

PAPER CODE NO.
COMP202

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THE UNIVERSITY
of LIVERPOOL

MAY 2005 EXAMINATIONS

Bachelor of Arts : Year 2
Bachelor of Science : Year 2

Complexity of Algorithms

TIME ALLOWED : Two Hours

INSTRUCTIONS TO CANDIDATES

Answer **four** questions only.

If you attempt to answer more questions than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).



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QUESTION 1

1.A What is Dijkstra's algorithm used for and what is the *worst-case* time-complexity in general ?
What improvement in run-time would result if a priority queue were used ?

[3 MARKS]

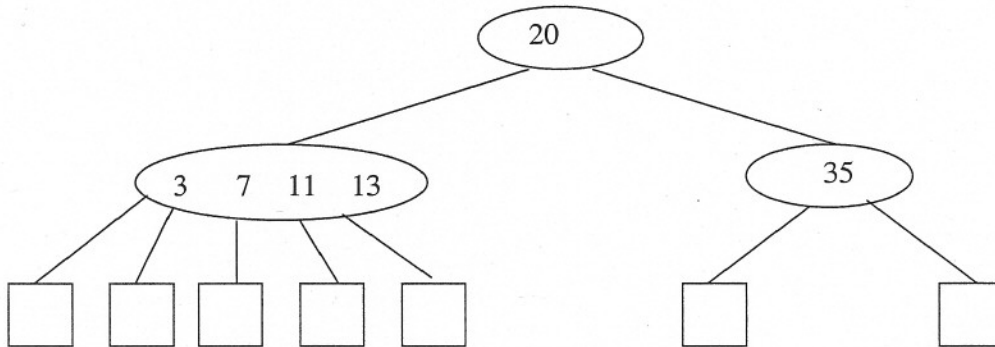
1.B What is the difference, in terms of *time-complexity*, between the *shortest path* problem and
the *longest path* problem ?

[2 MARKS]

1.C Describe both symmetric (secret) and public-key encryption schemes and *two* differences
between them.

[10 MARKS]

1.D State the definition of a (2-4) tree. Describe the process (using a diagram) that changes the
tree shown below into a (2-4) tree.



[10 MARKS]

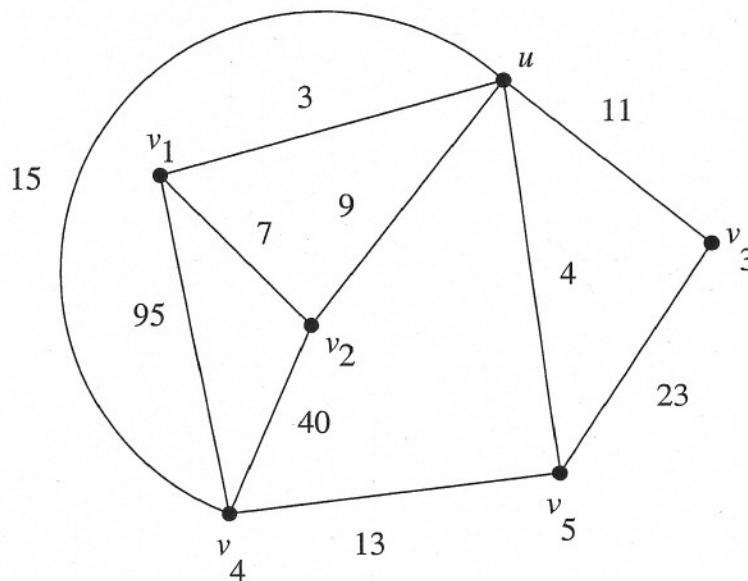
TOTAL [25 MARKS]



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QUESTION 2

2.A Given the graph below, use Prim's algorithm to find a minimum weight spanning tree (MST) rooted at vertex u . What is the weight of the MST found ?



[10 MARKS]

2.B Write a recursive pseudo-code algorithm that will print out the values stored at the nodes of a binary tree, in pre-order fashion. What is the time-complexity of your algorithm ?

[10 MARKS]

2.C What do LIFO and FIFO stand for ? Give an example of a data structure for each.

[5 MARKS]

TOTAL [25 MARKS]



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QUESTION 3

3.A What is the *worst-case* time-complexity of merge-sort ?

[3 MARKS]

3.B Describe the *Dynamic Programming* (DP) method and the key feature that it uses. What is the main difference between dynamic programming and the divide-and-conquer method ?

[7 MARKS]

3.C Write a recursive pseudo-code algorithm that performs a *binary-search* within a *binary-search* tree (assume that the data structure used is a linked-list). What is the *worst-case* time-complexity of binary-search ?

[10 MARKS]

3.D Using Euclid's algorithm, find the greatest common divisor (GCD) of 437 and 254. Clearly show a trace table which shows the steps taken to find the GCD.

[5 MARKS]

TOTAL [25 MARKS]



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QUESTION 4

4.A Define the complexity classes **P** and **NP**. What does it mean to say that a problem is NP-complete ?

[8 MARKS]

4.B Give three examples of NP-complete problems. For each example give the form that the problem takes and the question that is asked.

[3 MARKS]

4.C What is an *Optimisation Problem* (OP) ? Give an example of an optimisation problem and describe how, in general, we can transform an Optimisation Problem into a corresponding Decision Problem (DP).

[8 MARKS]

4.D Give three types of reduction (used to show NP-completeness) and briefly explain each.

[6 MARKS]

TOTAL [25 MARKS]



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QUESTION 5

5.A Compare and contrast the *synchronous* and *asynchronous* models of distributed computing.

[5 MARKS]

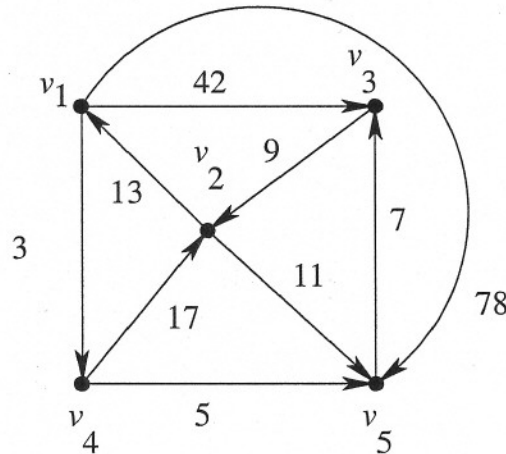
5.B Explain the *Round Robin* algorithm used for *leader-election* in the distributed computing model.

[7 MARKS]

5.C Describe the *heap* data structure. What is the time-complexity of *insertion* and *deletion* in a heap ?

[5 MARKS]

5.D Apply the Floyd-Warshall algorithm to the graph below to find the (length of) the shortest paths between *all* pairs of vertices. Clearly show your working out.



[8 MARKS]

TOTAL [25 MARKS]