

# BCS Certificate in Systems Design Techniques

**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.

# SYSTEMS DESIGN TECHNIQUES

## Questions on design approaches, class diagram, component design, refactoring, RDA, and data access paths

### Scenario 1

Sun Villas has developed and now manages a complex of 700 villas in The Algarve, situated next to two 18 hole golf courses owned by Algarve Golfing. Algarve Golfing has recently merged with Sun Villas and this scenario describes requirements emerging from this merger. The merger agreement has created a holding company and has specified that the two enterprises shall continue to operate as separate businesses but shall exploit business opportunities arising from shared interests. One opportunity is for villa visitors to become temporary members of the golf club whilst they are on holiday.

Sun Villas sells villas to private owners. Sales are generated through their website which they manage with their own IT support staff. Most villa owners will offer their villa for rental when they are not there. Although the villas can be seen on the website they cannot be booked through it. Providing an internet based rental booking system is one of the developments Sun Villas wants to introduce.

The holding company wants to separate the villa rental business from villa construction and sales so the construction business can concentrate on sales to prospective clients. The current web-based villa sales system stores the descriptions of the different types of villa and their facilities and the details of current villa owners. These are stored as XML documents and the villa descriptions can be viewed by both prospective sales and rental clients. A Class diagram of this is attached as Appendix 3. The group's IT strategy is to develop the web-based technology to include rental bookings. All the villas are built to standard designs and each design accommodates a maximum number of occupants. All occupants for a rental booking must be registered by name when the booking is made and the balance of all fees is payable no later than 30 days before the Start Date of the Rental Period. For legal reasons, the renter cannot be younger than 18 years of age at the time of booking.

Algarve Golfing uses a Golf Club Membership package which holds membership details on an SQL server database to bill members for their fees. Guests are registered as temporary members and pay green fees per round. Algarve Golfing were joint developers of this package and are committed to it for the foreseeable future. Any visitor registered as renting a Sun Villas apartment may play as a guest member. Members and guests want to be able to book rounds on future dates and Algarve Golfing want to extend their system to accommodate this. The holding company has also specified a management information requirement for an analysis of the course usage by member, guest, villa occupant, date and time. The marketing director has asked for a further analysis by weather conditions at the time of the round but this requirement has yet to be agreed.

Amongst the solution delivery tasks that have been specified are:-

- 1.1 Refactor the objects, shown in Appendix 3, which at present hold the details of the villa owner, the villa and the villa type, to hold details of villa guests and prospective villa buyers to meet the requirements referred to above.
- 1.2 Redesign the SQL database, shown in Appendix 1, to store bookings from members and villa occupants and to accumulate management information.
- 1.3 Propose a target design, using a component diagram, for the integration of the Villa web-based system with the Algarve Golfing system, retaining both companies' present discreet system facilities.

### Question

Specify two different design approaches you would recommend Sun Villas could use to successfully deliver the developments referred to in the scenario and for each approach state, with reference to the scenario, the aspect of the development which has influenced your recommendation

(4 Marks)

Identify, from the scenario, one business constraint, one application constraint and one IT constraint that will impact upon the design of the solution. For each constraint state a significant issue that Sun Villas should be aware of.

(6 Marks)

### Question

Appendix 3 shows a class model used by the present web-based system. The objects are stored as documents defined by XML schemas. Refactor this design to **improve re-usability** and **include** the details of villa rental clients and their rental start and end dates, the number of occupants and the name of the occupants of each rented villa and the name and address of prospective purchasers together with the type of villa they have shown an interest in.

(10 Marks).

### Question

Show, with a component diagram, a platform independent model with required and provided interfaces, which will meet the requirements of the present systems and the proposed developments.

(10 Marks)

Note. You should state any assumptions you have made to produce this model.

### Question

Appendix 4 shows a sequence diagram of the present web based system. Appendix 5 shows a class diagram in which the Villa object has the attribute Rental Calendar which holds the available dates for a particular villa. The object 'Complex' holds general details of the locations Sun Villas own. Details of each type of villa and its facilities are held by the object Villa Type.

Refactor this sequence diagram to include a facility for the prospective rental clients to view the availability of villas.

(9 Marks)

NB. The class model shown in Appendix 5 incorporates some of the refactorisation required by Question 2 above, and also includes the object 'Complex' .

### Question

- (a) Appendix 1 shows a subset of the entity/attribute model of the SQL database at Algarve Golfing dealing with membership payments. Modify this data structure to store bookings from members to play a round of golf. The booking data should:
- i) Identify the member who made the booking and the date and time the booking was made
  - ii) Identify the players (members) and the results for each member
  - iii) Record the fee charged for the booking (note: the fee is based on the course but course fees may change over time)
  - iv) Record the name of the course where the round was played
  - v) Record each player's handicap when the round was played

(Note: your answer to question 5(a) must be supplied by amendments to appendix 1).

(10 Marks)

- (b) Appendix 2 contains a sample villa booking form used with the existing business process. Using Relational Data Analysis produce a normalised data structure from this data source showing the progressive normalisation through first, second and third normal forms. State any assumptions you have made when producing your answer.

(8 Marks)

## Question

(a) The management information reporting requirements for the new Sun Villas booking system include an analysis of the course usage by member. The report is to be selected by course and date range and is to include the following data attributes:

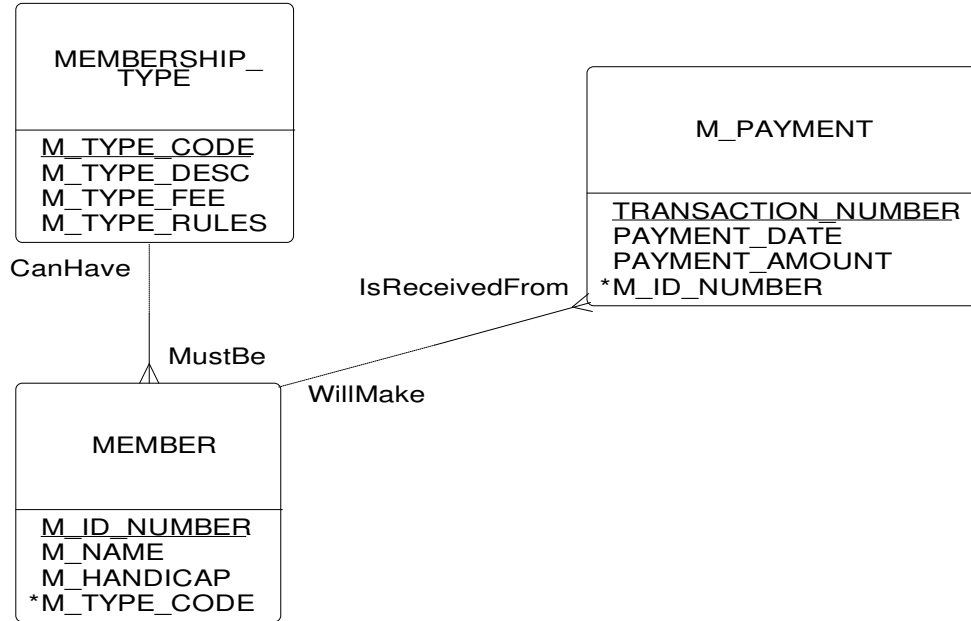
- Course name
- Booking date
- Member name (who made the booking)
- Member type (description)
- Fee charged
- Date and time of the round
- Player name
- Player handicap
- Result

Draw a data access path on to your solution to question 5 a) to reflect this requirement. Your solution should indicate which attributes are retrieved from which entities.

(6 Marks)

## APPENDIX 1

NOTE: Primary Key field underlined; Foreign Key Field marked \*



**APPENDIX 2**

# Sun Villas

## Rental Booking

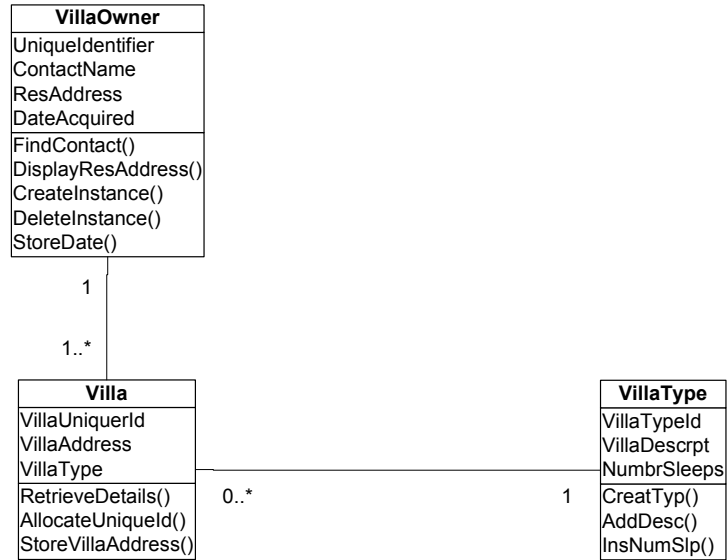
|                      |         |              |            |
|----------------------|---------|--------------|------------|
| Booking reference no | 0089762 | Booking date | 21/02/2011 |
|----------------------|---------|--------------|------------|

| PRINCIPAL RENTER DETAILS |  | RENTAL DETAILS  |               |
|--------------------------|--|-----------------|---------------|
| Renter id                | 056351   | Villa Id        | BCT08219A     |
| Renter name              | Harry Michaels                                   | Villa type      | 6-berth cabin |
| Address                  | The Wolds<br>Harpenden Road<br>Amersham<br>Bucks | Start date      | 11/06/2011    |
|                          |  | End date        | 18/06/2011    |
|                          |  | Booking deposit | 250.00 GBP    |
| Post code                | AM2 9XP  | Damage deposit  | 500.00 GBP    |
| Telephone                | 07999 100255                                     | No of guests    | 5             |
| Date of birth            | 27/08/1958                                       |                 |               |

|    | Guest name      | Age<br><i>(if under 18)</i> | Golf handicap |
|----|-----------------|-----------------------------|---------------|
| 1  | Harry Michaels  |                             | 7             |
| 2  | Denis Wilson    |                             | 10            |
| 3  | Paul Kell       |                             | 12            |
| 4  | Andrew McCarthy |                             | 9             |
| 5  | Ben McCarthy    | 17                          | 15            |
| 6  |                 |                             |               |
| 7  |                 |                             |               |
| 8  |                 |                             |               |
| 9  |                 |                             |               |
| 10 |                 |                             |               |

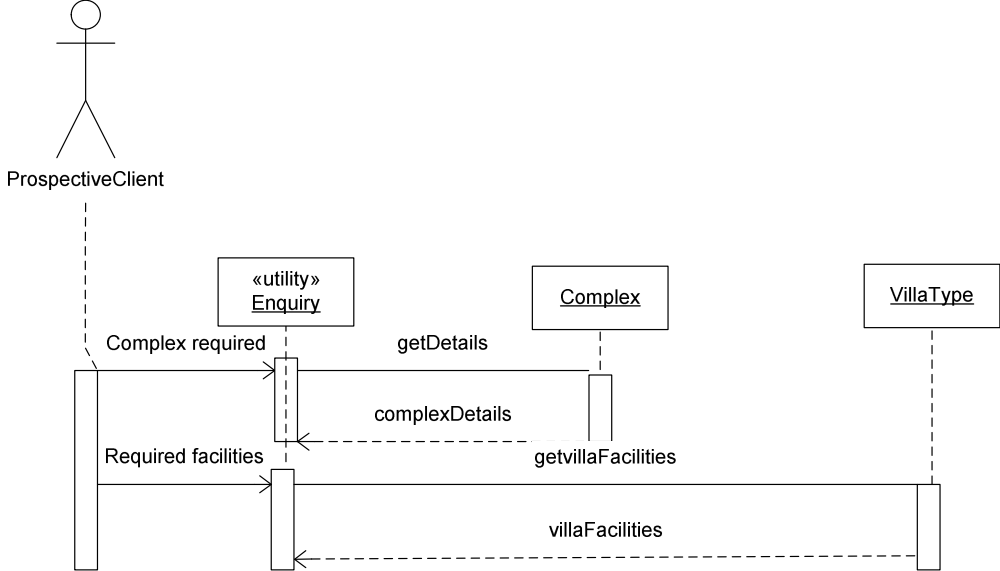
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## APPENDIX 3

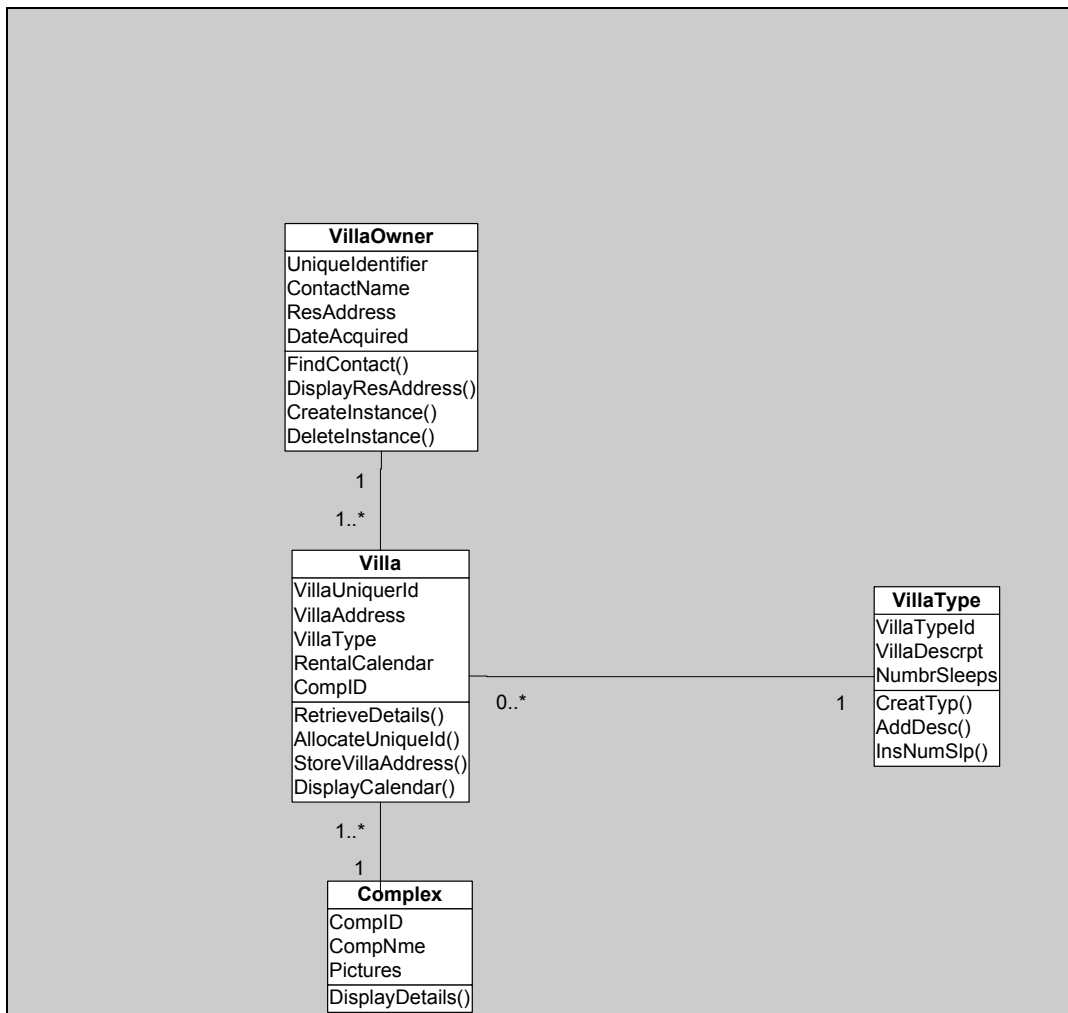




APPENDIX 4



## APPENDIX 5



## Specimen answer and marking scheme

### Question 1.

Specify two different design methods you would recommend Sun Villas to use to successfully deliver the developments referred to in the scenario and for each method state the aspect of the development which has influenced your recommendation

(4 Marks)

Identify, from the scenario, one business constraint, one application constraint and one IT constraint that will impact upon the design of the solution. For each constraint state a significant issue that Sun Villas should be aware of.

(6 Marks)

From the scenario:

A component based approach is recommended for the development of the rental booking scheme because:

*'The group's IT strategy is to develop the web-based technology to include rental bookings.'*

A data driven approach is recommended for the development of the golf booking scheme because:

*"Algarve Golfing holds membership details on an SQL server database which is used to bill members for their fees"*

and, an ancillary reason:

*"The holding company has also specified a management information requirement for an analysis of the course usage by member, guest, villa occupant, date and time"*

Business Constraint:

*". The merger agreement which is managed by a holding company has specified that the **two enterprises** shall continue to operate as separate businesses"*

*"Algarve Golfing were **joint developers of this package** and are committed to it for the foreseeable future"*

Application Constraint:

*"The current **web-based sales system** stores the descriptions of the different types of villa and their facilities and all the details of the owners"*

*"Algarve Golfing uses a **Golf Club Membership package** which holds membership details on an SQL server database to bill members for their fees."  
"*

IT Constraint

*"An **SQL server database**"*

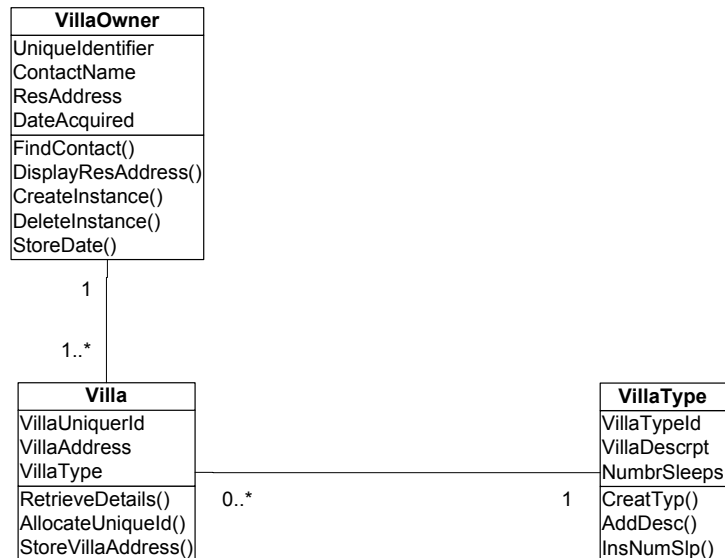
*"These are stored **as XML documents** and the villa descriptions can be viewed by both prospective sales and rental clients."*

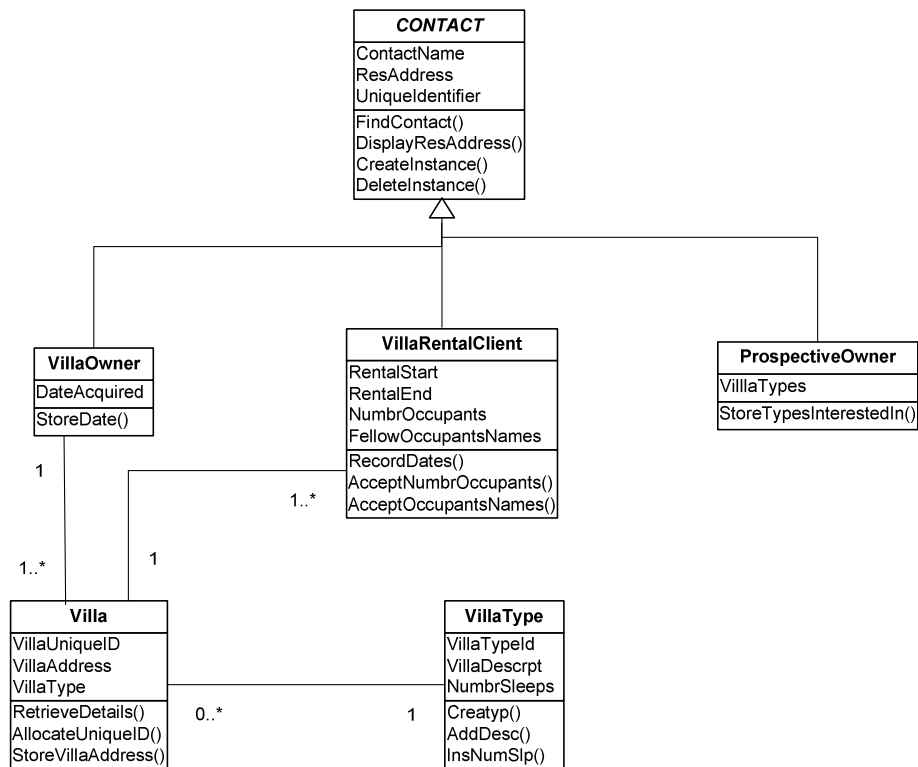
## Question 2.

Appendix 3 shows a class model used by the present web-based system. The objects are stored as documents defined by XML schemas. Refactor this design to **improve re-usability** and **include** the details of villa rental clients and their rental start and end dates, the number of occupants and the name of the occupants of each rented villa and the name and address of prospective purchasers together with the type of villa they have shown an interest in.

(10 Marks).

## Appendix 3





4 marks for the superclass CONTACT showing the generalisation and associations.

2 marks for suitable attributes for the superclass (1 mark per attribute).

2 marks for suitable operations for the superclass. (1 mark per operation). The operations do not have to match exactly the ones shown in the solution but should be appropriate for the class. Assumptions about the behaviour of the class may be included to clarify your answer.

1 mark for the additional class Prospective Owner.

1 mark each for the associations between Villa Owner and Villar Rental Client and Villa.

(The multiplicities are shown for clarification and are not included/excluded in the award of these marks).

Alternative solutions will be awarded marks. A solution which does not include the generalisation but includes objects which will meet the requirement will be awarded 2/1/1 marks respectively.

### Question 3

Show, with a component diagram, a platform independent model with required and provided interfaces which will meet the requirements of the present systems and the proposed developments.

(10 Marks)

Note. You should state any assumptions you have made to produce this model.

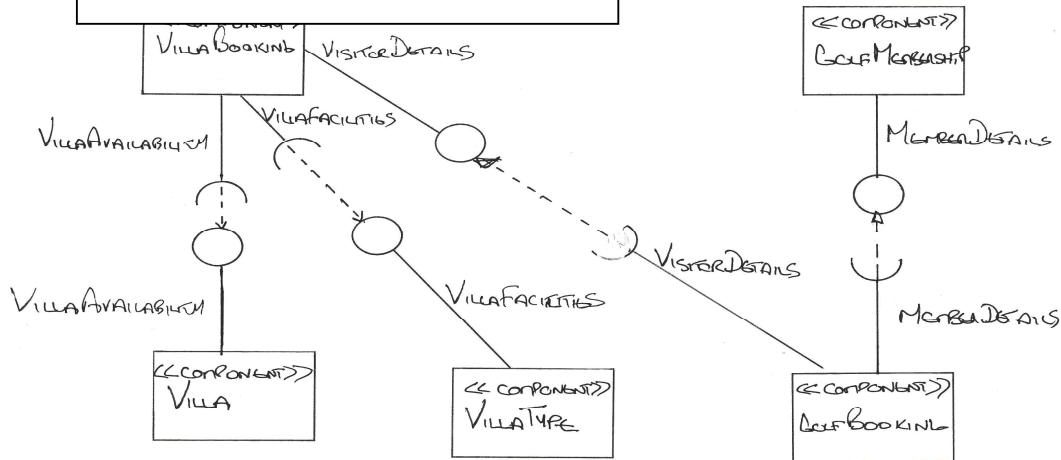
5 marks for the components - 1 per component. 1/2 mark for a component shown with wrong notation.


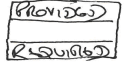
4 marks for the interfaces - 1/2 mark for an interface shown the wrong way round.

1 mark for all the four dependency arrows.



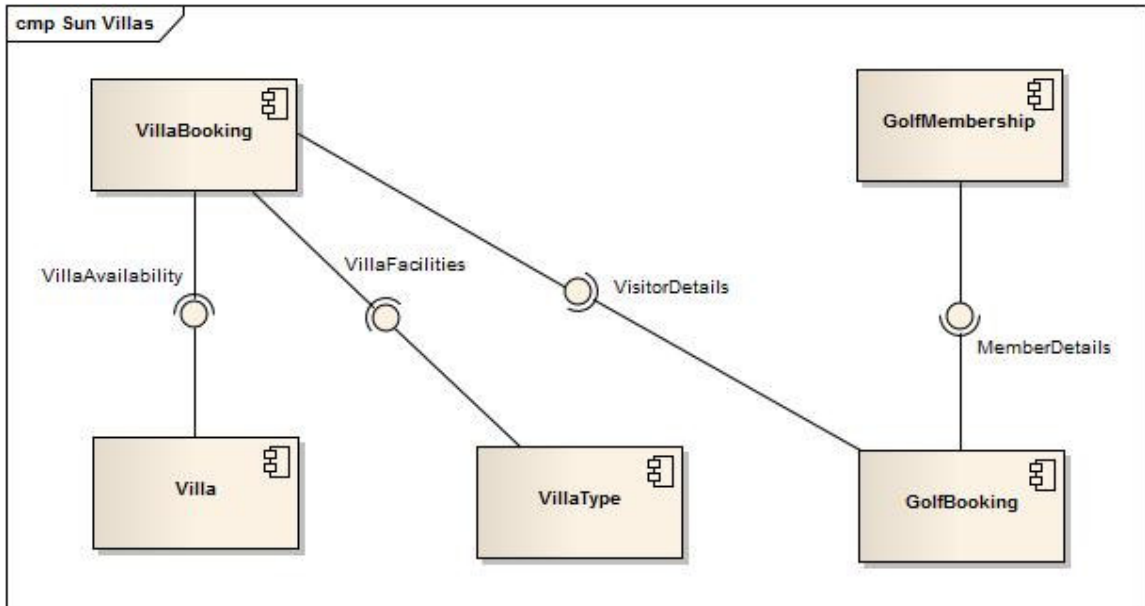
Question 3 Component diagram



- ALTERNATIVES:
- i) <<COMPONENTS>> MIGHT BE SUBSTITUTED BY  IN RECTANGLES
  - ii) INTERFACES MIGHT BE SHOWN AS TEXT 
  - iii) ALTERNATIVE COMPONENTS eg: VillaBooking & VillaVisitor AS SEPARATE.

UML2 component diagram. Notation based on :-  
<http://www.ibm.com/developerworks/rational/library/dec04/bel>

Alternative notations are acceptable for the component diagram where these notations are recognised as being UML diagramming conventions. A tool drawn solution as shown below would receive 1.25 marks per interface correctly shown.



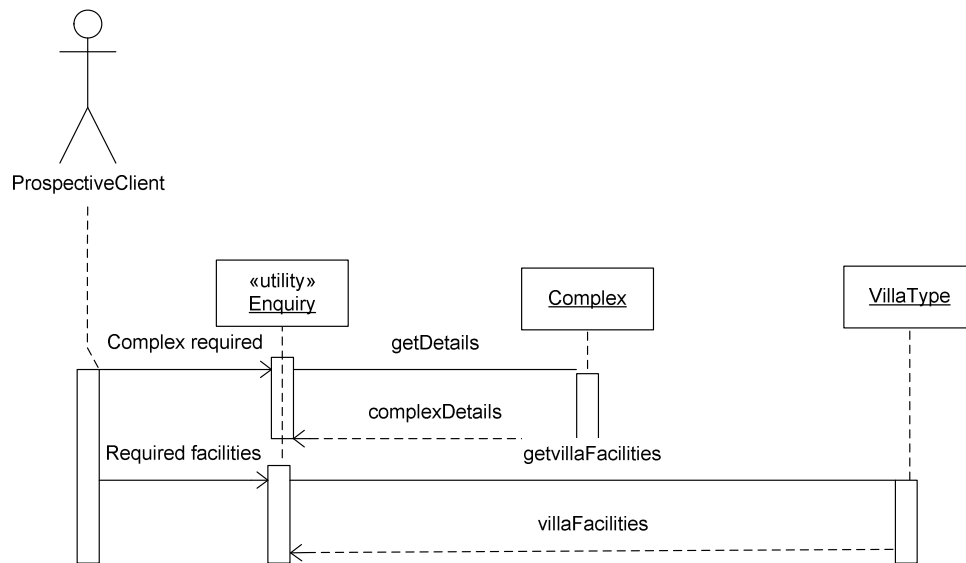
### Question 4

Appendix 4 shows a sequence diagram of the present web based system. Appendix 5 shows a class diagram in which the Villa object has the attribute Rental Calendar which holds the available dates for a particular villa. The object 'Complex' holds general details of the locations Sun Villas own. Details of each type of villa and its facilities are held by the object Villa Type.

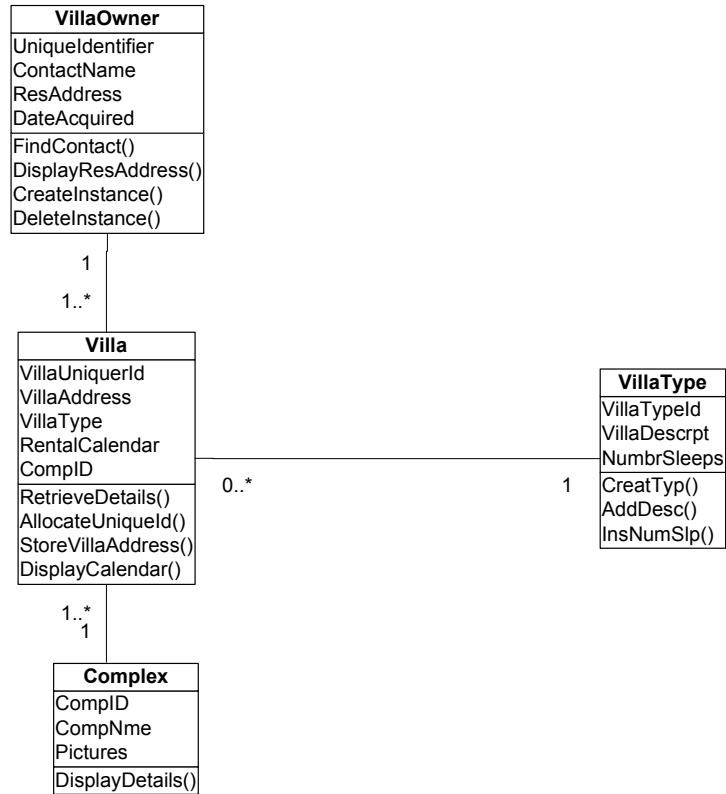
Refactor this sequence diagram to include a facility for the prospective rental clients to view the availability of villas.

(9 Marks)

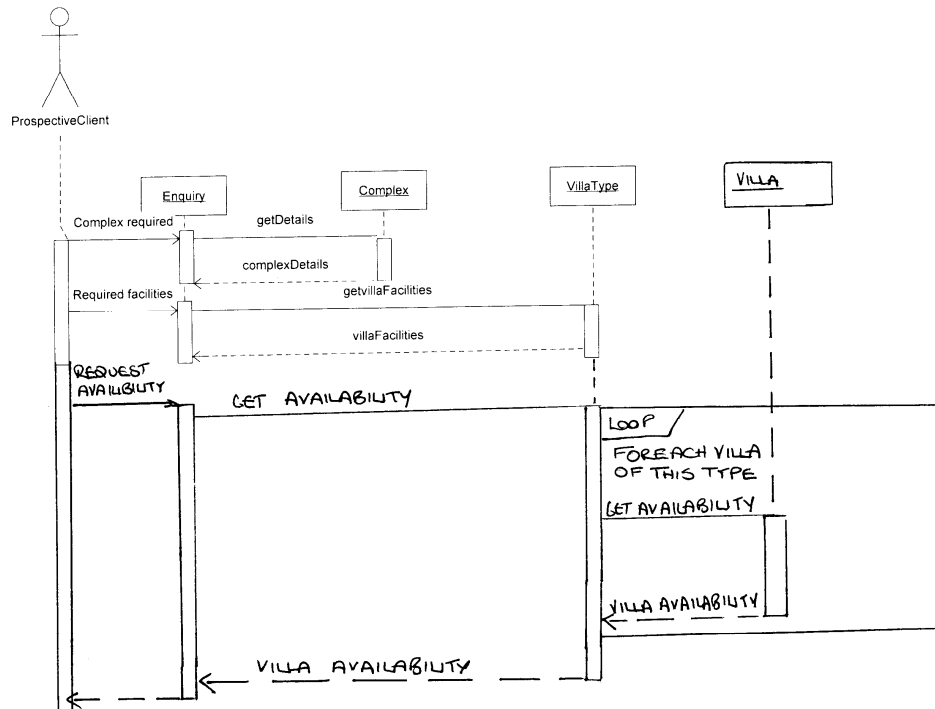
### APPENDIX 4



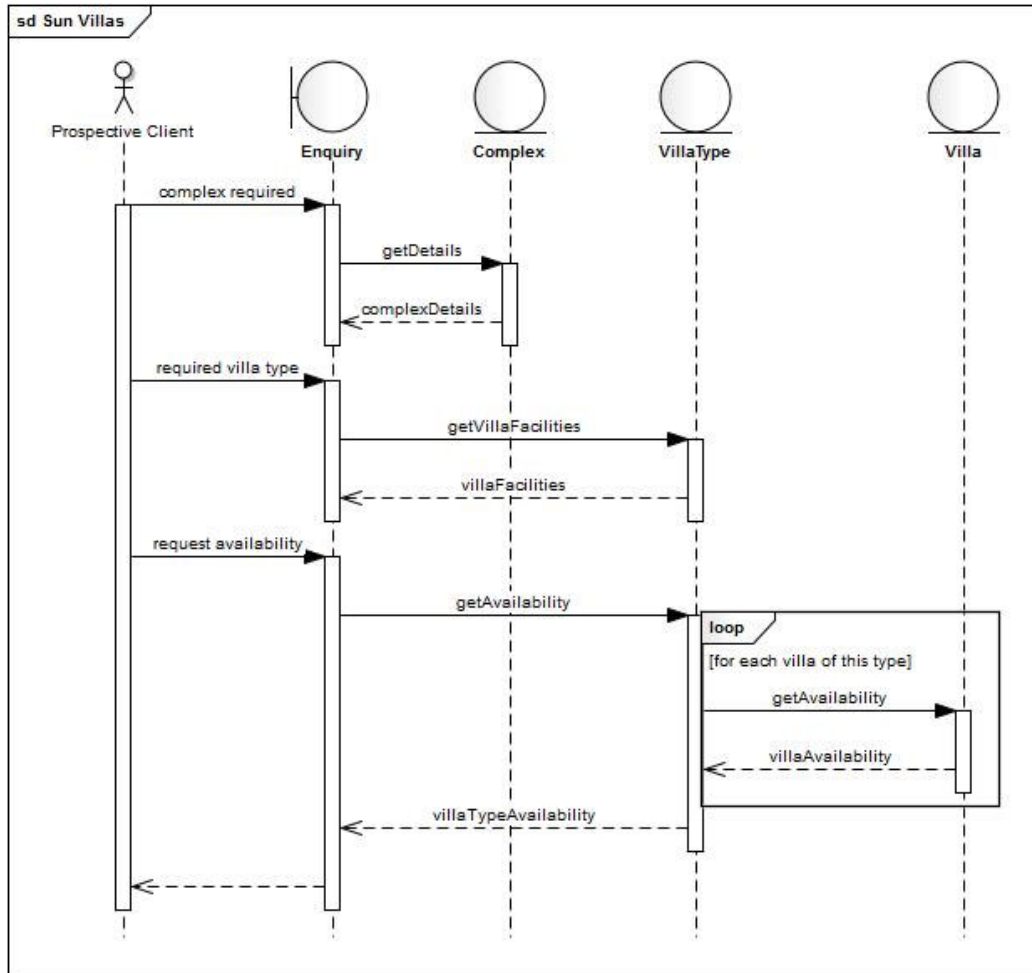
## APPENDIX 5



## Question 4 Solution hand drawn



## Machine Drawn Solution.



1 mark each for the 3 messages

1 mark each for the 3 returns.

1 mark for the object Villa

1 mark for re-activation of Villa Type

2 marks for the loop

### Question 5

a) Appendix 1 shows a subset of the entity/attribute model of the SQL database at

Algarve Golfing dealing with membership payments. Modify this data structure to

store bookings from members to play a round of golf. The booking data should:

- i) Identify the member who made the booking and the date and time the booking was made
- ii) Identify the players (members) and the results for each member
- iii) Record the fee charged for the booking (note: the fee is based on the course but course fees may change over time)
- iv) Record the name of the course where the round was played
- v) Record each player's handicap when the round was played

(Note: your answer to question 5(a) must be supplied by amendments to appendix 1).

(10 Marks)

b) Appendix 2 contains a sample villa booking form used with the existing business

process. Using Relational Data Analysis produce a normalised data structure from

this data source showing the progressive normalisation through first, second and

third normal forms. State any assumptions you have made when producing your

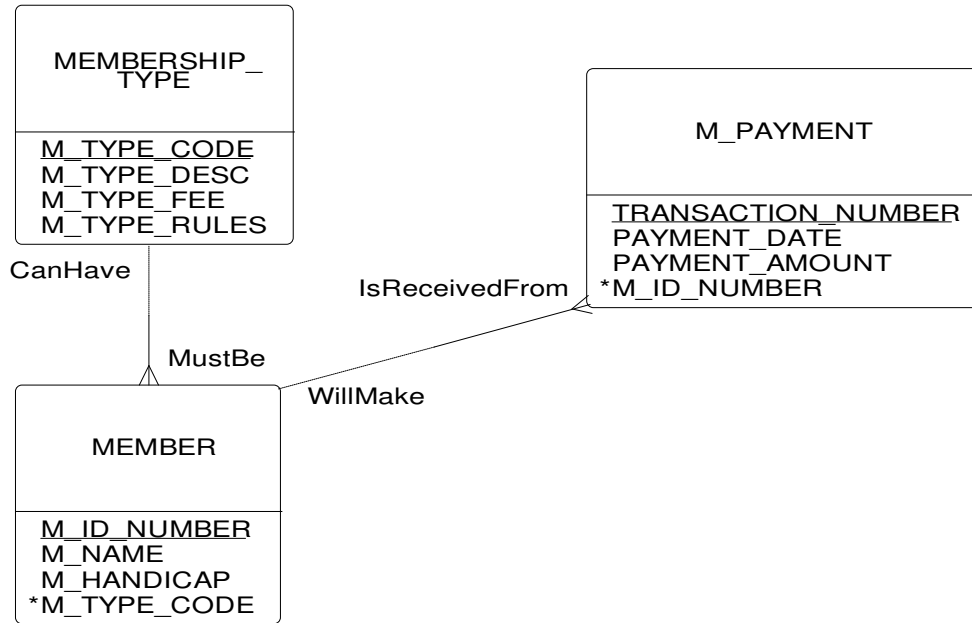
answer.

(8 Marks)

### APPENDIX 1

NOTE: Primary Key field underlined; Foreign Key Field marked \*





**APPENDIX 2**

# Sun Villas

## Rental Booking

|                      |         |              |            |
|----------------------|---------|--------------|------------|
| Booking reference no | 0089762 | Booking date | 21/02/2011 |
|----------------------|---------|--------------|------------|

| PRINCIPAL RENTER DETAILS |  | RENTAL DETAILS  |               |
|--------------------------|--|-----------------|---------------|
| Renter id                | 056351   | Villa Id        | BCT08219A     |
| Renter name              | Harry Michaels                                   | Villa type      | 6-berth cabin |
| Address                  | The Wolds<br>Harpenden Road<br>Amersham<br>Bucks | Start date      | 11/06/2011    |
|                          |  | End date        | 18/06/2011    |
|                          |  | Booking deposit | 250.00 GBP    |
| Post code                | AM2 9XP  | Damage deposit  | 500.00 GBP    |
| Telephone                | 07999 100255                                     | No of guests    | 5             |
| Date of birth            | 27/08/1958                                       |                 |               |

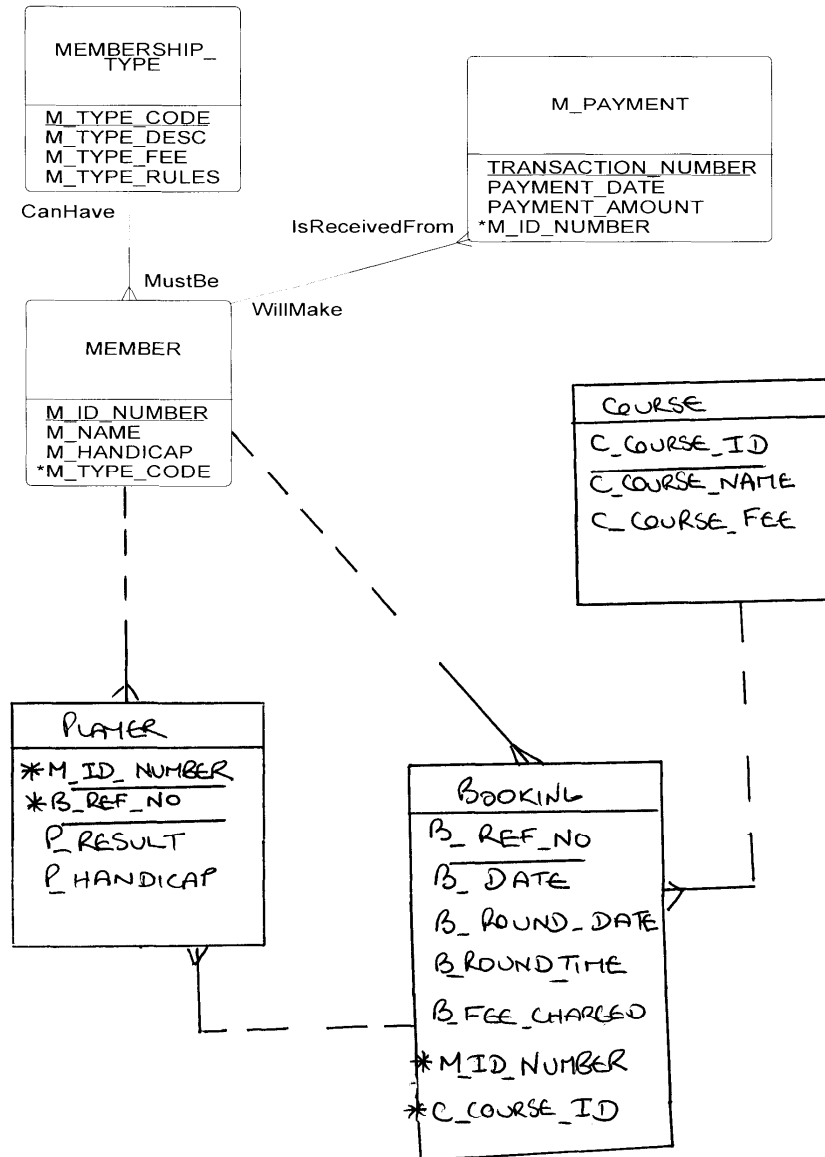
|    | Guest name      | Age<br><i>(if under 18)</i> | Golf handicap |
|----|-----------------|-----------------------------|---------------|
| 1  | Harry Michaels  |                             | 7             |
| 2  | Denis Wilson    |                             | 10            |
| 3  | Paul Kell       |                             | 12            |
| 4  | Andrew McCarthy |                             | 9             |
| 5  | Ben McCarthy    | 17                          | 15            |
| 6  |                 |                             |               |
| 7  |                 |                             |               |
| 8  |                 |                             |               |
| 9  |                 |                             |               |
| 10 |                 |                             |               |

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# Question 5a manual submission

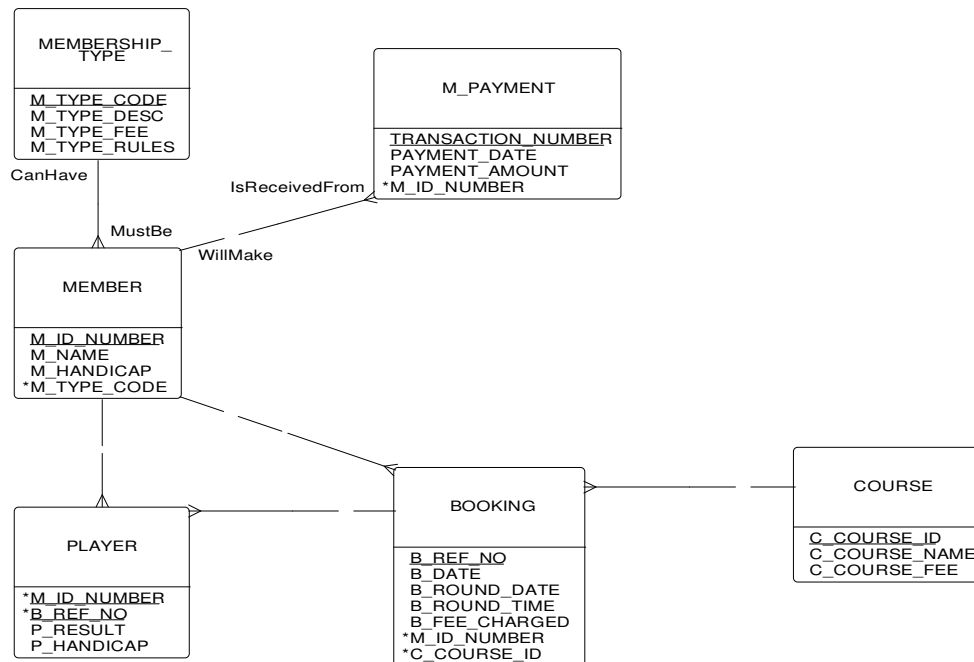
## APPENDIX 1

NOTE: Primary Key field underlined; Foreign Key Field marked \*





## Question 5a Revised Entity Model ( Machine Drawn)



Award marks as follows:

- 1 mark for each correct additional entity with correct foreign and primary keys. (total 3 marks - 1/2 mark for correct entity with incorrect keys)
- 1 mark for each correct attribute set (total 3 marks)
- 1 mark for each relationship showing the correct cardinality (total 4 marks)

(Total 10 marks)





## Question 6

(a) The management information reporting requirements for the new Sun Villas booking system include an analysis of the course usage by member. The report is to be selected by course and date range and is to include the following data attributes:

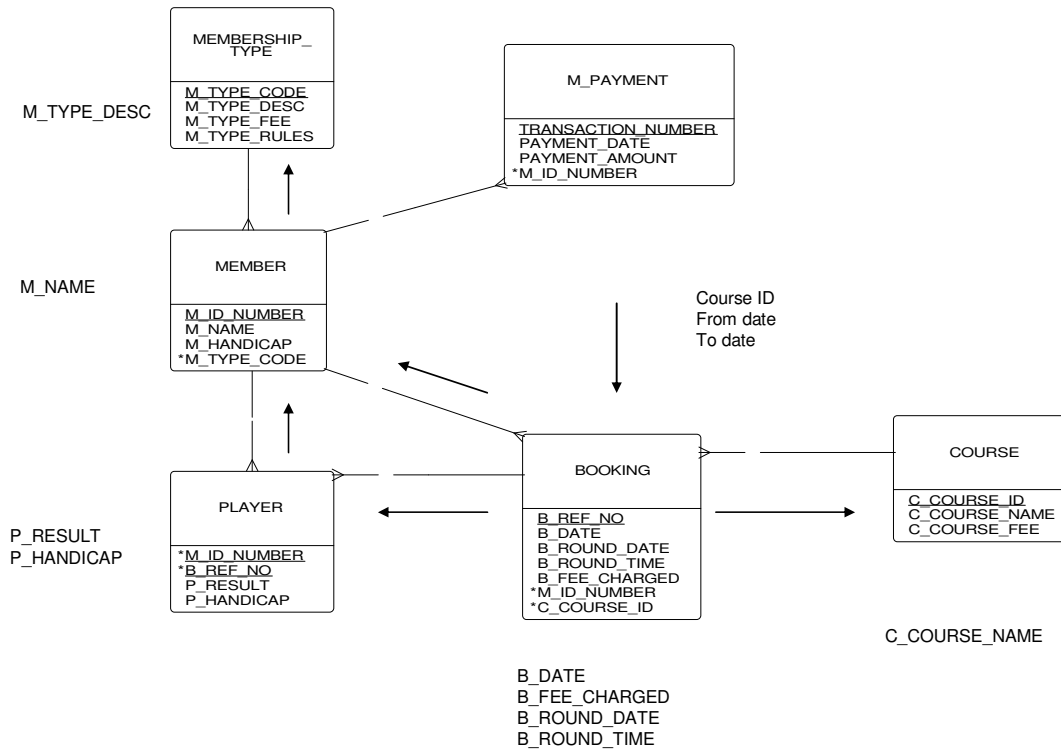
- Course name
- Booking date
- Member name (who made the booking)
- Member type (description)
- Fee charged
- Date and time of the round
- Player name
- Player handicap
- Result

Draw a data access path on to your solution to question 5 a) to reflect this requirement. Your solution should indicate which attributes are retrieved from which entities.

(6 Marks)



### Question 6 ( Data Access Diagram)





Award marks as follows:

- ½ mark for each correct navigation arrow (total 3 marks)
- ½ mark for each correct attribute list (total 3 marks)

(Total 6 marks)