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**ICS3B – 107691**

**Assignment 3**

***Question 1***

Construct a B+ tree of order 4 with the following set of data: 1,4,10,17,21,31,25,19,20,28,42.

**M = 4; M-1 = 3 keys**

**Steps(Using right-bias)**

1. Create the first node with 1,4 and 10 ie

|  |  |  |
| --- | --- | --- |
| 1 | 4 | 10 |

1. To insert 17, get the median of 1,4,10 and 17 to get 10 therefore 10 is pushed up and copied in its child node. ie

|  |
| --- |
| 10 |

|  |  |
| --- | --- |
| 1 | 4 |

|  |  |
| --- | --- |
| 10 | 17 |

1. To insert 21, insert it after the node with 17. It will be now;

|  |
| --- |
| 10 |

|  |  |
| --- | --- |
| 1 | 4 |

|  |  |  |
| --- | --- | --- |
| 10 | 17 | 21 |

1. To insert 31, the median of 10,17,21 and 31 is gotten which is 21, therefore 21 is pushed up to the node with 10 and it is copied in its child node.

|  |  |
| --- | --- |
| 10 | 21 |

|  |  |
| --- | --- |
| 1 | 4 |

|  |  |
| --- | --- |
| 10 | 17 |

|  |  |
| --- | --- |
| 21 | 31 |

1. To insert 25, it can be placed in between the node with 21 and 31 so it will be:

|  |  |
| --- | --- |
| 10 | 21 |

|  |  |
| --- | --- |
| 1 | 4 |

|  |  |
| --- | --- |
| 10 | 17 |

|  |  |  |
| --- | --- | --- |
| 21 | 25 | 31 |

1. To insert 19, insert it after the node with 10 and 17.

|  |  |
| --- | --- |
| 10 | 21 |

|  |  |
| --- | --- |
| 1 | 4 |

|  |  |  |
| --- | --- | --- |
| 10 | 17 | 19 |

|  |  |  |
| --- | --- | --- |
| 21 | 25 | 31 |

1. To insert 20, you get the median of10,17,19 and 20 because the node is already full, so the median will now be 19, which will be pushed upwards to the node containing 10 and 21

|  |  |  |
| --- | --- | --- |
| 10 | 19 | 21 |

|  |  |
| --- | --- |
| 1 | 4 |

|  |  |  |
| --- | --- | --- |
| 10 | 17 | 19 |

|  |  |
| --- | --- |
| 19 | 20 |

|  |  |  |
| --- | --- | --- |
| 21 | 25 | 31 |

1. To insert 28, it can be placed in the node containing 21, 25 and 31 but then again, the node is full so the median needs to be gotten which is 28 so then 28 is pushed upwards and the value is copied into the child node. However, the node containing 10,19, and 20 is already full therefore, the median of the 4 is got and 21 is pushed up and now becomes the root node.

|  |
| --- |
| 21 |

|  |  |
| --- | --- |
| 10 | 19 |

|  |
| --- |
| 28 |

|  |  |
| --- | --- |
| 28 | 31 |

|  |  |
| --- | --- |
| 1 | 4 |

|  |  |
| --- | --- |
| 21 | 25 |

|  |  |
| --- | --- |
| 10 | 17 |

|  |  |
| --- | --- |
| 19 | 20 |

1. Finally, to insert 42, it can be inserted after the node containing 28 and 31 and the final B+ tree is:

|  |
| --- |
| 21 |

|  |  |
| --- | --- |
| 10 | 19 |

|  |
| --- |
| 28 |

|  |  |  |
| --- | --- | --- |
| 28 | 31 | 42 |

|  |  |
| --- | --- |
| 1 | 4 |

|  |  |
| --- | --- |
| 21 | 25 |

|  |  |
| --- | --- |
| 10 | 17 |

|  |  |
| --- | --- |
| 19 | 20 |

**Question 2**

Construct a B+ tree of order 3 with the following set of data: 8, 5, 1, 7, 3, 12, 9, 6.

**M = 3; M-1 = 2 keys**

***Steps***

1. First you insert 8 and 5 and it will look like this

|  |  |
| --- | --- |
| 5 | 8 |

1. So as to insert 1, you will have to get the median of 1,5 and 8 which is 5, therefore 5 will be pushed upward and the node will be split and 5 will be copied into the new node ie

|  |
| --- |
| 5 |

|  |  |
| --- | --- |
| 5 | 8 |



|  |
| --- |
| 1 |

1. To insert 7, you can put it in between 5 and 8 but the node will be full so you find the median of 5,7 and 8 which is 7, therefore 7 is now pushed upwards to the root node containing 5 and the value is copied onto the child node which is 5 and 8 ie

|  |  |
| --- | --- |
| 5 | 7 |

|  |
| --- |
| 5 |



|  |
| --- |
| 1 |

|  |  |
| --- | --- |
| 7 | 8 |

1. To insert 3, place it after the leaf node containing 1. So, the tree will become,

|  |  |
| --- | --- |
| 5 | 7 |

|  |
| --- |
| 5 |



|  |  |
| --- | --- |
| 7 | 8 |

|  |  |
| --- | --- |
| 1 | 3 |

1. To insert 12, it can be put in the node containing 7 and 8 but after number 8. However, this cannot be done because node is already full so the median value has to be gotten ie median of 7,8 and 12 which is 8, thus, 8 is pushed up into the node containing 5 and 7. However, that node is also full so the median has to be gotten again ie media of 5,7 and 8 which is 7. Thus, 7 is pushed upwards and now becomes the root node. The values that have been pushed up, ie 8 and 7 have to e copied into their respective child node. The B+ tree will look like this:

|  |
| --- |
| 7 |

|  |  |
| --- | --- |
| 7 | 8 |

|  |
| --- |
| 5 |

|  |
| --- |
| 5 |



|  |
| --- |
| 7 |

|  |  |
| --- | --- |
| 1 | 3 |

|  |  |
| --- | --- |
| 8 | 12 |

1. To insert 9, it can be put in the node containing 8 and 12 but the node is already going to be full therefore, the median value is going to be pushed up ie 9. When it gets to the node containing 7 and 8,the node will once again be full therefore the median value, which is 8, is forced upwards and therefore the root node will have 7 and 8 in it. The tree will look like this now:

|  |  |
| --- | --- |
| 7 | 8 |

|  |  |
| --- | --- |
| 8 | 9 |

|  |
| --- |
| 5 |

|  |
| --- |
| 5 |



|  |
| --- |
| 7 |

|  |  |
| --- | --- |
| 1 | 3 |

|  |
| --- |
| 8 |

|  |  |
| --- | --- |
| 9 | 12 |

1. To insert 6, you simply insert it after the node with 5 only.

|  |  |
| --- | --- |
| 7 | 8 |

|  |  |
| --- | --- |
| 8 | 9 |

|  |
| --- |
| 5 |



|  |
| --- |
| 7 |

|  |  |
| --- | --- |
| 1 | 3 |

|  |
| --- |
| 8 |

|  |  |
| --- | --- |
| 9 | 12 |

|  |  |
| --- | --- |
| 5 | 6 |

* The final B+ tree is now:

|  |  |
| --- | --- |
| 7 | 8 |

|  |  |
| --- | --- |
| 8 | 9 |

|  |
| --- |
| 5 |



|  |
| --- |
| 7 |

|  |  |
| --- | --- |
| 1 | 3 |

|  |
| --- |
| 8 |

|  |  |
| --- | --- |
| 9 | 12 |

|  |  |
| --- | --- |
| 5 | 6 |