1. **B+-trees (50 pts):** Construct a B+-tree for the following set of key values: (4, 5, 6, 7, 10, 12, 14, 19, 20, 21, 23) Assume that the tree is initially empty and values are added in ascending order. Assume that the number of pointers that will fit on one node is 4. Show the tree after each node split operation.

Solution:

![B+-tree diagram]

2. **Extendible Hashing (50 pts):** Consider an extendible hashing structure that is initially empty and where each bucket can hold up to 2 records. Show the contents of extendible hashing after inserting keys 8, 16, 4, 3, 11, 12 in order, using the lowest-bits for the hash function. That is, records in a bucket of local depth d agree on their rightmost d bits. Show the contents after each directory doubling operation.

Solution: