of extra time for foreign language candidates
Version 3.1 October 2011	Updated 3.2 Activity Diagrams from 25% to 10%. Updated title page
Version 3.0 August 2011	Updated ISEB to BCS logos and strapline. Added table of contents, levels of knowledge, levels of skill and responsibility, format of the examination, change history and definition of terminology. No change to structured approach Minor corrections to UML/OO approach. UML 2.0 specification added to reading list
V3.1 October 2011	Updated 3.2 Activity Diagrams from 25% to 10%. Updated title page

BCS Certificate in Systems Modelling Techniques

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Introduction

The certificate is primarily concerned with modelling systems from a variety of perspectives. It requires candidates to construct three main types of model reflecting different perspectives and to describe the interactions between them.

The syllabus has two common sections (comprising 15% of the syllabus) and three others where the exam provider will need to select one of two approaches. It should be noted that the two approaches differ in one key area; the UML version does not include the concept of modelling the existing system whereas this is included in the Structured version.

Organisations are able to examine alternative approaches or techniques to those shown below. In this case, details of the standard to be examined, including a description of the principles and notation, should be submitted with the examination accreditation application.

Objectives

The candidate should be able to:

- Justify the need for IT system modelling and modelling techniques.
- Explain why it is important to model IT system requirements from different perspectives.
- Develop models of system functionality. These models should be either process models with supporting process descriptions or use case diagrams with supporting use case descriptions.
- Develop models of system data. These models should be either entity relationship models or analysis class models, both with supporting descriptions.
- Develop a dynamic model. This model should be either an entity life history showing the effect of events on an entity or a sequence diagram showing the realisation of a use case.
- Evaluate selected models against business objectives and system requirements.
- Appreciate how the selected models inter-relate with each other.
- Describe how the products of analysis feed into the design and development of a system.

Eligibility for the Examination

There are no specific pre-requisites for entry to the examination; however candidates should possess the appropriate level of knowledge to fulfil the objective shown above.

Format of the Examination

The format for the examination is a one hour written (open book) examination based on a business scenario with 15 minutes reading time.

Candidates who are awarded a pass for the examination are awarded the BCS Certificate in Systems Modelling Techniques.

Accreditation Guidelines for Training Providers

This qualification is subject to the accreditation guidelines applied to all BCS BSD qualifications. It is the view of BCS that, for full coverage to be achieved, training courses leading to the certificate should normally run for 21 hours.

Additional Time for Candidates requiring Reasonable Adjustments due to a temporary or permanent disability

Candidates may request additional time if they require reasonable adjustments in line with the BCS [reasonable adjustments policy](#). It will be the Examination Provider's responsibility to make a decision regarding candidate eligibility and keep a record of the decision. This is subject to audit by BCS.

Additional Time for Candidates whose business language is not English

An additional 15 minutes will be allowed for candidates sitting the examination

- in a language that is not their mother tongue, **and**
- where the language of the exam is **not** their primary business language,

Foreign language candidates who meet the above requirements are also entitled to the use of a paper dictionary (to be supplied by the candidate).

It will be the Examination Provider's responsibility to make the decision regarding candidate eligibility and keep a record of the additional time allowed. Candidates must request additional time in advance of the examination to allow the Examination Provider enough time to make suitable arrangements with the invigilator.

Excerpts from BCS Books

Examination Providers may include excerpts from BCS books in the course materials. If you wish to use excerpts from the books you will need a license from BCS to do this. If you are interested in taking out a licence to use BCS published material you should contact the Head of Publishing at BCS outlining the material you wish to copy and the use to which it will be put.

Syllabus

1. Systems Modelling (5%)

- 1.1 The need for modelling and modelling standards
- 1.2 Rationale for the selected approach
- 1.3 The approach and Systems Development Lifecycle
- 1.4 Place of models within the Systems Development Lifecycle
- 1.5 Modelling the IT system from different perspectives
- 1.6 Interaction of the selected models
- 1.7 Validating and verifying models

2. Systems Modelling in Context (10%)

- 2.1 Monitoring analysis against business objectives and system requirements
- 2.2 The bridge to design, software package selection and development

UML Version

3. Modelling Functionality (35%)

3.1. Use Case Modelling (25%)

- Modelling user requirements
- Use cases
- Actors and the system boundary
- Use case diagrams
- Generalising actors and use cases
- Use case descriptions – template of the description, including pre-conditions and post-conditions
- Use case descriptions – defining the main and alternative flows
- <<include>> and <<extend>>

3.2. Activity Diagrams (10%)

- Activity diagrams – notation
- Using activity diagrams to model processing
- Using activity diagrams to model use case descriptions

4. Static Modelling (25%)

4.1 Analysis class modelling rationale

4.2 Objects and classes

4.3 Class diagrams and object diagrams

4.4 Abstraction and encapsulation

4.5 Representing classes: name, attributes and operations

4.6 Defining attributes: adornments

4.7 Associations

- Naming associations
- Defining multiplicities (minimum and maximum)
- Multiple associations
- Reflexive associations
- Constraints in associations
- Association classes

- Generalisation and inheritance
 - Modelling generalisation
 - Private, public and protected attributes
 - Concept of polymorphism

5. Dynamic Modelling (25%)

5.1 Use case realisation

5.2 Sequence diagrams

- Lifelines
- Focus
- Message notation
- Populating the class diagram
- Using opt, alt and loop in the sequence diagram

5.3 State machine diagrams

5.4 Communication diagrams – an introduction

Structured Version

3. Modelling Functionality (35%)

3.1. Modelling processes using a Data Flow Diagram

- Processes
- External Entities
- Datastores
- Dataflows
- Decomposition and levels

3.2. Elementary Process Descriptions

- Documenting the processing

3.3. Types of Data Flow Diagrams – current and required

4. Static Modelling (30%)

4.1. Modelling data using Entity Relationship Diagrams

- Entities
- Relationships including cardinality, optionality, exclusivity, recursion, multiple, relationship names

4.2. Supporting Documentation

- Entity descriptions
- Relationship descriptions
- Attribute descriptions

5. Dynamic Modelling (25%)

5.1. Analysing the behaviour of entities

- Events
- Enquiries
- Effects
- Entity Access Matrix
- Modelling the behaviour of entities
- Constructs for sequence, selection and iteration

5.2. Documenting navigation paths

Levels of Knowledge

This course will provide candidates with the levels of difficulty / knowledge highlighted within the following table, enabling them to develop the skills to operate at the levels of responsibility indicated.

The levels of knowledge are explained in the following text. Note that each K level subsumes lower levels. For example, a K4 level topic is one for which a candidate must be able to analyse a situation and extract relevant information. A question on a K4 topic could be at any level up to and including K4. As an example, a scenario requiring a candidate to analyse a scenario and select the best risk identification method would be at K4, but questions could also be asked about this topic at K3 and a question at K3 for this topic might require a candidate to apply one of the risk identification methods to a situation.

Level 1: Remember (K1)

The candidate should be able to recognise, remember and recall a term or concept but not necessarily be able to use or explain. Typical questions would use: define, duplicate, list, memorise, recall, repeat, reproduce, state.

Level 2: Understand (K2)

The candidate should be able to explain a topic or classify information or make comparisons. The candidate should be able to explain ideas or concepts. Typical questions would use: classify, describe, discuss, explain, identify, locate, recognise, report, select, translate, paraphrase.

Level 3: Apply (K3)

The candidate should be able apply a topic in a practical setting. The candidate should be able to use the information in a new way. Typical questions would use: choose, demonstrate, employ, illustrate, interpret, operate, schedule, sketch, solve, use, write.

Level 4: Analyse (K4)

The candidate should be able to distinguish/separate information related to a concept or technique into its constituent parts for better understanding, and can distinguish between facts and inferences. Typical questions would use: appraise, compare, contrast, criticise, differentiate, discriminate, distinguish, examiner, question, test.

Level 5: Synthesise (K5)

The candidate should be able to justify a decision and can identify and build patterns in facts and information related to a concept or technique, they can create new meaning or structure from parts of a concept. Typical questions would use: appraise, argue, defend, judge, select, support, value, evaluate.

Level 6: Evaluate (K6)

The candidate should be able to provide a new point of view and can judge the value of information and decide on its applicability in a given situation. Typical questions would use: assemble, contract, create, design, develop, formulate, write.

Levels of Skill and Responsibility (SFIA Levels)

The levels of knowledge above will enable candidates to develop the following levels of skill to be able to operate at the following levels of responsibility (as defined within the SFIA framework) within their workplace:

Level 1: Follow

Work under close supervision to perform routine activities in a structured environment. They will require assistance in resolving unexpected problems, but will be able to demonstrate an organised approach to work and learn new skills and applies newly acquired knowledge.

Level 2: Assist

Works under routine supervision and uses minor discretion in resolving problems or enquiries. Works without frequent reference to others and may have influence within their own domain. They are able to perform a range of varied work activities in a variety of structured environments and can identify and negotiate their own development opportunities. They can also monitor their own work within short time horizons and absorb technical information when it is presented systematically and apply it effectively.

Level 3: Apply

Works under general supervision and uses discretion in identifying and resolving complex problems and assignments. They usually require specific instructions with their work being reviewed at frequent milestones, but can determine when issues should be escalated to a higher level. Interacts with and influences department/project team members. In a predictable and structured environment they may supervise others. They can perform a broad range of work, sometimes complex and non-routine, in a variety of environments. They understand and use appropriate methods, tools and applications and can demonstrate an analytical and systematic approach to problem solving. They can take the initiative in identifying and negotiating appropriate development opportunities and demonstrate effective communication skills, sometimes planning, scheduling and monitoring their own work. They can absorb and apply technical information, works to required standards and understand and uses appropriate methods, tools and applications.

Level 4: Enable

Works under general direction within clear framework of accountability and can exercise substantial personal responsibility and autonomy. They can plan their own work to meet given objectives and processes and can influence their team and specialist peers internally. They can have some responsibility for the work of others and for the allocation of resources. They can make decisions which influence the success of projects and team objectives and perform a broad range of complex technical or professional work activities, in a variety of contexts. They are capable of selecting appropriately from applicable standards, methods, tools and applications and demonstrate an analytical and systematic approach to problem solving, communicating fluently orally and in writing, and can present complex technical information to both technical and non-technical audiences. They plan, schedule and monitor their work to meet time and quality targets and in accordance with relevant legislation and procedures, rapidly absorbing new technical information and applying it effectively. They have a good appreciation of the wider field of information systems, their use in relevant employment areas and how they relate to the business activities of the employer or client.

Level 5: Ensure and advise

Works under broad direction, being fully accountable for their own technical work and/or project/supervisory responsibilities, receiving assignments in the form of objectives. Their work is often self-initiated and they can establish their own milestones, team objectives, and delegates responsibilities. They have significant responsibility for the work of others and for the allocation of resources, making decisions which impact on the success of assigned projects i.e. results, deadlines and budget. They can also develop business relationships with customers, perform a challenging range and variety of complex technical or professional work activities and undertake work which requires the application of fundamental principles in a wide and often unpredictable range of contexts. They can advise on the available standards, methods, tools and applications relevant to own specialism and can make correct choices from alternatives. They can also analyse, diagnose, design, plan, execute and evaluate work to time, cost and quality targets, communicating effectively, formally and informally, with colleagues, subordinates and customers. They can demonstrate leadership, mentor more junior colleagues and take the initiative in keeping their skills up to date. Takes customer requirements into account and demonstrates creativity and innovation in applying solutions for the benefit of the customer.

Level 6: Initiate and influence

Have a defined authority and responsibility for a significant area of work, including technical, financial and quality aspects. They can establish organisational objectives and delegates responsibilities, being accountable for actions and decisions taken by them self and their subordinates. They can influence policy formation within their own specialism to business objectives, influencing a significant part of their own organisation and customers/suppliers and the industry at senior management level. They make decisions which impact the work of employing organisations, achievement of organisational objectives and financial performance, developing high-level relationships with customers, suppliers and industry leaders. They can perform highly complex work activities covering technical, financial and quality aspects. They contribute to the formulation of IT strategy, creatively applying a wide range of technical and/or management principles. They absorb complex technical information and communicate effectively at all levels to both technical and non-technical audiences, assesses and evaluates risk and understand the implications of new technologies. They demonstrate clear leadership and the ability to influence and persuade others, with a broad understanding of all aspects of IT and deep understanding of their own specialism(s). They take the initiative in keeping both their own and subordinates' skills up to date and to maintain an awareness of developments in the IT industry.

Level 7: Set strategy, inspire and mobilise

Have the authority and responsibility for all aspects of a significant area of work, including policy formation and application. They are fully accountable for actions taken and decisions made, by both them self and their subordinates. They make decisions critical to organisational success and influence developments within the IT industry at the highest levels, advancing the knowledge and/or exploitation of IT within one or more organisations. They develop long-term strategic relationships with customers and industry leaders, leading on the formulation and application of strategy. They apply the highest level of management and leadership skills, having a deep understanding of the IT industry and the implications of emerging technologies for the wider business environment. They have a full range of strategic management and leadership skills and can understand, explain and present complex technical ideas to both technical and non-technical audiences at all levels up to the highest in a persuasive and convincing manner. They have a broad and deep IT knowledge coupled with equivalent knowledge of the activities of those businesses and other organisations that use and exploit IT. Communicates the potential impact of emerging technologies on organisations and individuals and analyses the risks of using or not using such technologies. They also assess the impact of legislation, and actively promote compliance.

Level	Levels of knowledge	Levels of skill and responsibility (SFIA)
K7		Set strategy, inspire and mobilise
K6	Evaluate	Initiate and influence
K5	Synthesise	Ensure and advise
K4	Analyse	Enable
K3	Apply	Apply
K2	Understand	Assist
K1	Remember	Follow

Format of the Examination

This syllabus has an accompanying examination at which the candidate must achieve a pass score to gain the BCS Certificate in Systems Modelling Techniques.

Type	Written examination based on a business scenario
Duration	<p>1 hour preceded by 15 minutes reading time</p> <p>An additional 15 minutes will be allowed for candidates sitting the examination</p> <ul style="list-style-type: none"> in a language that is not their mother tongue, and where the language of the exam is not their primary business language, <p>Foreign language candidates who meet the above requirements are also entitled to the use of a paper dictionary (to be supplied by the candidate).</p>
Pre-requisites	None
Supervised / Invigilated	Yes
Open Book	Yes
Pass Mark	50%
Distinction Mark	None
Delivery	Paper based examination

Recommended Reading List

Systems Modelling Techniques (Structured techniques version)

Title: Systems Analysis and Design (2nd Edition)

Author: Donald Yeates and Tony Wakefield

Publisher: FT Prentice Hall

Publication Date: 2003

ISBN: 9780273655361

Title: Practical SSADM Version 4+ A Complete Tutorial Guide (2nd Edition)

Author: Philip Weaver, Nick Lanbrou and Matthew Walkley

Publisher: FT Pitman

Publication Date: 1998

ISBN: 9780273626756

Title: An Introduction to SSADM Version 4

Author: Caroline Ashworth and Laurence Slater

Publisher: McGraw-Hill

Publication Date: 1993

ISBN: 0077077253

Title: SSADM Version 4: A User's Guide (Limited Availability)

Author: Malcolm Eva

Publisher: McGraw-Hill

Publication Date: 1994

ISBN: 0077079590

Title: SSADM Version 4: A Practical Approach

Author: Mike Goodland and Caroline Slater

Publisher: McGraw-Hill

Publication Date: 1995

ISBN: 007709073X

Systems Modelling Techniques (UML Version)

Title: Introducing Systems Development

Author: Steve Skidmore and Malcolm Eva

Publisher: Palgrave Macmillan

Publication Date: 2003

ISBN: 0333973690

Title: UML and the Unified Process

Author: Jim Arlow and Ila Neustadt

Publisher: Addison Wesley

Publication Date: 2005

ISBN: 978-0321321275

Title: Object – Oriented Systems Analysis and Design Using UML

Author: Simon Bennett, Steve McRobb and Ray Farmer

Publisher: McGraw Hill

Publication Date: 2005

ISBN: 0077092444

UML Specification

www.uml.com