MTH785P: Programming for Business Analytics

Duration: 3 hours

Apart from this page, you are not permitted to read the contents of this question paper until instructed to do so by an invigilator.

The exam is intended to be completed within **3 hours**. However, you will have a period of **4 hours** to complete the exam and submit your solutions.

> **You should attempt ALL questions. Marks available are shown next to the questions.**

> You are allowed to bring **three A4 sheets of paper** as notes for the exam.
>
> **Calculators are not permitted** in this examination. The unauthorised use of a calculator constitutes an examination offence.

> Complete all rough work in the answer book and cross through any work that is not to be assessed.

Examiners: Dr Justin Ward and Dr Sebastian del Bano Rollin

Question 1 [33 marks].   MS Access and SQL
You work for a company that produces and sells widgets. The company manages its operations with a small MS Access database, containing 2 tables: Workers, and Assignments. Each worker has associated with them an ID, a name, and hourly rate. Workers can be assigned to tasks. Each such assignment consists of the worker assigned to the task, a description of the task, and the total number of hours required to complete the task.

Here are some tables with field names and records from out database. In both tables, the field ID is the primary key.

Workers		
ID	Name	Hourly Rate
1	"Justin Ward"	37.30
2	"Maximo Gallardo"	55.40
3	"Martyna Zawadzka"	50.20

Assignments			
ID	Worker	Name	Hours Required
1	1	"Clean break room"	2.5
2	2	"Make widgets"	38.0
3	1	"Paint widgets"	25.0
4	3	"Package and ship widgets"	25.0
5	3	"Update database"	5.0

(a) Give the table that is produced by running the following SQL instruction on this database.

```
SELECT Workers.Name, Assignments.Name, Assignments.Hours
FROM
Workers INNER JOIN Assignments
ON Assignments.Worker = Workers.ID;
```

[5]

(b) Give an SQL instruction that will prompt the user for a parameter "Wage Threshold" and then return a list containing the names of workers whose Hourly Rate is at least as large as the given threshold. For example, on the tables shown above if the user inputs 50 for "Wage Threshold", your instruction should produce:

Name
"Maximo Gallardo"
"Martyna Zawadzka"

[5]

(c) Give an SQL instruction that will return each worker's name followed by a column "Workload" giving the total number of hours for the tasks to which they have been assigned. For example, on the tables shown above, your instruction should produce:

Worker	Workload
"Justin Ward"	27.5
"Maximo Gallardo"	38.0
"Martyna Zawadzka"	30.0

[8]

(d) Briefly explain what happens when we run the following SQL instruction on the tables shown above.

```
INSERT INTO Workers
VALUES (1, "Sebastian Del Bano Rolin", 62.20);
```

[5]

(e) Suppose now that we want to be able to track tasks separately and (potentially) assign more than one worker to the same task. For example, we might want to assign Justin Ward and Maximo Gallardo to spend 10 and 17.5 hours, respectively, on painting widgets. Give a new database design to accomplish this.

You should list the tables, field names, and field data types for your database. You do **not** need to carry over the same data stored in the tables above. **Instead**, give 3 sample records for each table, and explain the working schedule they are meant to describe. [10]

Question 2 [33 marks].   Excel

The widget company is developing an Excel worksheet for managing orders. The current month's order sheet looks like this:

	A	B	C	D	E	F	G	H	I
1	Widget Orders							Price Bands	
2								A	£10.05
3								B	£9.80
4	Customer	Invoice Date	Quantity	Price Band	Invoice Total	Due Date		C	£9.20
5	Widgets 4 Less	11/12/2022	100					D	£8.80
6	Total Widget Solutions	13/11/2022	50						
7	The East End Widget Company	01/12/2022	65						
8	Ward's Widget Warehouse	13/12/2022	72						
9	Widget Direct	15/11/2022	30						
10									
11									
12									

For each customer order, a different price per widget can be given. The price per widgets must come from one of 4 pre-negotiated "price bands" A,B,C, or D. For example, if the "Widgets 4 Less" order is sold using price band B, then their total price will be $100 * 9.80 = 980.00$.

The range $H\$2:\$H\$5$ listing the bands has been named "PriceBandList" and the range $\$H\$2:\$I\$5$ containing the entire table has been named "PriceBandTable".

(a) Explain how you could create a drop-down entry box like the following for the Price Band column of the spreadsheet that only allowed users to select valid price band entries:

[5]

(b) Give a formula for the cell E5 that uses the selected price band and quantity to calculate the total cost of the widgets ordered for the customer in row 5. You should give a formula that can be copied down to all customer rows to give the correct total in column E for each row.   [5]

(c) Each order should be filled at most 5 days (including weekends and holidays) after its invoice date. Give a formula for the cell F5 that calculates the due date for the widgets ordered by the customer in row 5. You should give a formula that can be copied down to all customer rows to give the correct date in column F for each row **also briefly explain the rationale for how you used this formula to compute the date**. [8]

(d) After making these changes suppose we have a sheet that looks like this:

	A	B	C	D	E	F	G	H	I
1	Widget Orders							Price Bands	
2								A	£10.05
3								B	£9.80
4	Customer	Invoice Date	Quantity	Price Band	Invoice Total	Due Date		C	£9.20
5	Widgets 4 Less	11/12/2022	100	D	£880.00	16/12/2022		D	£8.80
6	Total Widget Solutions	13/11/2022	50	B	£490.00	18/11/2022			
7	The East End Widget Company	01/12/2022	65	B	£637.00	06/12/2022			
8	Ward's Widget Warehouse	13/12/2022	72	C	£662.40	18/12/2022			
9	Widget Direct	15/11/2022	30	A	£301.50	20/11/2022			
10									
11									

We want to change the background of cells in columns A through E to red in those rows for which the due date is today or earlier. Explain in detail how we could do this. You should state any formulas used in the formatting process. [5]

(e) Give two different Excel error codes with an example of when each might occur. [10]

Question 3 [34 marks].   Visual Basic for Applications (VBA)

(a) Provide a VBA subroutine that, on the currently active sheet, divides the value in cell B5 by the value in cell B7 and places the result in cell C2. If this causes an error to be raised, your subroutine should write the text "Error" in cell C2 instead. [8]

(b) Explain what Option Explicit does when added to the top line of a VBA script, and why we typically use this option. [4]

(c) Suppose we have a spreadsheet with a cell labelled "Total". Your colleague has developed the following VBA function ApplyDiscount that will apply a discount factor (between 0 and 1) to some value, and a subroutine DiscountTotal, that should apply a 25% discount to the cell "Total," store the result back into this cell, and raise a message box showing how much was saved by the discount:

```vba
Option Explicit

Function ApplyDiscount(price As Double, factor As Double) As Double
    'Rescale value using discount factor
    price = (1 – factor) * price
    'Return the updated value
    ApplyDiscount = price
End Function

Sub DiscountTotal()
    Dim priceBeforeDiscount As Double, priceAfterDiscount As Double
    'Get original price before processing
    priceBeforeDiscount = Range("Total").Value
    'Calculate price with 25% discount and update sheet
    priceAfterDiscount = ApplyDiscount(priceBeforeDiscount, 0.25)
    'Enter the new price in the sheet
    Range("Total").Value = priceAfterDiscount
    'Calculate how much was saved and print a message.
    MsgBox ("Total Savings was: " & (priceBeforeDiscount – priceAfterDiscount))
    Exit Sub
End Sub
```

Suppose we run DiscountTotal with 1000 stored in the cell "Total" of the current sheet. Answer the following questions:

(i) What will be stored in the cell "Total" after running the subroutine?

(ii) What will printed in the message box when the sub-routine runs?

(iii) How would you explain to your colleague what happened, and how would you modify their code so that it worked as intended?

[12]

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(d) Suppose we have an Excel sheet that has a list of books each with an ISBN (this is a number used by publishers to uniquely identifies books), author, publication date, title, and average user rating:

	A	B	C	D	E
1	ISBN	Author	Publication Date	Title	Average Rating
2	9780439023480	Suzanne Collins	2008	The Hunger Games	4.34
3	9780439554930	J.K. Rowling	1997	Harry Potter and the Philosopher's Stone	4.44
4	9780316015840	Stephenie Meyer	2005	Twilight	3.57
5	9780061120080	Harper Lee	1960	To Kill a Mockingbird	4.25
6	9780743273560	F. Scott Fitzgerald	1925	The Great Gatsby	3.89
7	9780525478810	John Green	2012	The Fault in Our Stars	4.26
8	9780618260300	J.R.R. Tolkien	1937	The Hobbit or There and Back Again	4.25
9	9780316769170	J.D. Salinger	1951	The Catcher in the Rye	3.79
10	9781416524790	Dan Brown	2000	Angels & Demons	3.85
11	9780679783270	Jane Austen	1813	Pride and Prejudice	4.24
12	9781594480000	Khaled Hosseini	2003	The Kite Runner	4.26
13	9780062024040	Veronica Roth	2011	Divergent	4.24
14	9780451524940	George Orwell	1949	Nineteen Eighty-Four	4.14
15	9780452284240	George Orwell	1945	Animal Farm: A Fairy Story	3.87

(i) Provide the VBA code for creating a user defined type called `Book` to store all the information about a single book. **[5]**

(ii) Using your datatype, provide a function `BookFromRow` that takes an integer, representing the row number from the spreadsheet, and returns a `Book` representing the book whose data is stored in this row of the spreadsheet. **[5]**

End of Paper.