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BSAI (B)

Code:

```cpp
1  #include <iostream>
2  using namespace std;
3
4  struct N {
5      int id;
6      N* p;
7      N* n;
8      N(int i) : id(i), p(nullptr), n(nullptr) {}
9  };
10
11 N* h = nullptr;
12 N* t = nullptr;
13
14 void addF(int i) {
15     N* x = new N(i);
16     if (!h) h = t = x;
17     else {
18         x->n = h;
19         h->p = x;
20         h = x;
21     }
22     cout << "ID " << i << " added first." << endl;
23 }
24
25 void addL(int i) {
26     N* x = new N(i);
27     if (!t) h = t = x;
28     else {
29         t->n = x;
30         x->p = t;
31         t = x;
32     }
33     cout << "ID " << i << " added last." << endl;
34 }
```

```cpp
 35
 36  void addP(int i, int pos) {
 37      if (pos <= 1 || !h) {
 38          addF(i);
 39          return;
 40      }
 41
 42      N* c = h;
 43      int idx = 1;
 44      while (c->n && idx < pos - 1) {
 45          c = c->n;
 46          idx++;
 47      }
 48
 49      if (!c->n) {
 50          addL(i);
 51          return;
 52      }
 53
 54      N* x = new N(i);
 55      N* nextN = c->n;
 56      c->n = x;
 57      x->p = c;
 58      x->n = nextN;
 59      nextN->p = x;
 60
 61      cout << "ID " << i << " added at position " << pos << "." << endl;
 62  }
 63
 64  void remF() {
 65      if (!h) return;
 66
 67      N* d = h;
 68      cout << "ID " << h->id << " removed." << endl;
```

```cpp
 68      cout << "ID " << h->id << " removed." << endl;
 69
 70      if (h == t) h = t = nullptr;
 71      else {
 72          h = h->n;
 73          h->p = nullptr;
 74      }
 75      delete d;
 76  }
 77
 78  void dispF() {
 79      cout << "\nList Forward (H → T): ";
 80      N* temp = h;
 81      while (temp) {
 82          cout << temp->id;
 83          if (temp->n) cout << " -> ";
 84          temp = temp->n;
 85      }
 86      cout << endl;
 87  }
 88
 89  void dispB() {
 90      cout << "List Backward (T → H): ";
 91      N* temp = t;
 92      while (temp) {
 93          cout << temp->id;
 94          if (temp->p) cout << " -> ";
 95          temp = temp->p;
 96      }
 97      cout << "\n" << endl;
 98  }
 99  |
```

```cpp
int main() {
    addL(01);
    addL(02);
    addF(200);
    addP(150, 2);
    remF();
    addL(300);

    dispF();
    dispB();

if (h)
    cout << "\nID at head: " << h->id << endl;
else
    cout << "\nh is NULL" << endl;

if (t)
    cout << "ID at tail: " << t->id << endl;
else
    cout << "t is NULL" << endl;

    return 0;
}
```
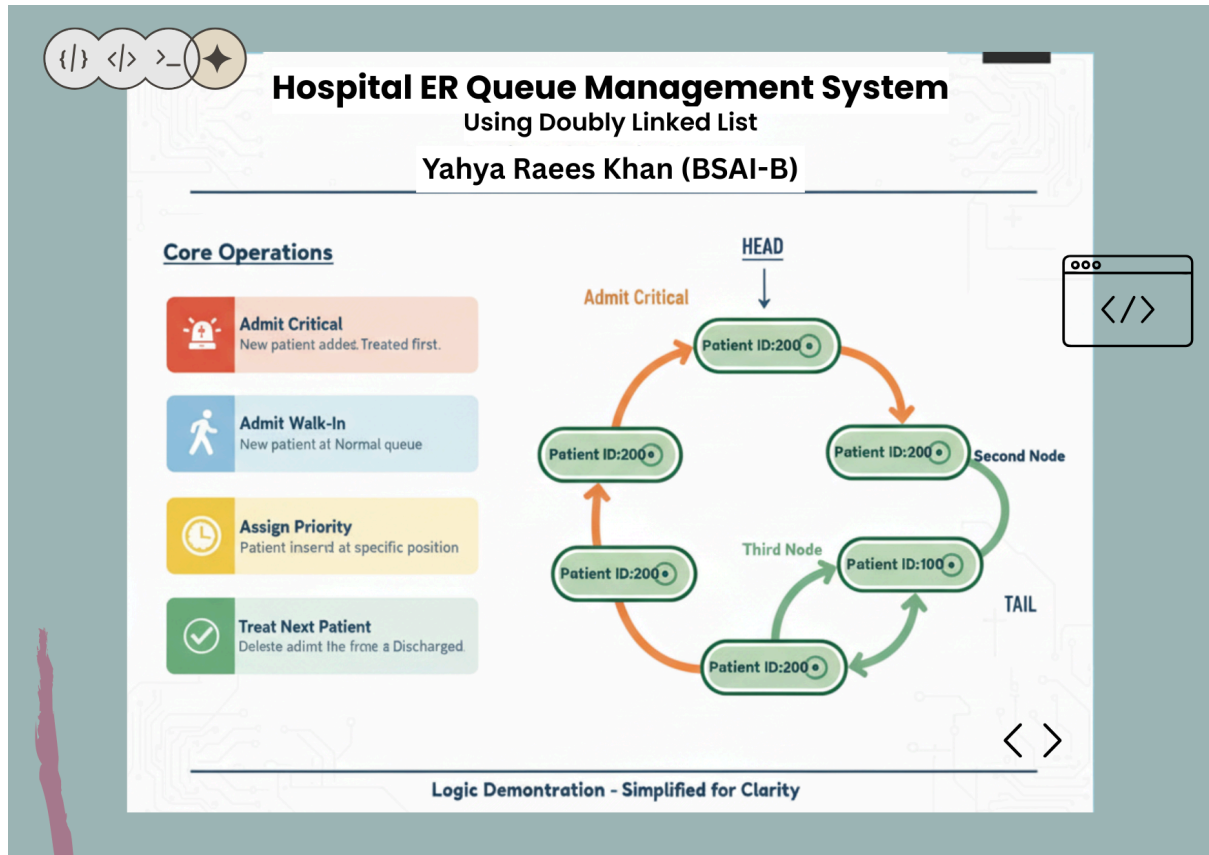
Output:

```
cd "/Users/apple/Desktop/DS Lab/" && g++ DSALab.cpp -o DSALab && "/Users/apple/Desktop/DS Lab/"DSALab
apple@Yahyas-Macbook DS Lab % cd "/Users/apple/Desktop/DS Lab/" && g++ DSALab.cpp -o DSALab && "/Users/apple/Desktop/DS Lab/"DSALab
ID 1 added last.
ID 2 added last.
ID 200 added first.
ID 150 added at position 2.
ID 200 removed.
ID 300 added last.

List Forward (H → T): 150 -> 1 -> 2 -> 300
List Backward (T → H): 300 -> 2 -> 1 -> 150


ID at head: 150
ID at tail: 300
apple@Yahyas-Macbook DS Lab %
```

Working Behaviour

Thank You