Level 3 Data representation and manipulation (7540-045)

Systems and Principles
Assignment guide for Candidates
Assignment A

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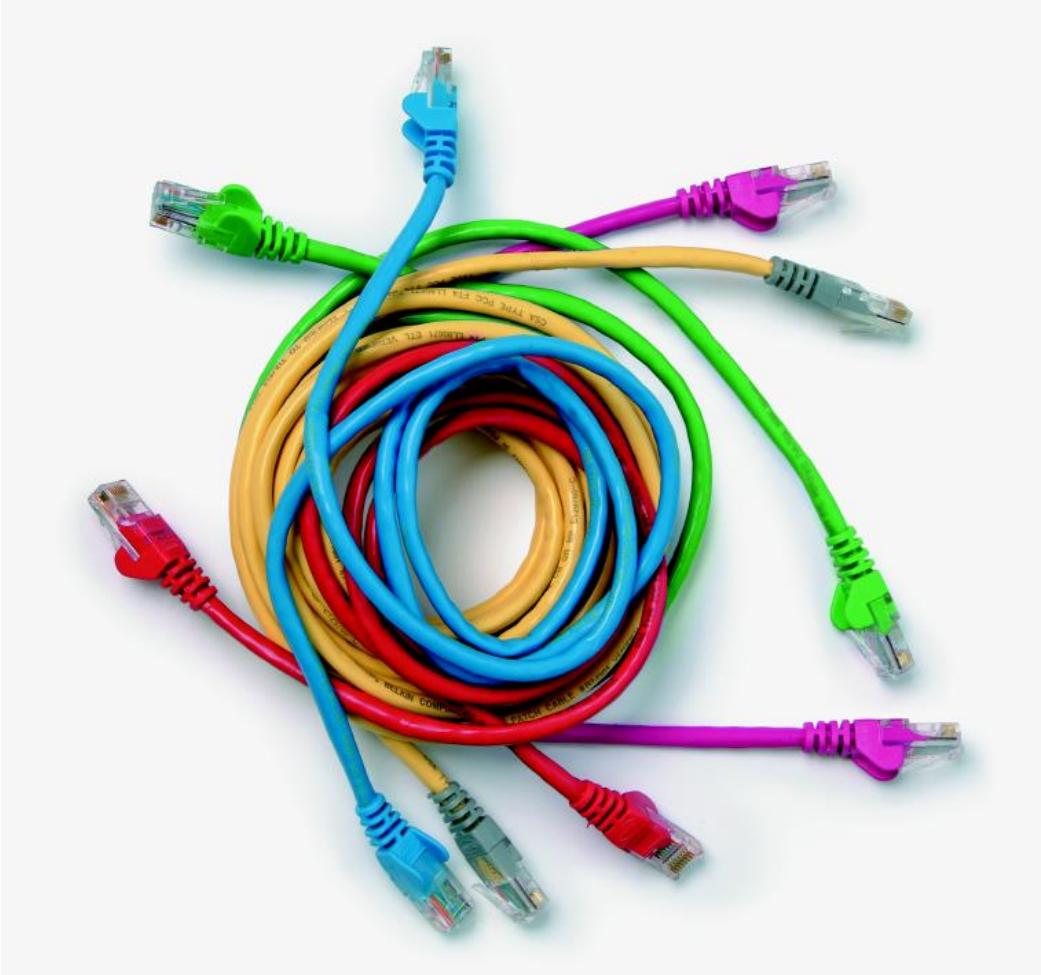

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Level 3 Data representation and manipulation (7540-045) Assignment A

Introduction – Information for Candidates

About this document

This assignment comprises all of the assessment for Level 3 Data representation and manipulation (7540-045).

Health and safety

You are asked to consider the importance of safe working practices at all times.

You are responsible for maintaining the safety of others as well as your own. Anyone behaving in an unsafe fashion will be stopped and a suitable warning given. You will **not** be allowed to continue with an assignment if you compromise any of the Health and Safety requirements. This may seem rather strict but, apart from the potentially unpleasant consequences, you must acquire the habits required for the workplace.

Time allowance

The recommended time allowance for this assignment is **3 hours**.

Level 3 Data representation and manipulation (7540-045)

Candidate Instructions

Time allowance: 3 hours

Assignment set up:

You should have the following for this assessment

- a pen with black or blue ink
- a pencil and eraser
- a 30cm ruler
- graph paper
- a calculator

- You may use a protractor.
- You may use a dictionary.

This assignment is made up of **three** tasks:

- Task A – Apply matrix methods
- Task B – Apply series, probability and recursions
- Task C – Apply graph theory

Task A – Apply matrix methods

Please use the Answer Sheet provided to complete Task A.

Scenario

A large software house that creates CADSIM systems has used Visual C++ to develop a product that allows shapes to be drawn in a window then to animate the shape. The shape is a wire-frame model using simple coordinate vertices and then translation of these points to move the object about the window. The implementation of this in the software program uses the creation and manipulation of dimensional arrays; the mathematics behind this concept is matrix applications. Below are some practice matrix manipulation exercises that need to be solved, these exercises with your solutions will then be used as examples and added to the 'help' facility that will be issued with the software.

Write your working out and answers in the space provided on the Answer Sheet.
You should check your work as you go along.

1 Matrices are a method of representing ordered data. Explain what ordered data means and what the relationship between matrices and variable arrays are in computer programs.

2 Use index notation to reference the element values 3 and 5 in matrix **A** below:

$$\text{Matrix } \mathbf{A} \begin{pmatrix} 2 & 3 & 6 \\ 1 & 2 & 5 \\ 4 & 7 & 1 \end{pmatrix} \qquad \text{Matrix } \mathbf{B} \begin{pmatrix} 4 & 2 & 7 \\ 3 & 1 & 8 \\ 2 & 6 & 3 \end{pmatrix}$$

3 Find the value of a matrix **C** that is derived from **C** = **A** + **B**.

4 Find the value of a matrix **D** that is derived from **D** = **A** − **B**.

5 Find the value of a matrix **E** that is derived from **3xA**.

6 Find the value of a matrix **F** that is derived from **F** = **G** X **H**:

$$\text{Matrix } \mathbf{G} \begin{pmatrix} 4 & 2 \\ 3 & 1 \end{pmatrix} \qquad \text{Matrix } \mathbf{H} \begin{pmatrix} 3 & 7 \\ 1 & 2 \end{pmatrix}$$

7 Find the inverse of matrix **G**.

8 Find the transposition of matrix **H**.

9 Solve for **X** and **Y** using matrix techniques, the simultaneous equations given below:

$$3\mathbf{X} + 5\mathbf{Y} = 17 \text{ and } 5\mathbf{X} - \mathbf{Y} = 5$$

10 The two-dimensional vector **V** is rotated about 90 degrees, use matrix transformation methods to find $\mathbf{V}^{-1}$.

$$\text{Vector } \mathbf{V} \begin{pmatrix} 3 \\ 7 \end{pmatrix}$$

11 Plot the simple shape on graph paper whose coordinate vertices are given by the position vectors **Q**$_1$, **Q**$_2$, **Q**$_3$, and **Q**$_4$ found below. Ensure that the graph includes the zero point (0,0).

Use the **R** matrix given to rotate the position vectors about zero and derive the resulting position vectors **S**$_1$, **S**$_2$, **S**$_3$, and **S**$_4$.

Plot the simple shape on graph paper whose coordinate vertices are given in the resulting position vectors **S**$_1$, **S**$_2$, **S**$_3$, and **S**$_4$.

Show that the plotted shape of the position vectors **S**$_1$, **S**$_2$, **S**$_3$, and **S**$_4$ is a $\pi/6$ transposed image of **Q**$_1$, **Q**$_2$, **Q**$_3$, and **Q**$_4$. To do this assume the xy plane is to be rotated by $\theta = \pi/6$ radians. Use $x = r\cos\theta$ and $y = r\sin\theta$; where r is a radius to some arbitrary point $P(X_1,Y_1)$ to derive the **R** matrix used above to rotate the coordinates of the transposed image OF **Q**$_1$, **Q**$_2$, **Q**$_3$, and **Q**$_4$. Show your workings.

Position vectors:

Q$_1$	**Q**$_2$	**Q**$_3$	**Q**$_4$
$\begin{pmatrix} 2 \\ 0 \end{pmatrix}$	$\begin{pmatrix} 4 \\ 0 \end{pmatrix}$	$\begin{pmatrix} 4 \\ 2 \end{pmatrix}$	$\begin{pmatrix} 2 \\ 2 \end{pmatrix}$

Transposing matrix **R**

$$\begin{pmatrix} 0.866 & -0.5 \\ 0.5 & 0.866 \end{pmatrix}$$

Task B – Apply series, probability and recursions

Please use the Answer Sheet provided to complete Task B.

Scenario

A computer company uses number series and probability to create patterns on an interactive piece of software. As a new trainee to the organisation you are working your way through the software tutorial guide (this task) and providing the input solutions as needed.

Write your working out and answers in the space provided on the Answer Sheet.
You should check your work as you go along.

1 For the series **u**, give a functional expression for the addition of this series using sigma notation:

$$U_1 + U_2 + U_3 + U_4 + ... + U_n$$

2 An **A.P.** (Arithmetic Progression) series shown in the source document starts with the first term (***a***) and ends with the last term (***l***). Derive a formula for the sum of these terms:

$$a + (a+d) + (a+2d) + (a+3d) ... + (l-d) + l$$

3 Use the series formula shown below to find the sum of 15 terms of an **A.P.** that starts with the number 3 and ends with 19:

$$S_n = \frac{n}{2}(a + l)$$

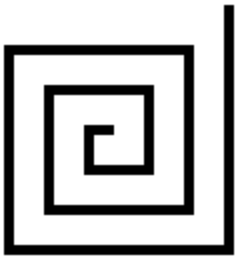
4 A fair six-sided die is thrown. What is the probability of a multiple of 2 being thrown? Express the answer as a fraction.

5 A fair six-sided die is thrown. What is the probability of a multiple of 3 being thrown? Express the answer as a decimal.

6 A fair six-sided die is thrown. What is the probability of a 6 being thrown? Express the answer as a percentage.

7 The software program shown below, using recursive techniques draws the square spiral shown below. Use the series formula for the **A.P.** in 2.3 to express the line lengths of this spiral and hence calculate the total spiral length:

Square spiral



Software program

```
start
to r_spiral: line
forward: line left 90
r_spiral sum: line –2
if line greater than –24 stop
end
```

8 Amend the square spiral program to lengthen each spiral leg by two units but reduce the number of lines by three.

9 Write a similar program to produce the original spiral in reverse.

Task C – Apply graph theory

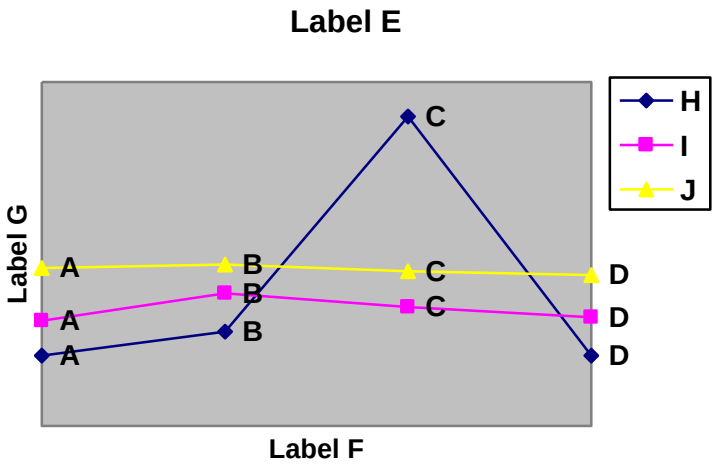
Please use the Answer Sheet provided to complete Task C.

Scenario

The car sales department of Right-on Motors have instigated a random road survey concerning vehicle colours in order to ascertain the most likely colours to stock in their showrooms. They have assumed that the information collected will be very useful and have asked you to provide support for this by graphics (this task).

Write your working out and answers in the space provided on the Answer Sheet.
You should check your work as you go along.

1 Describe the components of the graph labelled below and detail the properties of each component:



2 Explain the characteristics of undirected, directed and mixed graphs.

3 Data was collected for the first 100 colours of car to pass an observer on the roads listed on a certain day, plot on an appropriate graph the given table of data **T**:

Road / Car Colour	A77	M3	B1068	A42
Blue	27	33	81	23
Red	33	52	11	57
Yellow	12	6	4	6
Green	28	9	4	14
Total	100	100	100	100

4 What type of problem can be modelled by a weighted graph?

When you have finished working:

- Sign each document above your name and label all removable storage media with your name.
- Hand all paperwork and removable storage media to your assessor.

If the assignment is taken over more than one period, all paperwork and removable media must be returned to the test supervisor at the end of each sitting.

End of assignment

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