Assignment Brief

| Module title and code | Maths and Algorithms (QACO20C115) |
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| Qualification |  |
| Issue Date | 29/1/2018 |
| Final Submission | (Week 10) 23/3/2018 @23:59 |
| Assessor(s) | Dr |
| Assignme | Na |
| The purpose of this assignment is enable the learner to: <br> - Demonstrates a broad understanding of the knowledge base of this module, and its terminology, including working knowledge of mathematical notation and the applications of maths and algorithms with special reference to computing; <br> - Identifies principles and concepts underlying the theoretical frameworks underpinning mathematical computation and computing algorithms, as highlighted in this module; <br> - Collects information from a variety of authoritative sources to inform a choice of solutions to standard problems highlighted in this module, with special emphasis on mathematical solutions in IT and computing; <br> - Will apply numerics, solutions of equations, mathematical approximation, numerical techniques and algorithms in computing. |  |

## Assessment

Coursework: 50\%: Assignment (involving a case study)
Exam: 50\%: 2 hours online examination
Note: To pass this module

- You must attempt all pieces of assessment.
- You must achieve at least $40 \%$ overall.
- If you have a re-sit, you must attempt all the elements you have failed as failing marks cannot be carried forward without attempting re-sits.
- You must show all the steps you followed in answering the questions in this assignment. If you just give the answers (even if they are correct) but have not shown the process you followed, you will not get any marks.
- Reference and cite your sources or any material that you use in your solution using the Harvard referencing System.

Word Count : $\mathbf{3 0 0 0}$ Max

For written assignments, students need to state the word count at the end of the assignment. 10\% over the stated word count is permitted without penalty. If students go beyond this, then there is a penalty of 5 marks for every additional 10\% beyond the word count. The word count includes the Abstract or Executive Summary and all in-text citations. The word count excludes the Bibliography and Appendices. Please note that Appendices should only include supplementary information not provided in the main text. There is no specific penalty for submitting a piece which is below the word count, but please note that shorter written submissions are likely to attract poorer grades, particularly where they lack the necessary depth of analysis.

## Section 1 - Propositional and Predicate Logic [10 Marks]

1. The alarm in the server room will sound and send an SMS if the security door is opened and the override button is not pushed while the alarm is activated, or if motion is detected and it is not the case that either the override button is pushed or the alarm is deactivated.
a. Write a logical expression that describes the above sentence using propositional variables.
b. Provide a pseudocode or actual code snippet in a language you feel comfortable implementing the above logic.
[5 Marks]
2. Using Logical simplification, prove that the following are tautologies, contradictions or neither. Use truth tables to verify your final conclusion.
a. $\quad(p \Rightarrow q) \vee(q \Rightarrow p)$
b. $\quad p \wedge((\neg p \vee q) \wedge \neg q)$
c. $\quad((P \Rightarrow Q) \Rightarrow P) \Rightarrow P$
[5 MARKS]
Evidence you must produce for this task: Solution to all the given problems
Criteria covered by this task: Understanding of mathematical logic and its applications

## Section 2 - Sets [10 Marks]

1. In a batch of 70 degree students, it was found that 40 passed programming in Java, 30 passed Mathematics, 40 passed HTML, 20 passed programming in Java and Mathematics, 25 passed both programming in Java and HTML, 15 passed Mathematics and HTML and 10 passed all modules. By showing the steps you followed clearly:
a. Show the progress of all the 70 students in a Venn diagram.
b. Find the number of people who passed at least one of the three modules.
c. Find the number of students who passed only two modules.
d. Find the number of students who passed none of the modules.
[4 MARKS]
2. By representing a set as a list, create algorithms in pseudo-code or actual code in a language of your choice for the following set operations.
a. To check if an element is a member of a given set
b. To check if a given set is a subset of another set
c. Set intersection
d. Set union
e. Set difference

## [6 MARKS]

Evidence you must produce for this task: Solution to all the given problems
Criteria covered by this Task: Understanding of set theory and its applications

## Section 3 - Relations and Functions [10 Marks]

1. Let $A=\{1,2,3\}, B=\{3,4,6\}$ and $C=\{9,12,19\}$. $R$ is a relation from $A$ to $B$ where $A$ is a factor of $B$ and $S$ is a relation from $B$ to $C$ where $B$ squared is less than $C$ :
a. Determine the domain and range of $R$ and $S$.
b. Find $\mathrm{R}^{-1}$ and $\mathrm{S}^{-1}$.
c. Draw an arrow diagram of the relations $R$ and $S$.
d. Find the composition relation RoS.
[3 MARKS]
2. Let $x$ and $y$ be integers where $f(x, y)=5$ if $x<y$ and $f(x, y)=f(x-y, y+2)+1$ if $x>=y$. Express the following relations in their simplest forms.
a. $f(2,7)$
b. $f(5,3)$
c. $f(15,2)$
[2 MARKS]
3. In the rock, paper, scissors game, rock beats scissors, scissors beats paper and paper beats rock.
a. Draw an arrow diagram to show the relation 'Beats' between the three objects.
b. Write an algorithm in pseudocode to allow a user to play the game against a computer until such time that the user decides to terminate the game. Your Algorithm must track the scores of the player and the computer and at the end of the game, it must declare the winner. A point is given for each win, no point is given to the losing player or when the outcome of each game is a draw. A draw means when both the player and the computer produce the same object.
[5 MARKS]

Evidence you must produce for this task: Solution to all the given problems

## Criteria Covered by this Task: Understanding of relations and functions and their applications

## Section 4 - Algorithms and Pseudocode [15 Marks]

1. You have been tasked to create a student attendance management system. Students are given full attendance (marked as $\mathbf{P}$ ) if they arrive within 10 minutes of the class starting and stay in class until after the last 10 minutes of the session. Students who arrive 10 minutes later than the start of the class and stay until the last 10 minutes of the session will be marked (L) for late. Those who arrive within the first 10 minutes but leave before the session is in its last 10 minutes are marked (E) for Early leavers. If a student has arrived late and left early as per the definition of early leavers and late arrivals above, they will be marked as (LE) for Late arrival and Early Leavers. A student who fails to turn up is marked as absent (A). Formulate an algorithm in pseudocode (Not an actual code implementation) for the logic described.
[5 MARKS]
2. In mathematics, the greatest common divisor (gcd) of two non-zero integers is the largest positive integer that divides each of the integers without a remainder. One way of finding the gcd of two different positive integers is to replace the largest value by the magnitude of their difference, stopping when both the numbers are the same, this final value is the GCD of the two original numbers. Write two algorithms - (1) non-recursive and (2) recursive in pseudocode to output the gcd of any two different integers using the algorithm described above. Your algorithm must handle scenarios when a user enters non numeric or numbers less or equal to zero. [5 MARKS]
3. Mr Jones owns a farm. He has hens and pigs. One day he decided to count how many heads and how many legs there are in his farm. His count showed there were 30 heads and 80 legs. Write an algorithm in pseudocode to find the exact number of hens and pigs.
[5 MARKS]
Evidence you must produce for this task: Solutions to all the given problems

Criteria Covered by this Task: Understanding of algorithmic solutions to various practical problems with pseudocode.

## Section 5 - Mathematical Proof [10 Marks]

1. Explain what mathematical deduction is and what mathematical induction is. To demonstrate your understanding fully, your explanation must include their difference and where each one should be applied.
[1 MARKS]
2. Prove by deduction the following claims:
a. The sum of any two positive odd integers is even.
b. Let x and y be two integers such that x and $\mathrm{x}+\mathrm{y}$ are even. Prove that y is also even.
c. If $r$ is an irrational number then sqrt( $r$ ) is also an irrational number.
[4 MARKS]
3. Prove by induction the following claims:
a. $1+3+5+\ldots+(2 n-1)=n^{2} \quad$ for all $n>=1$
b. The Fibonacci sequence $1,1,2,3,5,8,13, \ldots$ is generalised as $F(n)=F(n-1)+F(n-2)$ Where $F(0)=F(1)$ $=1$. Prove that for all $n>0, F(n)<2^{n}$
[5 MARKS]
Evidence you must produce for this task: Solution to all the given problems
Criteria covered by this task: Understanding of mathematical proof and application in practical problems

## Section 6 - Linear Algebra [10 Marks]

1. A local shop sells 3 types of pies a) Beef pies cost $£ 5$ each b) Chicken pies cost $£ 4$ each and c) Vegetable pies cost $£ 3$ each. The table below shows how many pies the shop sold over the three days indicated.

|  | Monday | Tuesday | Wednesday |
| :--- | :--- | :--- | :--- |
| Beef | 7 | 3 | 10 |
| Chicken | 9 | 8 | 5 |
| Vegetable | 4 | 6 | 2 |

a. Create a matrix for the Pie prices and another for the quantity sold over the three days.
b. Use matrix approach to find how much the shop made on each day from the sales.
c. Create a pseudocode or actual code in a language you feel comfortable with that demonstrates how to multiply each row inside the Pie price matrix with each column in the quantity sold matrix.
[5 MARKS]
2. Write algorithms in pseudo-code to perform the following matrix operations.
a. Add two matrices $A$ and $B$ and save the result in matrix $C$.
b. Compute the transpose of a matrix $A$.
c. Compute the determinant of a $2 \times 2$ matrix $A$
[5 MARKS]
Evidence you must produce for this task: Solutions to all the given problems.

## Criteria Covered by this Task: Understanding of vectors and matrices and their applications

## Section 7 - Sequence and Series [15 Marks]

1. A population of bacteria in a petri dish grows in such a way that after every passing of a minute, the number of bacteria in the population doubles. Assume there was 1 bacterium to start with. How many will there be after 24 hours assuming none of the bacteria dies and that the available nutrients for the bacteria in the petri dish were unlimited. Show the steps you followed to arrive at your answer and derive a generalised formula that can be used to find the population of the bacteria at any given time.
[5 MARKS]
2. A ball is dropped from a height of 10 meters, on each bounce the ball loses $25 \%$ of the previous height it reached. Using the appropriate formula for the series and by showing the steps you followed clearly, answer the questions below.
a. What would be the total vertical distance covered by the ball after 10 bounces and 100 bounces?
b. Generalize your answer with reasoning by a simplified formula for large number of bounces.
[5 MARKS]
3. Given that $2 m-8,2 m+4$ and $5 m-2$ are the first three successive terms of a geometric sequence. Find the value of $m$ and thus the summation of the first 10 elements.
[5 MARKS]

## Evidence you must produce for this task: Solution to all the given problems

Criteria Covered by this Task: Understanding of sequence and series and their applications, e.g. iteration

## Section 8-Statistics and Probability

This section along with the $\mathbf{7}$ sections covered here will be assessed in the exam.

Evidence you must produce for this task: Solutions to all the given problems.
Criteria Covered by this Task: Understanding of basics of statistics and probability theory

## Section 9 - Graph Theory

This section along with the $\mathbf{7}$ sections covered here will be assessed in the exam.

Evidence you must produce for this task: Solutions to all the given problems.
Criteria Covered by this Task: Understanding of graph theory in software development

## Referencing and Bibliography

Although much of your report will contain existing body of knowledge, you must write your assignment with your own words to demonstrate your understanding of the subject. You are required to follow the Harvard referencing system when citing others' work. An accompanying list of references must also be provided as part of your report. Extensively referenced work reflects the level of research you conducted in the process of producing the document. It is also an acknowledgement of other people's work. Correct referencing demonstrates your academic and professional skill. It also reflects your academic honesty and thus to some degree protects you from cases of plagiarism. Please refer to the documents contained in the BSc Digital \& Technology Solutions course in Canvas for guidelines on Harvard referencing system.

## Preparation Guidelines for Assignment Report

- All components of the assignment report must be word processed (hand written text or hand drawn diagrams are not acceptable), font size must be within the range of 12 point to 14 point including the headings, body text and any texts within diagrams.
- Standard and commonly used fonts such as Times New Roman, Arial or Calibri should be used.
- Your document must be aligned left or justified with line spacing of 1.5.
- All figures, graphs and tables must be numbered and labelled.
- Material from external sources must be properly refereed and cited within the text using the Harvard referencing system.
- All components of the assignment (text, diagrams. Code etc.) must be submitted in one pdf file.


## Extensions to Assessment Deadlines and Late Submission

- You may apply on grounds of mitigating circumstances for an extension to the deadline for this assessment. Applications for extension must be made sufficiently in advance. Extension may be granted where among other conditions the mitigating circumstances and supporting evidence are judged to be sufficient.
- Late submission, where the student submits work up to 2 pm , seven calendar days after the deadline, will be accepted and marked. The percentage mark for the component of assessment will be capped at $40 \%$.


## Plagiarism and Collusion

Any act of plagiarism (presenting another person's published or unpublished work e.g. from a book or the web in any quantity without adequately identifying it and citing its source) or collusion (copying another learner's assignment or work submitted by others in previous years and submitting it as your own effort) is a serious academic misconduct and will be seriously dealt with according to the regulations.
This brief has been verified as being fit for purpose

| Assessor's Name |  |  |  |
| :--- | :--- | :--- | :--- |
| Signature |  |  |  |
| Internal verifier's Name |  | Date |  |
|  |  |  |  |
| Signature |  | Date |  |

Note: This assignment is written with the assumption that small changes and/or modifications to the brief post the issue date can be accommodated providing it serves to improve the learners understanding of what is required of them in the process of carrying out the tasks outlined.

