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Data Structures Laboratory (3CSL01)

III Semester CSE
LAB MANUAL

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Data Structures Laboratory

Instructions

- All the C programs need to be executed using GCC Compiler.
- All experiments must be included in practical examinations.

Chapter 1

File Management

Question

Write a C program to create a sequential file with at least five records, each record having the structure shown in the table:

Write necessary functions to perform the following operations:

i) to display all the records in the file.

ii) to search for a specific record based on EMPLOYEE ID/SALARY/DEPARTMENT/AGE.

In case if the required record is not found, suitable message should be displayed.

EMPLOYEE_ID	NAME	DEPARTMENT	SALARY	AGE
Non-Zero +ve Integer	25 Characters	25 Characters	+ve Integer	+ve Integer

1.1 C Code - Text I/O

```
=====
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  typedef struct{
5      unsigned emp_id;
6      char emp_name[25];
7      char emp_dept[25];
8      unsigned emp_salary, emp_age;
9  }employee_t;
10
11 /* FUNCTION PROTOTYPES */
12 void fnAddRecord(void);
13 void fnSearchEmpID(int);
14 void fnSearchEmpSal(int);
15 void fnSearchEmpDept(char[]);
16 void fnSearchEmpAge(int);
17 void fnDisplayAllRecords(void);
18
19 int main()
20 {
21     int id, sal, age, iChoice;
22     char dept[10];
23
24     for(;;)
25     {
26         printf("\n1.Add Record\n2.Display Records\n3.Search Employee by ID\n");
27         printf("4.Search Employee by Dept\n5.Search Employee by salary\n");
28         printf("6.Search Employee by Age\n7.Exit");
```

```

29     printf("\nEnter your choice : ");
30     scanf("%d",&iChoice);
31
32     switch(iChoice)
33     {
34         case 1: fnAddRecord();
35                 break;
36
37         case 2: printf("\n Employee Details \n");
38                 fnDisplayAllRecords();
39                 break;
40
41         case 3: printf("\nEnter the emp_id that you want to search\n");
42                 scanf("%d",&id);
43                 fnSearchEmpID(id);
44                 break;
45
46         case 4: printf("\nEnter the dept that you want to search\n");
47                 scanf("%s",dept);
48                 fnSearchEmpDept(dept);
49                 break;
50
51         case 5: printf("\nEnter the salary that you want to search\n");
52                 scanf("%d",&sal);
53                 fnSearchEmpSal(sal);
54                 break;
55
56         case 6: printf("\nEnter the age that you want to search\n");
57                 scanf("%d",&age);
58                 fnSearchEmpAge(age);
59                 break;
60
61         case 7: exit(0);
62     }
63 }
64 return 0;
65 }
66
67 void fnDisplayAllRecords()
68 {
69     int iCount = 0;
70     employee_t ep;
71     FILE *fp;
72
73     fp = fopen("emp.dat", "r");
74     if(fp==NULL)
75     {
76         printf("\nFile does not exist\n");
77         return;
78     }
79     printf("\nID\tName\tDept\tSalary\tAge\n");
80     while(fscanf(fp, "%d%s%d", &ep.emp_id, ep.emp_name, ep.emp_dept, &ep.
emp_salary, &ep.emp_age) != EOF)
81     {
82         printf("%d\t%s\t%s\t%d\t%d\n", ep.emp_id, ep.emp_name, ep.emp_dept, ep.
emp_salary, ep.emp_age);
83         iCount++;
84     }
85     if(0 == iCount)
86         printf("\nNo Records found\n");
87     fclose(fp);
88 }

```

```

89
90 void fnAddRecord()
91 {
92     FILE *fp;
93     employee_t emp;
94
95     printf("\nEnter Employee details\n");
96     printf("\nID : ");
97     scanf("%d", &emp.emp_id);    getchar();
98     printf("\nName : ");
99     scanf("%s", emp.emp_name);
100    printf("\nDept : ");
101    scanf("%s", emp.emp_dept);
102    printf("\nSalary : ");
103    scanf("%d", &emp.emp_salary);
104    printf("\nAge : ");
105    scanf("%d", &emp.emp_age);
106
107    fp = fopen("emp.dat", "a");
108    fprintf(fp, "%d\t%s\t%s\t%d\t%d\n", emp.emp_id, emp.emp_name, emp.emp_dept, emp.
emp_salary, emp.emp_age);
109    fclose(fp);
110 }
111
112 void fnSearchEmpID(int id)
113 {
114     int iCount = 0;
115     employee_t ep;
116     FILE *fp;
117
118     fp = fopen("emp.dat", "r");
119     if(fp==NULL)
120     {
121         printf("\nFile does not exist\n");
122         return;
123     }
124     printf("\nID\tName\tDept\tSalary\tAge\n");
125     while(fscanf(fp, "%d%s%s%d%d", &ep.emp_id, ep.emp_name, ep.emp_dept, &ep.
emp_salary, &ep.emp_age) != EOF)
126     {
127         if(ep.emp_id == id)
128         {
129             printf("%d\t%s\t%s\t%d\t%d\n", ep.emp_id, ep.emp_name, ep.emp_dept, ep.
emp_salary, ep.emp_age);
130             iCount++;
131         }
132     }
133     if(0 == iCount)
134         printf("\nNo Records found\n");
135     fclose(fp);
136 }
137
138 void fnSearchEmpSal(int sal)
139 {
140     int iCount = 0;
141     employee_t ep;
142     FILE *fp;
143
144     fp = fopen("emp.dat", "r");
145     if(fp==NULL)
146     {
147         printf("\nFile does not exist\n");

```

```

148         return;
149     }
150     printf("\nID\tName\tDept\tSalary\tAge\n");
151     while(fscanf(fp, "%d%s%d", &ep.emp_id, ep.emp_name, ep.emp_dept, &ep.
emp_salary, &ep.emp_age) != EOF)
152     {
153         if(ep.emp_salary == sal)
154         {
155             printf("%d\t%s\t%s\t%d\t%d\n", ep.emp_id, ep.emp_name, ep.emp_dept, ep.
emp_salary, ep.emp_age);
156             iCount++;
157         }
158     }
159     if(0 == iCount)
160         printf("\nNo Records found\n");
161     fclose(fp);
162 }
163
164 void fnSearchEmpDept(char dept[])
165 {
166     int iCount = 0;
167     employee_t ep;
168     FILE *fp;
169
170
171     fp = fopen("emp.dat", "r");
172     if(fp==NULL)
173     {
174         printf("\nFile does not exist\n");
175         return;
176     }
177     printf("\nID\tName\tDept\tSalary\tAge\n");
178     while(fscanf(fp, "%d%s%d", &ep.emp_id, ep.emp_name, ep.emp_dept, &ep.
emp_salary, &ep.emp_age) != EOF)
179     {
180         if(!strcmp(ep.emp_dept, dept))
181         {
182             printf("%d\t%s\t%s\t%d\t%d\n", ep.emp_id, ep.emp_name, ep.emp_dept, ep.
emp_salary, ep.emp_age);
183             iCount++;
184         }
185     }
186     if(0 == iCount)
187         printf("\nNo Records found\n");
188 }
189
190 void fnSearchEmpAge(int age)
191 {
192     int iCount = 0;
193     employee_t ep;
194     FILE *fp;
195
196     fp = fopen("emp.dat", "r");
197     if(fp==NULL)
198     {
199         printf("\nFile does not exist\n");
200         return;
201     }
202     printf("\nID\tName\tDept\tSalary\tAge\n");
203     while(fscanf(fp, "%d%s%d", &ep.emp_id, ep.emp_name, ep.emp_dept, &ep.
emp_salary, &ep.emp_age) != EOF)
204     {

```



```

205         if(ep.emp_age == age)
206         {
207             printf("%d\t%s\t%s\t%d\t%d\n", ep.emp_id, ep.emp_name, ep.emp_dept, ep.
emp_salary, ep.emp_age);
208             iCount++;
209         }
210     }
211     if(0 == iCount)
212         printf("\nNo Records found\n");
213 }

```

Listing 1.1: 01EmployeeDB.c

1.2 C Code - Binary I/O

```

=====
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  typedef struct{
5      unsigned emp_id;
6      char emp_name[25];
7      char emp_dept[25];
8      unsigned emp_salary, emp_age;
9  }employee_t;
10
11 void fnAddRecord(void);
12 void fnSearchEmpID(int);
13 void fnSearchEmpSal(int);
14 void fnSearchEmpDept(char[]);
15 void fnSearchEmpAge(int);
16 void fnDisplayAllRecords(void);
17
18 int main()
19 {
20     int id, sal, age, iChoice;
21     char dept[10];
22     printf("%lu bytes\n", sizeof(employee_t));
23     for(;;)
24     {
25         printf("\n1.Add Record\n2.Display Records\n3.Search Employee by ID\n");
26         printf("4.Search Employee by Dept\n5.Search Employee by salary\n");
27         printf("6.Search Employee by Age\n7.Exit");
28         printf("\nEnter your choice : ");
29         scanf("%d", &iChoice);
30
31         switch(iChoice)
32         {
33             case 1: fnAddRecord();
34                     break;
35
36             case 2: printf("\n Employee Details \n");
37                     fnDisplayAllRecords();
38                     break;
39
40             case 3: printf("\nEnter the emp_id that you want to search\n");
41                     scanf("%d", &id);
42                     fnSearchEmpID(id);
43                     break;
44
45             case 4: printf("\nEnter the dept that you want to search\n");

```

```

46         scanf("%s", dept);
47         fnSearchEmpDept(dept);
48         break;
49
50     case 5: printf("\nEnter the salary that you want to search\n");
51             scanf("%d", &sal);
52             fnSearchEmpSal(sal);
53             break;
54
55     case 6: printf("\nEnter the age that you want to search\n");
56             scanf("%d", &age);
57             fnSearchEmpAge(age);
58             break;
59
60     case 7: exit(0);
61 }
62 }
63 return 0;
64 }
65
66 void fnDisplayAllRecords()
67 {
68     int iCount = 0;
69     employee_t rEmp;
70     FILE *fp;
71
72     fp = fopen("bemp.dat", "rb");
73     if(fp==NULL)
74     {
75         printf("\nFile does not exist\n");
76         return;
77     }
78
79     while(fread(&rEmp, sizeof(employee_t), 1, fp))
80     {
81         printf("%6d\t%15s\t%8s\t%8d\t%4d\n", rEmp.emp_id, rEmp.emp_name, rEmp.
emp_dept, rEmp.emp_salary, rEmp.emp_age);
82         iCount++;
83         if(feof(fp))
84             break;
85     }
86
87     if(0 == iCount)
88         printf("\nNo Records found\n");
89     fclose(fp);
90 }
91
92 void fnAddRecord()
93 {
94     FILE *fp;
95     employee_t wEmp;
96
97     printf("\nEnter Employee details\n");
98     printf("\nID : ");
99     scanf("%d", &wEmp.emp_id);          getchar();
100    printf("\nName : ");
101    scanf("%s", wEmp.emp_name);
102    //fgets(wEmp.emp_name, 25, stdin);
103    printf("\nDept : ");
104    scanf("%s", wEmp.emp_dept);
105    //fgets(wEmp.emp_dept, 25, stdin);
106    printf("\nSalary : ");

```

```

107     scanf("%d", &wEmp.emp_salary);
108     printf("\nAge : ");
109     scanf("%d", &wEmp.emp_age);
110
111     fp = fopen("bemp.dat", "ab");
112
113     fwrite(&wEmp, sizeof(employee_t), 1, fp);
114     //write(fp, &wEmp, sizeof(employee_t));
115
116     fclose(fp);
117 }
118
119 void fnSearchEmpID(int id)
120 {
121     int iCount = 0;
122     employee_t sEmp;
123     FILE *fp;
124
125     fp = fopen("bemp.dat", "r");
126     if(fp==NULL)
127     {
128         printf("\nFile does not exist\n");
129         return;
130     }
131     while(fread(&sEmp, sizeof(employee_t), 1, fp))
132     {
133         if(sEmp.emp_id == id)
134         {
135             printf("%d\t%s\t%s\t%d\t%d\n", sEmp.emp_id, sEmp.emp_name, sEmp.
emp_dept, sEmp.emp_salary, sEmp.emp_age);
136             iCount++;
137         }
138         if(feof(fp))
139             break;
140     }
141
142     if(0 == iCount)
143         printf("\nNo Records found\n");
144     fclose(fp);
145 }
146
147 void fnSearchEmpSal(int sal)
148 {
149     int iCount = 0;
150     employee_t sEmp;
151     FILE *fp;
152
153     fp = fopen("bemp.dat", "r");
154     if(fp==NULL)
155     {
156         printf("\nFile does not exist\n");
157         return;
158     }
159     while(fread(&sEmp, sizeof(employee_t), 1, fp))
160     {
161         if(sEmp.emp_salary == sal)
162         {
163             printf("%d\t%s\t%s\t%d\t%d\n", sEmp.emp_id, sEmp.emp_name, sEmp.
emp_dept, sEmp.emp_salary, sEmp.emp_age);
164             iCount++;
165         }
166     }

```

```

167     if(0 == iCount)
168         printf("\nNo Records found\n");
169     fclose(fp);
170 }
171
172 void fnSearchEmpDept(char dept[])
173 {
174     int iCount = 0;
175     employee_t sEmp;
176     FILE *fp;
177
178
179     fp = fopen("bemp.dat", "r");
180     if(fp==NULL)
181     {
182         printf("\nFile does not exist\n");
183         return;
184     }
185     while(fread(&sEmp, sizeof(employee_t), 1, fp))
186     {
187         if(!strcmp(sEmp.emp_dept, dept))
188         {
189             printf("%d\t%s\t%s\t%d\t%d\n", sEmp.emp_id, sEmp.emp_name, sEmp.
emp_dept, sEmp.emp_salary, sEmp.emp_age);
190             iCount++;
191         }
192     }
193     if(0 == iCount)
194         printf("\nNo Records found\n");
195 }
196
197 void fnSearchEmpAge(int age)
198 {
199     int iCount = 0;
200     employee_t sEmp;
201     FILE *fp;
202
203
204     fp = fopen("bemp.dat", "r");
205     if(fp==NULL)
206     {
207         printf("\nFile does not exist\n");
208         return;
209     }
210     while(fread(&sEmp, sizeof(employee_t), 1, fp))
211     {
212         if(sEmp.emp_age == age)
213         {
214             printf("%d\t%s\t%s\t%d\t%d\n", sEmp.emp_id, sEmp.emp_name, sEmp.
emp_dept, sEmp.emp_salary, sEmp.emp_age);
215             iCount++;
216         }
217     }
218     if(0 == iCount)
219         printf("\nNo Records found\n");
220 }

```

Listing 1.2: 01EmployeeDBBinary.c

Output

```
=====
```

```

1  /*****
2  putta:Programs$ gcc 01EmployeeDB.c
3  putta:Programs$ ./a.out
4
5  1.Add Record
6  2.Display Records
7  3.Search Employee by ID
8  4.Search Employee by Dept
9  5.Search Employee by salary
10 6.Search Employee by Age
11 7.Exit
12 Enter your choice : 1
13
14 Enter Employee details
15
16 ID : 123
17 Name : Raju
18 Dept : CSE
19 Salary : 24000
20 Age : 26
21
22 1.Add Record
23 2.Display Records
24 3.Search Employee by ID
25 4.Search Employee by Dept
26 5.Search Employee by salary
27 6.Search Employee by Age
28 7.Exit
29 Enter your choice : 2
30
31 Employee Details
32
33 ID Name      Dept      Salary Age
34 123 Raju      CSE 24000  26
35
36 1.Add Record
37 2.Display Records
38 3.Search Employee by ID
39 4.Search Employee by Dept
40 5.Search Employee by salary
41 6.Search Employee by Age
42 7.Exit
43 Enter your choice : 1
44
45 Enter Employee details
46
47 ID : 124
48 Name : Susy
49 Dept : ISE
50 Salary : 26000
51 Age : 25
52
53 1.Add Record
54 2.Display Records
55 3.Search Employee by ID
56 4.Search Employee by Dept
57 5.Search Employee by salary
58 6.Search Employee by Age
59 7.Exit
60 Enter your choice : 1
61
62 Enter Employee details

```

```

63
64 ID : 125
65 Name : John
66 Dept : CSE
67 Salary : 27000
68 Age : 29
69
70 1.Add Record
71 2.Display Records
72 3.Search Employee by ID
73 4.Search Employee by Dept
74 5.Search Employee by salary
75 6.Search Employee by Age
76 7.Exit
77 Enter your choice : 2
78
79 Employee Details
80
81 ID   Name   Dept   Salary  Age
82 123 Raju   CSE    24000   26
83 124 Susy   ISE    26000   25
84 125 John   CSE    27000   29
85
86 1.Add Record
87 2.Display Records
88 3.Search Employee by ID
89 4.Search Employee by Dept
90 5.Search Employee by salary
91 6.Search Employee by Age
92 7.Exit
93 Enter your choice : 3
94
95 Enter the emp_id that you want to search
96 127
97
98 ID   Name   Dept   Salary  Age
99
100 No Records found
101
102 1.Add Record
103 2.Display Records
104 3.Search Employee by ID
105 4.Search Employee by Dept
106 5.Search Employee by salary
107 6.Search Employee by Age
108 7.Exit
109 Enter your choice : 3
110
111 Enter the emp_id that you want to search
112 125
113
114 ID   Name   Dept   Salary  Age
115 125 John   CSE    27000   29
116
117 1.Add Record
118 2.Display Records
119 3.Search Employee by ID
120 4.Search Employee by Dept
121 5.Search Employee by salary
122 6.Search Employee by Age
123 7.Exit
124 Enter your choice : 4

```

```

125
126 Enter the dept that you want to search
127 CSE
128
129 ID   Name   Dept   Salary  Age
130 123 Raju   CSE    24000   26
131 125 John   CSE    27000   29
132
133 1.Add Record
134 2.Display Records
135 3.Search Employee by ID
136 4.Search Employee by Dept
137 5.Search Employee by salary
138 6.Search Employee by Age
139 7.Exit
140 Enter your choice : 5
141
142 Enter the salary that you want to search
143 27000
144
145 ID   Name   Dept   Salary  Age
146 125 John   CSE    27000   29
147
148 1.Add Record
149 2.Display Records
150 3.Search Employee by ID
151 4.Search Employee by Dept
152 5.Search Employee by salary
153 6.Search Employee by Age
154 7.Exit
155 Enter your choice : 6
156
157 Enter the age that you want to search
158 26
159
160 ID   Name   Dept   Salary  Age
161 123 Raju   CSE    24000   26
162
163 1.Add Record
164 2.Display Records
165 3.Search Employee by ID
166 4.Search Employee by Dept
167 5.Search Employee by salary
168 6.Search Employee by Age
169 7.Exit
170 Enter your choice : 7
171 *****/

```

Listing 1.3: out1.c

Chapter 2

Stack Implementation

Question

Write a C program to implement STACK to perform the PUSH, POP and DISPLAY operations.

2.1 C Code - Array Representation

```
=====
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <stdbool.h>
4
5  #define MAX 4
6
7  bool fnStkFull(int);
8  bool fnStkEmpty(int);
9  void fnPush(int [], int*);
10 int fnPop(int [], int*);
11 void fnDisplay(int[], int);
12 int fnPeek(int [], int);
13
14 int main()
15 {
16     int stkArray[MAX];
17     int top = -1;
18     int iElem, iChoice;
19
20     for(;;)
21     {
22         printf("\nSTACK OPERATIONS\n");
23         printf("=====");
24         printf("\n1.PUSH\n2.POP\n3.DISPLAY\n4.PEEK\n5.EXIT\n");
25         printf("Enter your choice\n");
26         scanf("%d", &iChoice);
27         switch(iChoice)
28         {
29             case 1: fnPush(stkArray, &top);
30                     break;
31
32             case 2: iElem = fnPop(stkArray, &top);
33                     if(iElem != -1)
34                         printf("\nPopped Element is %d\n", iElem);
35                     break;
36
37             case 3: fnDisplay(stkArray, top);
38                     break;
```



```
39
40     case 4: if(!fnStkEmpty(top))
41         {
42             iElem = fnPeek(stkArray, top);
43             printf("\nElement at the top of the stack is %d\n", iElem
44         );
45         }
46     else
47         printf("\nEmpty Stack\n");
48     break;
49
50     case 5: exit(1);
51
52     default: printf("\nWrong choice\n");
53 }
54 return 0;
55 }
56
57 bool fnStkFull(int t)
58 {
59     return ((t == MAX-1) ? true : false);
60 }
61
62 bool fnStkEmpty(int t)
63 {
64     return ((t == -1) ? true : false);
65 }
66
67 void fnPush(int stk[], int *t)
68 {
69     int iElem;
70     if(fnStkFull(*t))
71     {
72         printf("\nStack Overflow\n");
73         return;
74     }
75     printf("\nEnter element to be pushed onto the stack\n");
76     scanf("%d", &iElem);
77
78     *t = *t + 1;
79     stk[*t] = iElem;
80 }
81
82 int fnPop(int stk[], int *t)
83 {
84     int iElem;
85     if(fnStkEmpty(*t))
86     {
87         printf("\nStack Underflow\n");
88         return -1;
89     }
90     iElem = stk[*t];
91     *t = *t - 1;
92
93     return iElem;
94 }
95
96 void fnDisplay(int stk[], int t)
97 {
98     int i;
99     if(fnStkEmpty(t))
```

```

100     {
101         printf("\nStack Empty\n");
102         return;
103     }
104     printf("\nStack Contents are: \n");
105     for(i = t ; i > -1; --i)
106     {
107         printf("\t%d\n", stk[i]);
108     }
109 }
110
111 int fnPeek(int stk[], int t)
112 {
113     return stk[t];
114 }

```

Listing 2.1: 02Stack.c

2.2 C Code - Structure Representation

```

=====
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <stdbool.h>
4
5  #define STK_SIZE 5
6
7  typedef struct{
8      int stkArray[STK_SIZE];
9      int top;
10 }STACK_TYPE;
11
12 bool fnStkFull(STACK_TYPE);
13 bool fnStkEmpty(STACK_TYPE);
14 void fnPush(STACK_TYPE*, int);
15 int fnPop(STACK_TYPE*);
16 void fnDisplay(STACK_TYPE);
17 int fnPeek(STACK_TYPE);
18
19 int main()
20 {
21     STACK_TYPE myStack;
22     myStack.top = -1;
23     int iElem, iChoice;
24
25     for(;;)
26     {
27         /*Code to display Menu and accept response */
28         printf("\n1.PUSH\n2.POP\n3.DISPLAY\n4.PEEK\n5.EXIT\n");
29         printf("\nEnter your Choice : ");
30         scanf("%d", &iChoice);
31         switch(iChoice)
32         {
33             case 1: if(!fnStkFull(myStack))
34                     {
35                         printf("\nEnter element to be pushed\n");
36                         scanf("%d", &iElem);
37
38                         fnPush(&myStack, iElem);
39                     }
40             else

```

```

41         {
42             printf("\nStack Overflow\n");
43         }
44         break;
45
46     case 2: if(!fnStkEmpty(myStack))
47     {
48         iElem = fnPop(&myStack);
49         printf("\nPopped element is %d\n", iElem);
50     }
51     else
52     {
53         printf("\nStack Underflow\n");
54     }
55     break;
56
57     case 3: if(!fnStkEmpty(myStack))
58     {
59         fnDisplay(myStack);
60     }
61     else
62     {
63         printf("\nStack is Empty\n");
64     }
65     break;
66     case 4: if(!fnStkEmpty(myStack))
67     {
68         iElem = fnPeek(myStack);
69         printf("\nElement at the top of the stack is %d\n", iElem)
70     ;
71     }
72     else
73     {
74         printf("\nStack is Empty\n");
75     }
76     break;
77
78     case 5: exit(0);
79
80 }
81 return 0;
82 }
83
84 bool fnStkFull(STACK_TYPE stk)
85 {
86     if(stk.top == STK_SIZE-1)
87         return true;
88     else
89         return false;
90 }
91
92 bool fnStkEmpty(STACK_TYPE stk)
93 {
94     if(stk.top == -1)
95         return true;
96     else
97         return false;
98 }
99
100 void fnPush(STACK_TYPE *stk, int elem)
101 {

```

```

102     stk->top = stk->top + 1;
103     stk->stkArray[stk->top] = elem;
104
105 }
106
107 int fnPop(STACK_TYPE *stk)
108 {
109     int elem;
110     elem = stk->stkArray[stk->top];
111     stk->top = stk->top - 1;
112     return elem;
113 }
114
115 void fnDisplay(STACK_TYPE stk)
116 {
117     int i;
118     printf("\nContents of the stack :\n");
119     for(i = stk.top; i>=0; i--)
120     {
121         printf("%d\n", stk.stkArray[i]);
122     }
123     printf("\n");
124 }
125
126 int fnPeek(STACK_TYPE stk)
127 {
128     return stk.stkArray[stk.top];
129 }

```

Listing 2.2: 02StructStack.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 02Stack.c
3  putta:Programs$ ./a.out
4
5  STACK OPERATIONS
6  =====
7  1.PUSH
8  2.POP
9  3.DISPLAY
10 4.PEEK
11 5.EXIT
12 Enter your choice
13 2
14
15 Stack Underflow
16
17 STACK OPERATIONS
18 =====
19 1.PUSH
20 2.POP
21 3.DISPLAY
22 4.PEEK
23 5.EXIT
24 Enter your choice
25 3
26
27 Stack Empty

```

```
28
29 STACK OPERATIONS
30 =====
31 1.PUSH
32 2.POP
33 3.DISPLAY
34 4.PEEK
35 5.EXIT
36 Enter your choice
37 1
38
39 Enter element to be pushed onto the stack
40 1
41
42 STACK OPERATIONS
43 =====
44 1.PUSH
45 2.POP
46 3.DISPLAY
47 4.PEEK
48 5.EXIT
49 Enter your choice
50 1
51
52 Enter element to be pushed onto the stack
53 2
54
55 STACK OPERATIONS
56 =====
57 1.PUSH
58 2.POP
59 3.DISPLAY
60 4.PEEK
61 5.EXIT
62 Enter your choice
63 1
64
65 Enter element to be pushed onto the stack
66 3
67
68 STACK OPERATIONS
69 =====
70 1.PUSH
71 2.POP
72 3.DISPLAY
73 4.PEEK
74 5.EXIT
75 Enter your choice
76 3
77
78 Stack Contents are:
79     3
80     2
81     1
82
83 STACK OPERATIONS
84 =====
85 1.PUSH
86 2.POP
87 3.DISPLAY
88 4.PEEK
89 5.EXIT
```

```
90 Enter your choice
91 4
92
93 Element at the top of the stack is 3
94
95 STACK OPERATIONS
96 =====
97 1.PUSH
98 2.POP
99 3.DISPLAY
100 4.PEEK
101 5.EXIT
102 Enter your choice
103 2
104
105 Popped Element is 3
106
107 STACK OPERATIONS
108 =====
109 1.PUSH
110 2.POP
111 3.DISPLAY
112 4.PEEK
113 5.EXIT
114 Enter your choice
115 4
116
117 Element at the top of the stack is 2
118
119 STACK OPERATIONS
120 =====
121 1.PUSH
122 2.POP
123 3.DISPLAY
124 4.PEEK
125 5.EXIT
126 Enter your choice
127 1
128
129 Enter element to be pushed onto the stack
130 3
131
132 STACK OPERATIONS
133 =====
134 1.PUSH
135 2.POP
136 3.DISPLAY
137 4.PEEK
138 5.EXIT
139 Enter your choice
140 1
141
142 Enter element to be pushed onto the stack
143 4
144
145 STACK OPERATIONS
146 =====
147 1.PUSH
148 2.POP
149 3.DISPLAY
150 4.PEEK
151 5.EXIT
```

```
152 Enter your choice
153 3
154
155 Stack Contents are:
156     4
157     3
158     2
159     1
160
161 STACK OPERATIONS
162 =====
163 1.PUSH
164 2.POP
165 3.DISPLAY
166 4.PEEK
167 5.EXIT
168 Enter your choice
169 1
170
171 Stack Overflow
172
173 STACK OPERATIONS
174 =====
175 1.PUSH
176 2.POP
177 3.DISPLAY
178 4.PEEK
179 5.EXIT
180 Enter your choice
181 5
182 *****/
```

Listing 2.3: out2.c

Chapter 3

Infix to Postfix Conversion

Question

Write a C program to convert the given infix expression to postfix expression.

C Code

```
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <ctype.h>
5
6  #define STK_SIZE 10
7
8  void fnPush(char [], int*, char);
9  char fnPop(char [], int*);
10 int fnPreced(char);
11
12 int main()
13 {
14     int i, j=0;
15     char acExpr[50], acStack[50], acPost[50], cSymb;
16     int top = -1;
17
18     printf("\nEnter a valid infix expression\n");
19     scanf("%s", acExpr);
20
21     fnPush(acStack, &top, '#');
22     for(i=0; acExpr[i]!='\0'; ++i)
23     {
24         cSymb = acExpr[i];
25         if(isdigit(cSymb))
26         {
27             fnPush(acStack, &top, cSymb);
28         }
29         else if(cSymb == '(')
30         {
31             fnPush(acStack, &top, cSymb);
32         }
33         else if(cSymb == ')')
34         {
35             while(acStack[top] != '(')
36             {
37                 acPost[j++] = fnPop(acStack, &top);
38             }
39             fnPop(acStack, &top);
```



```

40     }
41     else
42     {
43         while(fnPrecd(acStack[top]) >= fnPrecd(cSymb))
44         {
45             if(cSymb == '^' && acStack[top] == '^')
46                 break;
47             acPost[j++] = fnPop(acStack, &top);
48         }
49         fnPush(acStack, &top, cSymb);
50     }
51
52 }
53 while(acStack[top] != '#')
54 {
55     acPost[j++] = fnPop(acStack, &top);
56 }
57 acPost[j] = '\0';
58
59 printf("\nInfix Expression is %s\n", acExpr);
60 printf("\nPostfix Expression is %s\n", acPost);
61 return 0;
62 }
63
64 void fnPush(char Stack[], int *t , char elem)
65 {
66     *t = *t + 1;
67     Stack[*t] = elem;
68 }
69
70
71 char fnPop(char Stack[], int *t)
72 {
73     char elem;
74     elem = Stack[*t];
75     *t = *t - 1;
76     return elem;
77 }
78
79 int fnPrecd(char cSymb)
80 {
81     int iPrecd;
82     switch(cSymb)
83     {
84         case '#': iPrecd = -1;
85         case '(': iPrecd = 0;
86         case '+': iPrecd = 1;
87         case '-': iPrecd = 1;
88         case '*': iPrecd = 2;
89         case '/': iPrecd = 2;
90         case '^': iPrecd = 3;
91     }
92     return iPrecd;
93 }

```

Listing 3.1: 03ConvInfix.c

Output

```

1  /*****
2  putta:Programs$ gcc 03ConvInfix.c
3  putta:Programs$ ./a.out

```

```
4 Enter a valid infix expression
5 (a^b^c)+(d/(e-f))
6
7 Infix Expression is (a^b^c)+(d/(e-f))
8
9 Postfix Expression is abc^^def-/+
```

putta:Programs\$./a.out

```
12 Enter a valid infix expression
13 (a*(b-c)/(a+b*c))
14
15 Infix Expression is (a*(b-c)/(a+b*c))
16
17 Postfix Expression is abc-*abc*+/
18
19 *****/
```

Listing 3.2: out3.c

Chapter 4

Evaluation of Prefix Expression

Question

Write a C program to evaluate the given prefix expression.

C Code

```
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <ctype.h>
5
6  #define STK_SIZE 10
7
8  void fnPush(int [], int*, int);
9  int fnPop(int [], int*);
10
11 int main()
12 {
13     int iaStack[50], i, iOp1, iOp2, iRes;
14     char acExpr[50], cSymb;
15     int top = -1;
16
17     printf("\nEnter a valid prefix expression\n");
18     scanf("%s", acExpr);
19
20     for(i=strlen(acExpr)-1; i>=0; i--)
21     {
22         cSymb = acExpr[i];
23         if(isdigit(cSymb))
24         {
25             fnPush(iaStack, &top, cSymb-'0');
26         }
27         else
28         {
29             iOp1 = fnPop(iaStack, &top);
30             iOp2 = fnPop(iaStack, &top);
31             switch(cSymb)
32             {
33                 case '+': iRes = iOp1 + iOp2;
34                             break;
35                 case '-': iRes = iOp1 - iOp2;
36                             break;
37                 case '*': iRes = iOp1 * iOp2;
38                             break;
39                 case '/': iRes = iOp1 / iOp2;
```

```

40             break;
41         }
42         fnPush(iaStack, &top, iRes);
43     }
44
45     }
46     iRes = fnPop(iaStack, &top);
47     printf("\nValue of %s expression is %d\n", acExpr, iRes);
48     return 0;
49 }
50
51 void fnPush(int Stack[], int *t , int elem)
52 {
53     *t = *t + 1;
54     Stack[*t] = elem;
55
56 }
57
58 int fnPop(int Stack[], int *t)
59 {
60     int elem;
61     elem = Stack[*t];
62     *t = *t - 1;
63     return elem;
64 }

```

Listing 4.1: 04EvalPrefix.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 04EvalPrefix.c -Wall
3  putta:Programs$ ./a.out
4
5  Enter a valid prefix expression
6  ++34*23
7
8  Value of ++34*23 expression is 13
9
10 putta:Programs$ ./a.out
11
12 Enter a valid prefix expression
13 *+-525*25
14
15 Value of *+-525*25 expression is 80
16
17 *****/

```

Listing 4.2: out4.c

Chapter 5

Linear Queue

Question

Write a C program to implement ordinary QUEUE to perform the insertion, deletion and display operations.

5.1 C Code - Array Representation

```
=====
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <stdbool.h>
4
5  #define QUEUE_SIZE 5
6
7  void fnInsertRear(int [], int*, int);
8  int fnDeleteFront(int[], int*, int*);
9  void fnDisplay(int [], int, int);
10 bool fnQueueFull(int[], int);
11 bool fnQueueEmpty(int[], int, int);
12
13 int main()
14 {
15     int myQueue[QUEUE_SIZE];
16     int iFront = 0, iRear = -1;
17     int iElem, iChoice;
18
19     for(;;)
20     {
21         printf("\nQueue Operations\n");
22         printf("=====");
23         printf("\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
24         printf("Enter your choice\n");
25         scanf("%d", &iChoice);
26         switch(iChoice)
27         {
28             case 1: if(!fnQueueFull(myQueue, iRear))
29                     {
30                         printf("\nEnter an element : ");
31                         scanf("%d", &iElem);
32                         fnInsertRear(myQueue, &iRear, iElem);
33                     }
34             else
35             {
36                 printf("\nQueue is Full\n");
37             }

```

```

38
39         break;
40     case 2: if(!fnQueueEmpty(myQueue, iFront, iRear))
41     {
42         iElem = fnDeleteFront(myQueue, &iFront, &iRear);
43         printf("\nDeleted element is %d\n", iElem);
44     }
45     else
46     {
47         printf("\nQueue is Empty\n");
48     }
49
50     break;
51     case 3: if(!fnQueueEmpty(myQueue, iFront, iRear))
52     {
53         printf("\nContents of the Queue is \n");
54         fnDisplay(myQueue, iFront, iRear);
55     }
56     else
57     {
58         printf("\nQueue is Empty\n");
59     }
60
61     break;
62
63     case 4: exit(0);
64
65     default: printf("\nInvalid choice\n");
66
67     break;
68 }
69 }
70 return 0;
71 }
72
73 bool fnQueueFull(int queue[], int r)
74 {
75     if(r == QUEUE_SIZE-1)
76         return true;
77     else
78         return false;
79 }
80
81 bool fnQueueEmpty(int queue[], int f, int r)
82 {
83     if(r == f-1)
84         return true;
85     else
86         return false;
87 }
88
89 void fnInsertRear(int queue[], int *r, int iVal)
90 {
91     *r = *r + 1;
92     queue[*r] = iVal;
93 }
94
95 int fnDeleteFront(int queue[], int *f, int *r)
96 {
97     int iElem;
98     iElem = queue[*f];
99

```

```

100     if(*f == *r)
101     {
102         *f = 0;
103         *r = -1;
104     }
105     else
106     {
107         *f = *f + 1;
108     }
109     return iElem;
110 }
111
112 void fnDisplay(int queue[], int f, int r)
113 {
114     int i;
115     for(i=f; i<=r; i++)
116     {
117         printf("%d\t", queue[i]);
118     }
119     printf("\n");
120 }

```

Listing 5.1: 05LinearQueue.c

5.2 C Code - Structure Representation

```

=====
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <stdbool.h>
4
5
6  #define QUEUE_SIZE 5
7
8  typedef struct
9  {
10     int Queue[QUEUE_SIZE];
11     int iFront, iRear;
12 }QUEUE_T;
13
14
15 void fnInsertRear(QUEUE_T*, int);
16 int fnDeleteFront(QUEUE_T*);
17 void fnDisplay(QUEUE_T);
18 bool fnQueueFull(QUEUE_T);
19 bool fnQueueEmpty(QUEUE_T);
20
21 int main()
22 {
23     QUEUE_T myQueue;
24     int iElem, iChoice;
25
26     myQueue.iFront = 0;
27     myQueue.iRear = -1;
28
29
30     for(;;)
31     {
32         printf("\nQueue Operations\n");
33         printf("=====");
34         printf("\n1.Qinsert\n2.Qdelete\n3.Qdisplay\n4.Exit\n");

```

```
35     printf("Enter your choice\n");
36     scanf("%d",&iChoice);
37     switch(iChoice)
38     {
39         case 1: if(!fnQueueFull(myQueue))
40             {
41                 printf("\nEnter an element : ");
42                 scanf("%d", &iElem);
43                 fnInsertRear(&myQueue, iElem);
44             }
45         else
46             {
47                 printf("\nQueue is Full\n");
48             }
49
50         break;
51         case 2: if(!fnQueueEmpty(myQueue))
52             {
53                 iElem = fnDeleteFront(&myQueue);
54                 printf("\nDeleted element is %d\n", iElem);
55             }
56         else
57             {
58                 printf("\nQueue is Empty\n");
59             }
60
61         break;
62         case 3: if(!fnQueueEmpty(myQueue))
63             {
64                 printf("\nContents of the Queue is \n");
65                 fnDisplay(myQueue);
66             }
67         else
68             {
69                 printf("\nQueue is Empty\n");
70             }
71
72         break;
73
74         case 4: exit(0);
75
76         default: printf("\nInvalid choice\n");
77
78         break;
79     }
80 }
81 return 0;
82 }
83
84 bool fnQueueFull(Queue_T myQ)
85 {
86     if(myQ.iRear == QUEUE_SIZE-1)
87         return true;
88     else
89         return false;
90 }
91
92 bool fnQueueEmpty(Queue_T myQ)
93 {
94     if(myQ.iRear == myQ.iFront-1)
95         return true;
96     else
```



```

97         return false;
98     }
99
100 void fnInsertRear(QUEUE_T *myQ, int iVal)
101 {
102     (myQ->iRear)++;
103     myQ->Queue[myQ->iRear] = iVal;
104 }
105
106 int fnDeleteFront(QUEUE_T *myQ)
107 {
108     int iElem;
109     iElem = myQ->Queue[myQ->iFront];
110
111     if(myQ->iFront == myQ->iRear)
112     {
113         myQ->iFront = 0;
114         myQ->iRear = -1;
115     }
116     else
117     {
118         myQ->iFront = myQ->iFront + 1;
119     }
120     return iElem;
121 }
122
123 void fnDisplay(QUEUE_T myQ)
124 {
125     int i;
126     for(i=myQ.iFront; i<=myQ.iRear; i++)
127     {
128         printf("%d\t", myQ.Queue[i]);
129     }
130     printf("\n");
131 }

```

Listing 5.2: 05StructLinearQueue.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 05LinearQueue.c -Wall
3  putta:Programs$ ./a.out
4
5  Queue Operations
6  =====
7  1.Qinsert
8  2.Qdelete
9  3.Qdisplay
10 4.Exit
11 Enter your choice
12 2
13
14 Queue is Empty
15
16 Queue Operations
17 =====
18 1.Qinsert
19 2.Qdelete
20 3.Qdisplay

```

```
21 4.Exit
22 Enter your choice
23 3
24
25 Queue is Empty
26
27 Queue Operations
28 =====
29 1.Qinsert
30 2.Qdelete
31 3.Qdisplay
32 4.Exit
33 Enter your choice
34 1
35
36 Enter an element : 1
37
38 Queue Operations
39 =====
40 1.Qinsert
41 2.Qdelete
42 3.Qdisplay
43 4.Exit
44 Enter your choice
45 1
46
47 Enter an element : 2
48
49 Queue Operations
50 =====
51 1.Qinsert
52 2.Qdelete
53 3.Qdisplay
54 4.Exit
55 Enter your choice
56 1
57
58 Enter an element : 3
59
60 Queue Operations
61 =====
62 1.Qinsert
63 2.Qdelete
64 3.Qdisplay
65 4.Exit
66 Enter your choice
67 3
68
69 Contents of the Queue is
70 1 2 3
71
72 Queue Operations
73 =====
74 1.Qinsert
75 2.Qdelete
76 3.Qdisplay
77 4.Exit
78 Enter your choice
79 1
80
81 Enter an element : 4
82
```

```
83 Queue Operations
84 =====
85 1.Qinsert
86 2.Qdelete
87 3.Qdisplay
88 4.Exit
89 Enter your choice
90 1
91
92 Enter an element : 5
93
94 Queue Operations
95 =====
96 1.Qinsert
97 2.Qdelete
98 3.Qdisplay
99 4.Exit
100 Enter your choice
101 3
102
103 Contents of the Queue is
104 1  2  3  4  5
105
106 Queue Operations
107 =====
108 1.Qinsert
109 2.Qdelete
110 3.Qdisplay
111 4.Exit
112 Enter your choice
113 1
114
115 Queue is Full
116
117 Queue Operations
118 =====
119 1.Qinsert
120 2.Qdelete
121 3.Qdisplay
122 4.Exit
123 Enter your choice
124 2
125
126 Deleted element is 1
127
128 Queue Operations
129 =====
130 1.Qinsert
131 2.Qdelete
132 3.Qdisplay
133 4.Exit
134 Enter your choice
135 2
136
137 Deleted element is 2
138
139 Queue Operations
140 =====
141 1.Qinsert
142 2.Qdelete
143 3.Qdisplay
144 4.Exit
```

```
145 Enter your choice
146 2
147
148 Deleted element is 3
149
150 Queue Operations
151 =====
152 1.Qinsert
153 2.Qdelete
154 3.Qdisplay
155 4.Exit
156 Enter your choice
157 4
158 *****
159
160 *****/
```

Listing 5.3: out5.c

Chapter 6

Circular Queue

Question

Write a C program to implement CIRCULAR QUEUE to perform the insertion, deletion and display operations.

6.1 C Code - Array Representation

```
=====
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <stdbool.h>
4
5  #define QUEUE_SIZE 5
6
7  void fnInsertRear(int [], int*, int*, int);
8  int fnDeleteFront(int[], int*, int*);
9  void fnDisplay(int [], int, int);
10 bool fnQueueFull(int[], int, int);
11 bool fnQueueEmpty(int[], int, int);
12
13 int main()
14 {
15     int myQueue[QUEUE_SIZE];
16     int iFront = -1, iRear = -1;
17     int iElem, iChoice;
18
19     for(;;)
20     {
21         printf("\nQueue Operations\n");
22         printf("=====");
23         printf("\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
24         printf("Enter your choice\n");
25         scanf("%d", &iChoice);
26         switch(iChoice)
27         {
28             case 1: if(!fnQueueFull(myQueue, iFront, iRear))
29                     {
30                         printf("\nEnter an element : ");
31                         scanf("%d", &iElem);
32                         fnInsertRear(myQueue, &iFront, &iRear, iElem);
33                     }
34             else
35             {
36                 printf("\nQueue is Full\n");
37             }

```

```

38
39         break;
40     case 2: if(!fnQueueEmpty(myQueue, iFront, iRear))
41     {
42         iElem = fnDeleteFront(myQueue, &iFront, &iRear);
43         printf("\nDeleted element is %d\n", iElem);
44     }
45     else
46     {
47         printf("\nQueue is Empty\n");
48     }
49
50     break;
51     case 3: if(!fnQueueEmpty(myQueue, iFront, iRear))
52     {
53         printf("\nContents of the Queue is \n");
54         fnDisplay(myQueue, iFront, iRear);
55     }
56     else
57     {
58         printf("\nQueue is Empty\n");
59     }
60
61     break;
62
63     case 4: exit(0);
64
65     default: printf("\nInvalid choice\n");
66
67     break;
68 }
69 }
70 return 0;
71 }
72
73 bool fnQueueFull(int queue[], int f, int r)
74 {
75     if((r+1) % QUEUE_SIZE == f)
76         return true;
77     else
78         return false;
79 }
80
81 bool fnQueueEmpty(int queue[], int f, int r)
82 {
83     if(f == -1)
84         return true;
85     else
86         return false;
87 }
88
89 void fnInsertRear(int queue[], int *f, int *r, int iVal)
90 {
91     if(*r == -1)
92     {
93         *f = *f + 1;
94         *r = *r + 1;
95     }
96     else
97         *r = (*r + 1) % QUEUE_SIZE;
98
99     queue[*r] = iVal;

```

```

100 }
101
102 int fnDeleteFront(int queue[], int *f, int *r)
103 {
104     int iElem;
105     iElem = queue[*f];
106
107     if(*f == *r)
108     {
109         *f = -1;
110         *r = -1;
111     }
112     else
113     {
114         *f = (*f + 1)%QUEUE_SIZE;
115     }
116     return iElem;
117 }
118
119 void fnDisplay(int queue[], int f, int r)
120 {
121     int i;
122     if(f<=r)
123     {
124         for(i=f; i<=r; i++)
125         {
126             printf("%d\t", queue[i]);
127         }
128         printf("\n");
129     }
130     else
131     {
132         for(i=f; i<=QUEUE_SIZE-1; i++)
133         {
134             printf("%d\t", queue[i]);
135         }
136         for(i=0; i<=r; i++)
137         {
138             printf("%d\t", queue[i]);
139         }
140         printf("\n");
141     }
142 }

```

Listing 6.1: 06CircQueue.c

6.2 C Code - Structure Representation

```

=====
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <stdbool.h>
4
5
6 #define QUEUE_SIZE 5
7 #define NAME_LENGTH 30
8
9 typedef struct
10 {
11     int Queue[QUEUE_SIZE];
12     int iFront, iRear;

```

```
13 }QUEUE_T;
14
15
16 void fnInsertRear(QUEUE_T*, int);
17 int fnDeleteFront(QUEUE_T*);
18 void fnDisplay(QUEUE_T);
19 bool fnQueueFull(QUEUE_T);
20 bool fnQueueEmpty(QUEUE_T);
21
22 int main()
23 {
24     QUEUE_T myQueue;
25     int iElem, iChoice;
26
27     myQueue.iFront = -1;
28     myQueue.iRear = -1;
29
30
31     for(;;)
32     {
33         printf("\nQueue Operations\n");
34         printf("=====");
35         printf("\n1.Insert\n2.Delete\n3.Display\n4.Exit\n");
36         printf("Enter your choice\n");
37         scanf("%d",&iChoice);
38         switch(iChoice)
39         {
40             case 1: if(!fnQueueFull(myQueue))
41                 {
42                     printf("\nEnter an element : ");
43                     scanf("%d", &iElem);
44                     fnInsertRear(&myQueue, iElem);
45                 }
46             else
47                 {
48                     printf("\nQueue is Full\n");
49                 }
50
51             break;
52             case 2: if(!fnQueueEmpty(myQueue))
53                 {
54                     iElem = fnDeleteFront(&myQueue);
55                     printf("\nDeleted element is %d\n", iElem);
56                 }
57             else
58                 {
59                     printf("\nQueue is Empty\n");
60                 }
61
62             break;
63             case 3: if(!fnQueueEmpty(myQueue))
64                 {
65                     printf("\nContents of the Queue is \n");
66                     fnDisplay(myQueue);
67                 }
68             else
69                 {
70                     printf("\nQueue is Empty\n");
71                 }
72
73             break;
74
```



```
75         case 4: exit(0);
76
77         default: printf("\nInvalid choice\n");
78
79         break;
80     }
81 }
82 return 0;
83 }
84
85 bool fnQueueFull(Queue_T myQ)
86 {
87     if((myQ.iRear+1) % QUEUE_SIZE == myQ.iFront)
88         return true;
89     else
90         return false;
91 }
92
93 bool fnQueueEmpty(Queue_T myQ)
94 {
95     if(myQ.iFront == -1)
96         return true;
97     else
98         return false;
99 }
100
101 void fnInsertRear(Queue_T *myQ, int iVal)
102 {
103     if(myQ->iRear == -1)
104     {
105         (myQ->iRear)++;
106         (myQ->iFront)++;
107     }
108     else
109         myQ->iRear = (myQ->iRear + 1) % QUEUE_SIZE;
110
111     myQ->Queue[myQ->iRear] = iVal;
112 }
113
114 int fnDeleteFront(Queue_T *myQ)
115 {
116     int iElem;
117     iElem = myQ->Queue[myQ->iFront];
118
119     if(myQ->iFront == myQ->iRear)
120     {
121         myQ->iFront = myQ->iRear = -1;
122     }
123     else
124     {
125         myQ->iFront = (myQ->iFront + 1) % QUEUE_SIZE;
126     }
127     return iElem;
128 }
129
130 void fnDisplay(Queue_T myQ)
131 {
132     int i;
133     if(myQ.iFront <= myQ.iRear)
134     {
135         for(i=myQ.iFront; i <= myQ.iRear; i++)
136         {
```

```

137         printf("%d\t", myQ.Queue[i]);
138     }
139     printf("\n");
140 }
141 else
142 {
143     for(i=myQ.iFront; i<QUEUE_SIZE; i++)
144     {
145         printf("%d\t", myQ.Queue[i]);
146     }
147     for(i=0; i<=myQ.iRear; i++)
148     {
149         printf("%d\t", myQ.Queue[i]);
150     }
151     printf("\n");
152 }
153 }
154 }

```

Listing 6.2: 06StructCircularQueue.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 06CircQueue.c -Wall
3  putta:Programs$ ./a.out
4
5  Queue Operations
6  =====
7  1.Qinsert
8  2.Qdelete
9  3.Qdisplay
10 4.Exit
11 Enter your choice
12 2
13
14 Queue is Empty
15
16 Queue Operations
17 =====
18 1.Qinsert
19 2.Qdelete
20 3.Qdisplay
21 4.Exit
22 Enter your choice
23 1
24
25 Enter an element : 1
26
27 Queue Operations
28 =====
29 1.Qinsert
30 2.Qdelete
31 3.Qdisplay
32 4.Exit
33 Enter your choice
34 1
35
36 Enter an element : 2
37

```

```

38 Queue Operations
39 =====
40 1.Qinsert
41 2.Qdelete
42 3.Qdisplay
43 4.Exit
44 Enter your choice
45 1
46
47 Enter an element : 3
48
49 Queue Operations
50 =====
51 1.Qinsert
52 2.Qdelete
53 3.Qdisplay
54 4.Exit
55 Enter your choice
56 3
57
58 Contents of the Queue is
59 1 2 3
60
61 Queue Operations
62 =====
63 1.Qinsert
64 2.Qdelete
65 3.Qdisplay
66 4.Exit
67 Enter your choice
68 1
69
70 Enter an element : 2
71
72 Queue Operations
73 =====
74 1.Qinsert
75 2.Qdelete
76 3.Qdisplay
77 4.Exit
78 Enter your choice
79 4
80 putta:Programs$ clear
81
82 putta:Programs$ gcc 06CircQueue.c -Wall
83 putta:Programs$ ./a.out
84
85 Queue Operations
86 =====
87 1.Qinsert
88 2.Qdelete
89 3.Qdisplay
90 4.Exit
91 Enter your choice
92 2
93
94 Queue is Empty
95
96 Queue Operations
97 =====
98 1.Qinsert
99 2.Qdelete

```

```
100 3.Qdisplay
101 4.Exit
102 Enter your choice
103 1
104
105 Enter an element : 1
106
107 Queue Operations
108 =====
109 1.Qinsert
110 2.Qdelete
111 3.Qdisplay
112 4.Exit
113 Enter your choice
114 1
115
116 Enter an element : 2
117
118 Queue Operations
119 =====
120 1.Qinsert
121 2.Qdelete
122 3.Qdisplay
123 4.Exit
124 Enter your choice
125 1
126
127 Enter an element : 3
128
129 Queue Operations
130 =====
131 1.Qinsert
132 2.Qdelete
133 3.Qdisplay
134 4.Exit
135 Enter your choice
136 3
137
138 Contents of the Queue is
139 1  2  3
140
141 Queue Operations
142 =====
143 1.Qinsert
144 2.Qdelete
145 3.Qdisplay
146 4.Exit
147 Enter your choice
148 1
149
150 Enter an element : 4
151
152 Queue Operations
153 =====
154 1.Qinsert
155 2.Qdelete
156 3.Qdisplay
157 4.Exit
158 Enter your choice
159 1
160
161 Enter an element : 5
```

```
162
163 Queue Operations
164 =====
165 1.Qinsert
166 2.Qdelete
167 3.Qdisplay
168 4.Exit
169 Enter your choice
170 1
171
172 Queue is Full
173
174 Queue Operations
175 =====
176 1.Qinsert
177 2.Qdelete
178 3.Qdisplay
179 4.Exit
180 Enter your choice
181 3
182
183 Contents of the Queue is
184 1  2  3  4  5
185
186 Queue Operations
187 =====
188 1.Qinsert
189 2.Qdelete
190 3.Qdisplay
191 4.Exit
192 Enter your choice
193 2
194
195 Deleted element is 1
196
197 Queue Operations
198 =====
199 1.Qinsert
200 2.Qdelete
201 3.Qdisplay
202 4.Exit
203 Enter your choice
204 3
205
206 Contents of the Queue is
207 2  3  4  5
208
209 Queue Operations
210 =====
211 1.Qinsert
212 2.Qdelete
213 3.Qdisplay
214 4.Exit
215 Enter your choice
216 2
217
218 Deleted element is 2
219
220 Queue Operations
221 =====
222 1.Qinsert
223 2.Qdelete
```

```
224 3.Qdisplay
225 4.Exit
226 Enter your choice
227 3
228
229 Contents of the Queue is
230 3 4 5
231
232 Queue Operations
233 =====
234 1.Qinsert
235 2.Qdelete
236 3.Qdisplay
237 4.Exit
238 Enter your choice
239 1
240
241 Enter an element : 6
242
243 Queue Operations
244 =====
245 1.Qinsert
246 2.Qdelete
247 3.Qdisplay
248 4.Exit
249 Enter your choice
250 3
251
252 Contents of the Queue is
253 3 4 5 6
254
255 Queue Operations
256 =====
257 1.Qinsert
258 2.Qdelete
259 3.Qdisplay
260 4.Exit
261 Enter your choice
262 4
263
264 *****/
```

Listing 6.3: out6.c

Chapter 7

Singly Linked List

Question

Write a C program to perform the following operations using singly linked list:

- a to insert a node at the end of the list.***
- b to insert a node at the end of the list.***
- c to insert a node at the specified position in the list.***
- d to display the contents of the list.***
- e to reverse a given list.***

C Code

```
1 #include <stdio.h>
2 #include <stdlib.h>
3 struct node
4 {
5     int info;
6     struct node *link;
7 };
8
9 typedef struct node* NODEPTR;
10
11 NODEPTR fnGetNode(void);
12 void fnFreeNode(NODEPTR x);
13 NODEPTR fnInsertFront(int ,NODEPTR);
14 NODEPTR fnDeleteFront(NODEPTR);
15 NODEPTR fnDeletePosition(int, NODEPTR);
16 NODEPTR fnInsertPosition(int ,int ,NODEPTR);
17 void fnDisplay(NODEPTR first);
18 NODEPTR fnReverse(NODEPTR);
19
20 int main()
21 {
22     NODEPTR first = NULL;
23     int iElem, iChoice, iPos;
24     for(;;)
25     {
26         printf("\n1.Insert Front\n2.Delete Front\n3.Insert At Position");
27         printf("\n4.Display\n5.Reverse\n6.Exit\n");
28         printf("Enter your choice\n");
29         scanf("%d",&iChoice);
30         switch(iChoice)
31         {
```

```

32         case 1: printf("\nEnter a element\n");
33                 scanf("%d", &iElem);
34                 first = fnInsertFront(iElem, first);
35                 break;
36
37         case 2: first = fnDeleteFront(first);
38                 break;
39
40         case 3: printf("\nEnter a element\n");
41                 scanf("%d", &iElem);
42                 printf("\nEnter the position\n");
43                 scanf("%d", &iPos);
44                 first = fnInsertPosition(iElem, iPos, first);
45                 break;
46
47         case 4: fnDisplay(first);
48                 break;
49
50         case 5: first = fnReverse(first);
51                 break;
52         case 6: exit(0);
53     }
54 }
55 return 0;
56 }
57
58 NODEPTR fnGetNode(void)
59 {
60     NODEPTR newNode;
61     newNode = ( NODEPTR ) malloc (sizeof(struct node));
62     if(newNode == NULL)
63     {
64         printf("\nOut of Memory");
65         exit(0);
66     }
67     return newNode;
68 }
69
70 void fnFreeNode(NODEPTR x)
71 {
72     free(x);
73 }
74
75 NODEPTR fnInsertFront(int elem, NODEPTR first)
76 {
77     NODEPTR temp;
78     temp = fnGetNode();
79     temp->info = elem;
80     temp->link = first;
81     first = temp;
82     return first;
83 }
84
85
86 NODEPTR fnDeleteFront(NODEPTR first)
87 {
88     NODEPTR temp;
89     if(first == NULL)
90     {
91         printf("\nList is Empty cannot delete\n");
92         return first;
93     }

```



```

94
95     temp = first;
96     printf("\nElement deleted is %d\n", temp->info);
97     fnFreeNode(temp);
98     first = first->link;
99     return first;
100 }
101
102 NODEPTR fnInsertPosition(int elem,int pos,NODEPTR first)
103 {
104     NODEPTR temp,prev,cur;
105     int count;
106
107     temp = fnGetNode();
108     temp->info = elem;
109     temp->link = NULL;
110
111     if(first == NULL && pos == 1)
112         return temp;
113
114     if(first == NULL)
115     {
116         printf("\nInvalid Position");
117         return first;
118     }
119
120     if(pos == 1)
121     {
122         temp->link = first;
123         return temp;
124     }
125
126     count = 1;
127     prev = NULL;
128     cur = first;
129
130     while(cur != NULL && count != pos)
131     {
132         prev = cur;
133         cur = cur->link;
134         count++;
135     }
136
137     if(count == pos)
138     {
139         prev->link = temp;
140         temp->link = cur;
141         return first;
142     }
143
144     printf("\nInvalid Position");
145     return first;
146 }
147
148
149 void fnDisplay(NODEPTR first)
150 {
151     NODEPTR temp;
152
153     if(first == NULL)
154     {
155         printf("\nList is Empty\n");

```

```

156         return;
157     }
158
159     printf("\nList Contents\n");
160     printf("=====\n");
161     for(temp = first; temp != NULL; temp = temp->link)
162         printf("%4d", temp->info);
163     printf("\n=====\n");
164     printf("\n\n");
165
166 }
167
168 NODEPTR fnReverse(NODEPTR first)
169 {
170     NODEPTR cur, prev, next;
171     prev = first;
172     cur = first->link;
173     next = cur->link;
174     prev->link = NULL;
175     while(cur->link!=NULL)
176     {
177         cur->link = prev;
178         prev = cur;
179         cur = next;
180         next = next->link;
181     }
182     cur->link = prev;
183     return cur;
184 }

```

Listing 7.1: 07SinglyLinkedList.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 07SinglyLinkedList.c -Wall
3  putta:Programs$ ./a.out
4
5  1.Insert Front
6  2.Delete Front
7  3.Insert At Position
8  4.Display
9  5.Reverse
10 6.Exit
11 Enter your choice
12 1
13
14 Enter a element
15 4
16
17 1.Insert Front
18 2.Delete Front
19 3.Insert At Position
20 4.Display
21 5.Reverse
22 6.Exit
23 Enter your choice
24 1
25
26 Enter a element
27 3

```

```

28
29 1.Insert Front
30 2.Delete Front
31 3.Insert At Position
32 4.Display
33 5.Reverse
34 6.Exit
35 Enter your choice
36 1
37
38 Enter a element
39 2
40
41 1.Insert Front
42 2.Delete Front
43 3.Insert At Position
44 4.Display
45 5.Reverse
46 6.Exit
47 Enter your choice
48 4
49
50 List Contents
51 =====
52      2      3      4
53 =====
54
55
56
57 1.Insert Front
58 2.Delete Front
59 3.Insert At Position
60 4.Display
61 5.Reverse
62 6.Exit
63 Enter your choice
64 3
65
66 Enter a element
67 1
68
69 Enter the position
70 1
71
72 1.Insert Front
73 2.Delete Front
74 3.Insert At Position
75 4.Display
76 5.Reverse
77 6.Exit
78 Enter your choice
79 4
80
81 List Contents
82 =====
83      1      2      3      4
84 =====
85
86
87
88 1.Insert Front
89 2.Delete Front

```

```

90 3.Insert At Position
91 4.Display
92 5.Reverse
93 6.Exit
94 Enter your choice
95 5
96
97 1.Insert Front
98 2.Delete Front
99 3.Insert At Position
100 4.Display
101 5.Reverse
102 6.Exit
103 Enter your choice
104 4
105
106 List Contents
107 =====
108      4      3      2      1
109 =====
110
111
112
113 1.Insert Front
114 2.Delete Front
115 3.Insert At Position
116 4.Display
117 5.Reverse
118 6.Exit
119 Enter your choice
120 2
121
122 Element deleted is 4
123
124 1.Insert Front
125 2.Delete Front
126 3.Insert At Position
127 4.Display
128 5.Reverse
129 6.Exit
130 Enter your choice
131 4
132
133 List Contents
134 =====
135      3      2      1
136 =====
137
138
139
140 1.Insert Front
141 2.Delete Front
142 3.Insert At Position
143 4.Display
144 5.Reverse
145 6.Exit
146 Enter your choice
147 6
148
149 *****/

```

Listing 7.2: out7.c

Chapter 8

Ordered Linked List

Question

Write a C program to construct two ordered singly linked lists with the following operations:

a insert into list1.

b insert into list2.

c to perform UNION(list1,list2)

d to perform INTERSECTION(list1,list2)

e display the contents of all three lists.

C Code

```
1 #include <stdio.h>
2 #include <stdlib.h>
3 struct node
4 {
5     int info;
6     struct node *link;
7 };
8
9 typedef struct node* NODEPTR;
10
11 NODEPTR fnGetNode(void);
12 NODEPTR fnInsertOrder(int, NODEPTR);
13 NODEPTR fnInsertRear(int, NODEPTR);
14 NODEPTR fnUnion(NODEPTR, NODEPTR);
15 NODEPTR fnIntersection(NODEPTR, NODEPTR);
16 void fnDisplay(NODEPTR first);
17
18 int main()
19 {
20     NODEPTR list1, list2, list3, list4;
21     list1 = list2 = list3 = list4 = NULL;
22     int iElem, iChoice;
23     for(;;)
24     {
25         printf("\n1.Insert into List 1\n2.Insert into List 2\n3.Display");
26         printf("\n4.Union\n5.Intersection\n6.Exit\n");
27         printf("Enter your choice\n");
28         scanf("%d", &iChoice);
29         switch(iChoice)
30         {
31             case 1: printf("\nEnter a element\n");
```

```

32         scanf("%d", &iElem);
33         list1 = fnInsertOrder(iElem, list1);
34         break;
35
36     case 2: printf("\nEnter a element\n");
37             scanf("%d", &iElem);
38             list2 = fnInsertOrder(iElem, list2);
39             break;
40
41     case 3: printf("\nList 1 Contents\n");
42             fnDisplay(list1);
43             printf("\nList 2 Contents\n");
44             fnDisplay(list2);
45             break;
46
47     case 4: printf("\nList 1 Contents\n");
48             fnDisplay(list1);
49             printf("\nList 2 Contents\n");
50             fnDisplay(list2);
51             list3 = fnUnion(list1, list2);
52             printf("\nUnion\n");
53             fnDisplay(list3);
54             break;
55
56     case 5: printf("\nList 1 Contents\n");
57             fnDisplay(list1);
58             printf("\nList 2 Contents\n");
59             fnDisplay(list2);
60             list4 = fnIntersection(list1, list2);
61             printf("\nIntersection\n");
62             fnDisplay(list4);
63             break;
64     case 6: exit(0);
65 }
66 }
67 return 0;
68 }
69
70 NODEPTR fnGetNode(void)
71 {
72     NODEPTR newNode;
73     newNode = ( NODEPTR ) malloc (sizeof(struct node));
74     if(newNode == NULL)
75     {
76         printf("\nOut of Memory");
77         exit(0);
78     }
79     return newNode;
80 }
81
82 NODEPTR fnIntersection(NODEPTR l1, NODEPTR l2)
83 {
84     NODEPTR t1, t2, t3;
85     t1 = l1;
86     while(t1 != NULL)
87     {
88         t2 = l2;
89         while(t2 != NULL)
90         {
91             if(t1->info == t2->info)
92                 t3 = fnInsertRear(t1->info, t3);
93             t2 = t2->link;

```

```

94     }
95     t1 = t1->link;
96 }
97 return t3;
98 }
99
100
101 NODEPTR fnUnion(NODEPTR l1, NODEPTR l2)
102 {
103     NODEPTR t1, t2, t3;
104     t1 = l1;
105     t2 = l2;
106     while(t1 != NULL && t2 != NULL)
107     {
108         if(t1->info < t2->info)
109         {
110             t3 = fnInsertRear(t1->info, t3);
111             t1 = t1->link;
112         }
113         else if(t1->info > t2->info)
114         {
115             t3 = fnInsertRear(t2->info, t3);
116             t2 = t2->link;
117         }
118         else
119         {
120             t2 = t2->link;
121         }
122     }
123     while(t1 != NULL)
124     {
125         t3 = fnInsertRear(t1->info, t3);
126         t1 = t1->link;
127     }
128     while(t2 != NULL)
129     {
130         t3 = fnInsertRear(t2->info, t3);
131         t2 = t2->link;
132     }
133     return t3;
134 }
135 }
136
137
138 NODEPTR fnInsertOrder(int elem, NODEPTR first)
139 {
140     NODEPTR temp, prev, cur;
141
142     temp = fnGetNode();
143     temp->info = elem;
144     temp->link = NULL;
145
146     if(first == NULL)
147         return temp;
148
149     if(elem <= first->info)
150     {
151         temp->link = first;
152         return temp;
153     }
154
155     prev = NULL;

```

```

156     cur = first;
157
158     while(cur != NULL && elem > cur->info)
159     {
160         prev = cur;
161         cur = cur->link;
162     }
163     prev->link = temp;
164     temp->link = cur;
165     return first;
166 }
167
168 void fnDisplay(NODEPTR first)
169 {
170     NODEPTR temp;
171
172     if(first == NULL)
173     {
174         printf("\nList is Empty\n");
175         return;
176     }
177
178     printf("=====\n");
179     for(temp = first; temp != NULL; temp = temp->link)
180         printf("%4d", temp->info);
181     printf("\n=====\n");
182 }
183
184 NODEPTR fnInsertRear(int iElem, NODEPTR first)
185 {
186     NODEPTR temp, cur;
187     temp = fnGetNode();
188     temp->info = iElem;
189     temp->link = NULL;
190
191     if(first == NULL)
192         return temp;
193
194     cur = first;
195     while(cur->link != NULL)
196     {
197         cur = cur->link;
198     }
199     cur->link = temp;
200     return first;
201 }

```

Listing 8.1: 08OrderedSinglyLinkedList.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 08OrderedSinglyLinkedList.c -Wall
3  putta:Programs$ ./a.out
4
5  1.Insert into List 1
6  2.Insert into List 2
7  3.Display
8  4.Union
9  5.Intersection
10 6.Exit

```



```
11 Enter your choice
12 1
13
14 Enter a element
15 6
16
17 1.Insert into List 1
18 2.Insert into List 2
19 3.Display
20 4.Union
21 5.Intersection
22 6.Exit
23 Enter your choice
24 1
25
26 Enter a element
27 4
28
29 1.Insert into List 1
30 2.Insert into List 2
31 3.Display
32 4.Union
33 5.Intersection
34 6.Exit
35 Enter your choice
36 1
37
38 Enter a element
39 2
40
41 1.Insert into List 1
42 2.Insert into List 2
43 3.Display
44 4.Union
45 5.Intersection
46 6.Exit
47 Enter your choice
48 2
49
50 Enter a element
51 7
52
53 1.Insert into List 1
54 2.Insert into List 2
55 3.Display
56 4.Union
57 5.Intersection
58 6.Exit
59 Enter your choice
60 2
61
62 Enter a element
63 5
64
65 1.Insert into List 1
66 2.Insert into List 2
67 3.Display
68 4.Union
69 5.Intersection
70 6.Exit
71 Enter your choice
72 2
```

```

73
74 Enter a element
75 3
76
77 1.Insert into List 1
78 2.Insert into List 2
79 3.Display
80 4.Union
81 5.Intersection
82 6.Exit
83 Enter your choice
84 3
85
86 List 1 Contents
87 =====
88      2    4    6
89 =====
90
91 List 2 Contents
92 =====
93      3    5    7
94 =====
95
96
97 1.Insert into List 1
98 2.Insert into List 2
99 3.Display
100 4.Union
101 5.Intersection
102 6.Exit
103 Enter your choice
104 5
105
106 List 1 Contents
107 =====
108      2    4    6
109 =====
110
111 List 2 Contents
112 =====
113      3    5    7
114 =====
115
116 Intersection
117
118 List is Empty
119
120 1.Insert into List 1
121 2.Insert into List 2
122 3.Display
123 4.Union
124 5.Intersection
125 6.Exit
126 Enter your choice
127 2
128
129 Enter a element
130 2
131
132 1.Insert into List 1
133 2.Insert into List 2
134 3.Display

```

```

135 4.Union
136 5.Intersection
137 6.Exit
138 Enter your choice
139 2
140
141 Enter a element
142 4
143
144 1.Insert into List 1
145 2.Insert into List 2
146 3.Display
147 4.Union
148 5.Intersection
149 6.Exit
150 Enter your choice
151 3
152
153 List 1 Contents
154 =====
155      2    4    6
156 =====
157
158 List 2 Contents
159 =====
160      2    3    4    5    7
161 =====
162
163 1.Insert into List 1
164 2.Insert into List 2
165 3.Display
166 4.Union
167 5.Intersection
168 6.Exit
169 Enter your choice
170 5
171
172 List 1 Contents
173 =====
174      2    4    6
175 =====
176
177 List 2 Contents
178 =====
179      2    3    4    5    7
180 =====
181
182 Intersection
183 =====
184      2    4
185 =====
186
187 1.Insert into List 1
188 2.Insert into List 2
189 3.Display
190 4.Union
191 5.Intersection
192 6.Exit
193 Enter your choice
194 4
195
196 List 1 Contents

```

```
197 =====
198      2    4    6
199 =====
200
201 List 2 Contents
202 =====
203      2    3    4    5    7
204 =====
205
206 Union
207 =====
208      2    3    4    5    6    7
209 =====
210
211 1.Insert into List 1
212 2.Insert into List 2
213 3.Display
214 4.Union
215 5.Intersection
216 6.Exit
217 Enter your choice
218 6
219
220 *****/
```

Listing 8.2: out8.c

Chapter 9

Singly Linked List Applications

9.1 Stack using SLL

=====

Write a C program to implement a STACK using singly linked list.

C Code

```
1  #include<stdio.h>                                /*CPP*/
2  #include<stdlib.h>
3
4  struct node
5  {
6      int Info;
7      struct node *link;
8  };
9
10 typedef struct node* NODEPTR;
11
12 NODEPTR fnGetNode(void);
13 void fnFreeNode(NODEPTR x);
14 NODEPTR fnPush(int ,NODEPTR);
15 NODEPTR fnPop(NODEPTR);
16 void fnDisplay(NODEPTR first);
17
18 int main(void)
19 {
20     NODEPTR first = NULL;
21     int iChoice,iElem;
22
23
24     for(;;)
25     {
26         printf("\nSTACK OPERATIONS");
27         printf("\n1.PUSH\n2.POP\n3.DISPLAY\n4.EXIT\n");
28         printf("\nEnter your iChoice\n");
29         scanf("%d",&iChoice);
30
31         switch(iChoice)
32         {
33             case 1: printf("\nEnter Element to be pushed onto Stack\n");
34                     scanf("%d",&iElem);
35                     first = fnPush(iElem,first);
36                     break;
37
38             case 2: first = fnPop(first);
```

```

39         break;
40
41         case 3: fnDisplay(first);
42             break;
43
44         case 4: exit(0);
45     }
46 }
47 return 0;
48 }
49
50 NODEPTR fnGetNode()
51 {
52     NODEPTR newborn;
53     newborn = (NODEPTR)malloc(sizeof(struct node));
54
55     if(newborn == NULL)
56     {
57         printf("\nMemory Overflow");
58         exit(0);
59     }
60     return newborn;
61 }
62
63 void fnFreeNode(NODEPTR x)
64 {
65     free(x);
66 }
67
68
69 NODEPTR fnPush(int iElem, NODEPTR first) /*Insert front*/
70 {
71     NODEPTR temp;
72
73     temp = fnGetNode();
74
75     temp->Info = iElem;
76
77     temp->link = first;
78
79     return temp;
80 }
81
82 NODEPTR fnPop(NODEPTR first) /*Delete front*/
83 {
84     NODEPTR temp;
85     if(first == NULL)
86     {
87         printf("\nStack is empty cannot delete\n");
88         return first;
89     }
90     temp = first;
91
92     first = first->link;
93
94     printf("\nElement deleted is %d \n", temp->Info);
95     fnFreeNode(temp);
96
97     return first;
98 }
99 }
100

```

```

101
102
103 void fnDisplay(NODEPTR first)
104 {
105     NODEPTR curr;
106     if(first == NULL)
107     {
108         printf("\nStack is empty\n");
109         return;
110     }
111
112     printf("\nThe contents of Stack are :\n");
113     curr = first;
114     while(curr != NULL)
115     {
116         printf("\n%d", curr->Info);
117         curr = curr->link;
118     }
119     printf("\n");
120 }

```

Listing 9.1: 09aStackLL.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 09aStackLL.c -Wall
3  putta:Programs$ ./a.out
4
5  STACK OPERATIONS
6  1.PUSH
7  2.POP
8  3.DISPLAY
9  4.EXIT
10
11 Enter your iChoice
12 2
13
14 Stack is empty cannot delete
15
16 STACK OPERATIONS
17 1.PUSH
18 2.POP
19 3.DISPLAY
20 4.EXIT
21
22 Enter your iChoice
23 1
24
25 Enter Element to be pushed onto Stack
26 1
27
28 STACK OPERATIONS
29 1.PUSH
30 2.POP
31 3.DISPLAY
32 4.EXIT
33
34 Enter your iChoice
35 1
36

```

```
37 Enter Element to be pushed onto Stack
38 2
39
40 STACK OPERATIONS
41 1.PUSH
42 2.POP
43 3.DISPLAY
44 4.EXIT
45
46 Enter your iChoice
47 1
48
49 Enter Element to be pushed onto Stack
50 3
51
52 STACK OPERATIONS
53 1.PUSH
54 2.POP
55 3.DISPLAY
56 4.EXIT
57
58 Enter your iChoice
59 1
60
61 Enter Element to be pushed onto Stack
62 4
63
64 STACK OPERATIONS
65 1.PUSH
66 2.POP
67 3.DISPLAY
68 4.EXIT
69
70 Enter your iChoice
71 3
72
73 The contents of Stack are :
74
75 4
76 3
77 2
78 1
79
80 STACK OPERATIONS
81 1.PUSH
82 2.POP
83 3.DISPLAY
84 4.EXIT
85
86 Enter your iChoice
87 2
88
89 Element deleted is 4
90
91 STACK OPERATIONS
92 1.PUSH
93 2.POP
94 3.DISPLAY
95 4.EXIT
96
97 Enter your iChoice
98 3
```



```
99
100 The contents of Stack are :
101
102 3
103 2
104 1
105
106 STACK OPERATIONS
107 1.PUSH
108 2.POP
109 3.DISPLAY
110 4.EXIT
111
112 Enter your iChoice
113 2
114
115 Element deleted is 3
116
117 STACK OPERATIONS
118 1.PUSH
119 2.POP
120 3.DISPLAY
121 4.EXIT
122
123 Enter your iChoice
124 3
125
126 The contents of Stack are :
127
128 2
129 1
130
131 STACK OPERATIONS
132 1.PUSH
133 2.POP
134 3.DISPLAY
135 4.EXIT
136
137 Enter your iChoice
138 4
139
140 *****/
```

Listing 9.2: out9a.c

9.2 Queue using SLL

=====

Write a C program to implement a *QUEUE* using singly linked list.

C Code

```

1  #include<stdio.h>
2  #include<stdlib.h>
3
4  struct node
5  {
6      int Info;
7      struct node *link;
8  };
9
10 typedef struct node* NODEPTR;
11
12 NODEPTR fnGetNode(void);
13 void fnFreeNode(NODEPTR);
14 NODEPTR fnIns_Rear(int, NODEPTR);
15 NODEPTR fnDelFront(NODEPTR);
16 void fnDisplay(NODEPTR);
17
18 int main()
19 {
20     NODEPTR first = NULL;
21     int iChoice,iElem;
22
23     for(;;)
24     {
25         printf("\nQUEUE OPERATIONS\n");
26         printf("=====");
27         printf("\n1.Insert Rear\n2.Delete Front\n3.Display\n4.Exit\n");
28         printf("\nEnter your choice\n");
29         scanf("%d",&iChoice);
30
31         switch(iChoice)
32         {
33             case 1: printf("\nEnter Element to be inserted\n");
34                     scanf("%d",&iElem);
35                     first = fnIns_Rear(iElem,first);
36                     break;
37
38             case 2: first = fnDelFront(first);
39                     break;
40
41             case 3: fnDisplay(first);
42                     break;
43
44             case 4: exit(0);
45
46         }
47     }
48     return 0;
49
50 NODEPTR fnGetNode()
51 {
52     NODEPTR newborn;
53     newborn = (NODEPTR)malloc(sizeof(struct node));

```

```
54
55     if(newborn == NULL)
56     {
57         printf("\nMemory Overflow");
58         exit(0);
59     }
60     return newborn;
61 }
62
63
64 void fnFreeNode(NODEPTR x)
65 {
66     free(x);
67 }
68
69
70 NODEPTR fnIns_Rear(int iElem, NODEPTR first)
71 {
72     NODEPTR temp, cur;
73
74     temp = fnGetNode();
75     temp->Info = iElem;
76     temp->link = NULL;
77
78     if(first == NULL)
79         return temp;
80     cur = first;
81     while(cur->link != NULL)
82     {
83         cur = cur->link;
84     }
85     cur->link = temp;
86     return first;
87 }
88
89 NODEPTR fnDelFront(NODEPTR first)
90 {
91     NODEPTR temp;
92     if(first == NULL)
93     {
94         printf("\nQueue is empty cannot delete\n");
95         return first;
96     }
97     temp = first;
98     first = first->link;
99     printf("\nElement deleted is %d \n", temp->Info);
100    fnFreeNode(temp);
101    return first;
102 }
103
104 void fnDisplay(NODEPTR first)
105 {
106     NODEPTR curr;
107     if(first == NULL)
108     {
109         printf("\nQueue is empty\n");
110         return;
111     }
112
113     printf("\nThe contents of Queue are :\n");
114     curr = first;
115     printf("\n");
```

```

116     while(curr != NULL)
117     {
118         printf("%d\t", curr->Info);
119         curr = curr->link;
120     }
121     printf("\n");
122 }
123
124 /*CPP*/

```

Listing 9.3: 09bQueueLL.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 09bQueueLL.c -Wall
3  putta:Programs$ ./a.out
4
5  QUEUE OPERATIONS
6  =====
7  1.Insert Rear
8  2.Delete Front
9  3.Display
10 4.Exit
11
12 Enter your choice
13 2
14
15 Queue is empty cannot delete
16
17 QUEUE OPERATIONS
18 =====
19 1.Insert Rear
20 2.Delete Front
21 3.Display
22 4.Exit
23
24 Enter your choice
25 1
26
27 Enter Element to be inserted
28 1
29
30 QUEUE OPERATIONS
31 =====
32 1.Insert Rear
33 2.Delete Front
34 3.Display
35 4.Exit
36
37 Enter your choice
38 1
39
40 Enter Element to be inserted
41 2
42
43 QUEUE OPERATIONS
44 =====
45 1.Insert Rear
46 2.Delete Front
47 3.Display

```

```
48 4.Exit
49
50 Enter your choice
51 1
52
53 Enter Element to be inserted
54 3
55
56 QUEUE OPERATIONS
57 =====
58 1.Insert Rear
59 2.Delete Front
60 3.Display
61 4.Exit
62
63 Enter your choice
64 1
65
66 Enter Element to be inserted
67 4
68
69 QUEUE OPERATIONS
70 =====
71 1.Insert Rear
72 2.Delete Front
73 3.Display
74 4.Exit
75
76 Enter your choice
77 3
78
79 The contents of Queue are :
80
81 1    2    3    4
82
83 QUEUE OPERATIONS
84 =====
85 1.Insert Rear
86 2.Delete Front
87 3.Display
88 4.Exit
89
90 Enter your choice
91 2
92
93 Element deleted is 1
94
95 QUEUE OPERATIONS
96 =====
97 1.Insert Rear
98 2.Delete Front
99 3.Display
100 4.Exit
101
102 Enter your choice
103 3
104
105 The contents of Queue are :
106
107 2    3    4
108
109 QUEUE OPERATIONS
```

```
110 =====
111 1.Insert Rear
112 2.Delete Front
113 3.Display
114 4.Exit
115
116 Enter your choice
117 4
118
119 *****/
```

Listing 9.4: out9b.c

9.3 Polynomial Addition

Write a C program to implement addition of two polynomials using singly linked list..

C Code

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <math.h>
4
5  struct polynomial{
6      int coeff;
7      int exponent;
8      struct polynomial *link;
9  };
10 typedef struct polynomial *NODEPTR;
11
12 NODEPTR fnGetNode(void);
13 NODEPTR fnInsertRear(int, int, NODEPTR);
14 void fnDisplay(NODEPTR first);
15 NODEPTR fnAddPoly(NODEPTR, NODEPTR);
16 int evalPoly(NODEPTR, int);
17
18 int main()
19 {
20     NODEPTR poly1, poly2, poly3;
21     int i, iX, iRes, iDegree, iaCoeff[10];
22     poly1 = poly2 = poly3 = NULL;
23
24     printf("\nEnter the degree of polynomial 1\n");
25     scanf("%d", &iDegree);
26     printf("\nEnter the coefficients\n");
27     for(i=iDegree; i>=0; i--)
28     {
29         scanf("%d", &iaCoeff[i]);
30         poly1 = fnInsertRear(iaCoeff[i], i, poly1);
31     }
32     printf("\nEnter the degree of polynomial 2\n");
33     scanf("%d", &iDegree);
34     printf("\nEnter the coefficients\n");
35     for(i=iDegree; i>=0; i--)
36     {
37         scanf("%d", &iaCoeff[i]);
38         poly2 = fnInsertRear(iaCoeff[i], i, poly2);
39     }
40     poly3 = fnAddPoly(poly1, poly2);
41
42     printf("Polynomial 1   :\t");
43     fnDisplay(poly1);
44     printf("Polynomial 2   :\t");
45     fnDisplay(poly2);
46     printf("Polynomial Sum  :\t");
47     fnDisplay(poly3);
48     printf("\nEnter the value of x\n");
49     scanf("%d", &iX);
50     iRes = evalPoly(poly3, iX);
51     printf("\nValue of the polynomial sum for x = %d is %d\n", iX, iRes);
52     return 0;
53 }

```

```

54
55 NODEPTR fnInsertRear(int iCoeff, int iExp, NODEPTR first)
56 {
57     NODEPTR temp, cur;
58     temp = fnGetNode();
59     temp->coeff = iCoeff;
60     temp->exponent = iExp;
61     temp->link = NULL;
62
63     if(first == NULL)
64         return temp;
65     cur = first;
66     while(cur->link != NULL)
67     {
68         cur = cur->link;
69     }
70     cur->link = temp;
71     return first;
72 }
73
74 NODEPTR fnGetNode(void)
75 {
76     NODEPTR newNode;
77     newNode = ( NODEPTR ) malloc (sizeof(struct polynomial));
78     if(newNode == NULL)
79     {
80         printf("\nOut of Memory");
81         exit(0);
82     }
83     return newNode;
84 }
85
86 void fnDisplay(NODEPTR first)
87 {
88     NODEPTR cur;
89     for(cur = first; cur->link != NULL; cur = cur->link)
90     {
91         // printf(" (%d)x^(%d) +", cur->coeff, cur->exponent);
92         printf(" (%d)x^%d +", cur->coeff, cur->exponent);
93     }
94     printf(" %d\n", cur->coeff);
95 }
96
97 NODEPTR fnAddPoly(NODEPTR poly1, NODEPTR poly2)
98 {
99     NODEPTR tracker1, tracker2, poly3 = NULL;
100     tracker1 = poly1;
101     tracker2 = poly2;
102     while(tracker1 != NULL && tracker2 != NULL)
103     {
104         if(tracker1->exponent > tracker2->exponent)
105         {
106             poly3 = fnInsertRear(tracker1->coeff, tracker1->exponent, poly3);
107             tracker1 = tracker1->link;
108         }
109         else if(tracker1->exponent == tracker2->exponent)
110         {
111             poly3 = fnInsertRear(tracker1->coeff + tracker2->coeff, tracker1->
exponent, poly3);
112             tracker1 = tracker1->link;
113             tracker2 = tracker2->link;
114         }

```



```

115         else
116         {
117             poly3 = fnInsertRear(tracker2->coeff, tracker2->exponent, poly3);
118             tracker2 = tracker2->link;
119         }
120     }
121     return poly3;
122 }
123
124 int evalPoly(NODEPTR list, int x)
125 {
126     int iSum = 0;
127     NODEPTR cur = list;
128     while(cur!=NULL)
129     {
130         iSum += (cur->coeff * (int)pow(x, cur->exponent));
131         cur = cur->link;
132     }
133     return iSum;
134 }

```

Listing 9.5: 09cPolynomial.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 09cPolynomial.c -Wall -lm
3  putta:Programs$ ./a.out
4
5  Enter the degree of polynomial 1
6  4
7
8  Enter the coefficients
9  5 4 3 2 1
10
11 Enter the degree of polynomial 2
12 3
13
14 Enter the coefficients
15 4 3 2 1
16 Polynomial 1 :      (5)x^4 + (4)x^3 + (3)x^2 + (2)x^1 + 1
17 Polynomial 2 :      (4)x^3 + (3)x^2 + (2)x^1 + 1
18 Polynomial Sum :      (5)x^4 + (8)x^3 + (6)x^2 + (4)x^1 + 2
19
20 Enter the value of x
21 2
22
23 Value of the polynomial sum for x = 2 is 178
24
25 *****/

```

Listing 9.6: out9c.c

Chapter 10

Doubly Linked Lists with Header Node

Question

Write a C program to perform the following operations using doubly linked list with header node. Header node should maintain the count of number of nodes in the list after each operation:

a to insert a node next to a node whose information field specified.

b to delete first node if pointer to the last node is given.

c to delete a node at the specified position in the list.

d to display the contents of the list.

C Code

```
1  #include<stdio.h>
2  #include<stdlib.h>
3
4  struct node
5  {
6      int info;
7      struct node *llink;
8      struct node *rlink;
9  };
10
11 typedef struct node* NODEPTR;
12
13 NODEPTR fnSwapNodes(NODEPTR head, int m , int n);
14 void fnDisplay(NODEPTR head);
15 NODEPTR fnDelElemPos(NODEPTR head, int iPos);
16 NODEPTR fnInsertNext(NODEPTR head, int iItem);
17 NODEPTR fnDeleteFirst(NODEPTR last);
18 NODEPTR fnInsertFront(NODEPTR head, int iItem);
19 void fnFreeNode(NODEPTR x);
20 NODEPTR fnGetNode(void);
21
22
23
24 int main()
25 {
26     NODEPTR head, last;
27     int iChoice, iItem, iKey, iPos, iM, iN;
28
29     head = fnGetNode();
30     head->rlink = head;
31     head->llink = head;
```

```

32     head->info = 0;
33
34     for(;;)
35
36     {
37         printf("\n1.Insert Front\n2.Insert to the next of a given Node");
38         printf("\n3.Delete First Node");
39         printf("\n4.Delete a Node whose position is specified");
40         printf("\n5.Display\n6.Swap Nodes\n7.Exit\n");
41
42         printf("\nEnter your Choice\n");
43         scanf("%d",&iChoice);
44
45         switch(iChoice)
46         {
47             case 1: printf("\nEnter the iItem to be inserted\n");
48                     scanf("%d",&iItem);
49                     head = fnInsertFront(head, iItem);
50                     break;
51
52             case 2: printf("\nEnter the key value of the node\n");
53                     scanf("%d", &iKey);
54                     head = fnInsertNext(head, iKey);
55                     break;
56
57             case 3: last = head->llink;
58                     head = fnDeleteFirst(last);
59                     break;
60
61             case 4: printf("\nEnter the position of the element to be deleted\n");
62                     scanf("%d",&iPos);
63                     head = fnDelElemPos(head, iPos);
64                     break;
65
66             case 5: fnDisplay(head);
67                     break;
68
69             case 6: printf("\nEnter the positions m and n of the nodes to be
70 swapped such that m < n\n");
71                     scanf("%d%d",&iM, &iN);
72                     if(iM > iN)
73                     {
74                         printf("\nInvalid input\n");
75                     }
76                     else
77                     {
78                         head = fnSwapNodes(head, iM, iN);
79                     }
80                     break;
81             case 7: exit(0);
82         }
83     }
84     return 0;
85 }
86
87 NODEPTR fnGetNode(void)
88 {
89     NODEPTR x;
90     x = ( NODEPTR ) malloc (sizeof(struct node));
91     if(x == NULL)
92     {

```

```

93     printf("\nOut of Memory");
94     exit(0);
95 }
96 return x;
97 }
98
99 void fnFreeNode(NODEPTR x)
100 {
101     free(x);
102 }
103
104 NODEPTR fnInsertFront(NODEPTR head, int iItem)
105 {
106     NODEPTR temp, cur;
107     temp = fnGetNode();
108     temp = fnGetNode();
109     temp->info = iItem;
110
111     cur = head->rlink;
112
113     head->rlink = temp;
114     temp->llink = head;
115     temp->rlink = cur;
116     cur->llink = temp;
117
118     head->info += 1;
119
120     return head;
121 }
122
123
124 NODEPTR fnDeleteFirst(NODEPTR last)
125 {
126     NODEPTR second, first, head;
127
128     if(last->rlink == last)
129     {
130         printf("\nList is Empty");
131         return last;
132     }
133     head = last->rlink;
134     first = head->rlink;
135     second = first->rlink;
136
137     head->rlink = second;
138     second->llink = head;
139     fnFreeNode(first);
140     head->info -= 1;
141
142     return head;
143 }
144
145 NODEPTR fnInsertNext(NODEPTR head, int iItem)
146 {
147     NODEPTR temp, cur, next;
148
149     if(head->rlink == head)
150     {
151         printf("\nList is Empty\n");
152         return head;
153     }
154

```

```

155     cur = head->rlink;
156
157     while(cur != head && iItem != cur->info)
158     {
159         cur = cur->rlink;
160     }
161     if(cur == head)
162     {
163         printf("\nSpecified Node not found\n");
164         return head;
165     }
166
167     next = cur->rlink;
168
169     printf("\nEnter the item to be inserted to the next of %d\n",iItem);
170
171     temp = fnGetNode();
172     scanf("%d",&temp->info);
173
174     cur->rlink = temp;
175     temp->llink = cur;
176     next->llink = temp;
177     temp->rlink = next;
178     head->info += 1;
179
180     return head;
181
182 }
183
184 NODEPTR fnDelElemPos(NODEPTR head, int iPos)
185 {
186
187     NODEPTR prev,cur,next;
188     int count = 1;
189
190     if(head->rlink == head)
191     {
192         printf("\nList is Empty\n");
193         return head;
194     }
195
196     cur = head->rlink;
197
198     while(cur != head && count != iPos)
199     {
200         cur = cur->rlink;
201         count++;
202     }
203
204     if(count == iPos)
205     {
206         prev = cur->llink;
207         next = cur->rlink;
208
209         prev->rlink = next;
210         next->llink = prev;
211         head->info -= 1;
212
213         fnFreeNode(cur);
214     }
215
216     if(cur == head)

```

```
217     {
218         printf("\nItem not found\n");
219         return head;
220     }
221
222     return head;
223 }
224
225 void fnDisplay(NODEPTR head)
226 {
227     NODEPTR temp;
228     if(head->rlink == head)
229     {
230         printf("\nList is empty\n");
231         return;
232     }
233
234     printf("Contents of the List is\n");
235     for(temp = head->rlink; temp != head; temp = temp->rlink)
236         printf("%d\t", temp->info);
237
238     printf("\n");
239     printf("\nThere are %d nodes in the list", head->info);
240     printf("\n");
241
242 }
243
244
245
246 NODEPTR fnSwapNodes(NODEPTR head, int m , int n)
247 {
248     int temp, count = 1;
249     NODEPTR cur, mpos, npos;
250     cur = head->rlink;
251
252     while(cur != head && count != m)
253     {
254         cur = cur->rlink;
255         count++;
256     }
257
258     if(cur != head)
259     {
260         mpos = cur;
261     }
262     else
263     {
264         printf("\nNode #%d does not exist\n", m);
265         return head;
266     }
267
268     while(cur != head && count != n)
269     {
270         cur = cur->rlink;
271         count++;
272     }
273     if(cur != head)
274     {
275         npos = cur;
276     }
277     else
278     {
```

```

279         printf("\nNode #%d does not exist\n", n);
280         return head;
281     }
282
283     temp = mpos->info;
284     mpos->info = npos->info;
285     npos->info = temp;
286
287     return head;
288 }

```

Listing 10.1: 10DoublyLinkedList.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 10DoublyLinkedList.c -Wall
3  putta:Programs$ ./a.out
4
5  1.Insert Front
6  2.Insert to the next of a given Node
7  3.Delete First Node
8  4.Delete a Node whose position is specified
9  5.Display
10 6.Swap Nodes
11 7.Exit
12
13 Enter your Choice
14 1
15
16 Enter the iItem to be inserted
17 5
18
19 1.Insert Front
20 2.Insert to the next of a given Node
21 3.Delete First Node
22 4.Delete a Node whose position is specified
23 5.Display
24 6.Swap Nodes
25 7.Exit
26
27 Enter your Choice
28 1
29
30 Enter the iItem to be inserted
31 4
32
33 1.Insert Front
34 2.Insert to the next of a given Node
35 3.Delete First Node
36 4.Delete a Node whose position is specified
37 5.Display
38 6.Swap Nodes
39 7.Exit
40
41 Enter your Choice
42 5
43 Contents of the List is
44 4 5
45
46 There are 2 nodes in the list

```

```
47
48 1.Insert Front
49 2.Insert to the next of a given Node
50 3.Delete First Node
51 4.Delete a Node whose position is specified
52 5.Display
53 6.Swap Nodes
54 7.Exit
55
56 Enter your Choice
57 2
58
59 Enter the key value of the node
60 4
61
62 Enter the item to be inserted to the next of 4
63 8
64
65 1.Insert Front
66 2.Insert to the next of a given Node
67 3.Delete First Node
68 4.Delete a Node whose position is specified
69 5.Display
70 6.Swap Nodes
71 7.Exit
72
73 Enter your Choice
74 5
75 Contents of the List is
76 4 8 5
77
78 There are 3 nodes in the list
79
80 1.Insert Front
81 2.Insert to the next of a given Node
82 3.Delete First Node
83 4.Delete a Node whose position is specified
84 5.Display
85 6.Swap Nodes
86 7.Exit
87
88 Enter your Choice
89 6
90
91 Enter the positions m and n of the nodes to be swapped such that m < n
92 2
93 3
94
95 1.Insert Front
96 2.Insert to the next of a given Node
97 3.Delete First Node
98 4.Delete a Node whose position is specified
99 5.Display
100 6.Swap Nodes
101 7.Exit
102
103 Enter your Choice
104 5
105 Contents of the List is
106 4 5 8
107
108 There are 3 nodes in the list
```



```
109
110 1.Insert Front
111 2.Insert to the next of a given Node
112 3.Delete First Node
113 4.Delete a Node whose position is specified
114 5.Display
115 6.Swap Nodes
116 7.Exit
117
118 Enter your Choice
119 2
120
121 Enter the key value of the node
122 5
123
124 Enter the item to be inserted to the next of 5
125 6
126
127 1.Insert Front
128 2.Insert to the next of a given Node
129 3.Delete First Node
130 4.Delete a Node whose position is specified
131 5.Display
132 6.Swap Nodes
133 7.Exit
134
135 Enter your Choice
136 5
137 Contents of the List is
138 4 5 6 8
139
140 There are 4 nodes in the list
141
142 1.Insert Front
143 2.Insert to the next of a given Node
144 3.Delete First Node
145 4.Delete a Node whose position is specified
146 5.Display
147 6.Swap Nodes
148 7.Exit
149
150 Enter your Choice
151 1
152
153 Enter the iItem to be inserted
154 9
155
156 1.Insert Front
157 2.Insert to the next of a given Node
158 3.Delete First Node
159 4.Delete a Node whose position is specified
160 5.Display
161 6.Swap Nodes
162 7.Exit
163
164 Enter your Choice
165 5
166 Contents of the List is
167 9 4 5 6 8
168
169 There are 5 nodes in the list
170
```

```
171 1.Insert Front
172 2.Insert to the next of a given Node
173 3.Delete First Node
174 4.Delete a Node whose position is specified
175 5.Display
176 6.Swap Nodes
177 7.Exit
178
179 Enter your Choice
180 4
181
182 Enter the position of the element to be deleted
183 4
184
185 1.Insert Front
186 2.Insert to the next of a given Node
187 3.Delete First Node
188 4.Delete a Node whose position is specified
189 5.Display
190 6.Swap Nodes
191 7.Exit
192
193 Enter your Choice
194 5
195 Contents of the List is
196 9 4 5 8
197
198 There are 4 nodes in the list
199
200 1.Insert Front
201 2.Insert to the next of a given Node
202 3.Delete First Node
203 4.Delete a Node whose position is specified
204 5.Display
205 6.Swap Nodes
206 7.Exit
207
208 Enter your Choice
209 3
210
211 1.Insert Front
212 2.Insert to the next of a given Node
213 3.Delete First Node
214 4.Delete a Node whose position is specified
215 5.Display
216 6.Swap Nodes
217 7.Exit
218
219 Enter your Choice
220 5
221 Contents of the List is
222 4 5 8
223
224 There are 3 nodes in the list
225
226 1.Insert Front
227 2.Insert to the next of a given Node
228 3.Delete First Node
229 4.Delete a Node whose position is specified
230 5.Display
231 6.Swap Nodes
232 7.Exit
```

```
233
234 Enter your Choice
235 7
236
237 *****/
```

Listing 10.2: out10.c

Chapter 11

Double Ended Queue using Doubly Linked List

Question

Write a C program to implement DEQUE using doubly linked list to perform the insertion, deletion and display operations.

C Code

```
1  #include<stdio.h>
2  #include<stdlib.h>
3
4  struct node
5  {
6      int info;
7      struct node *llink;
8      struct node *rlink;
9  };
10 typedef struct node* NODEPTR;
11
12 NODEPTR fnGetNode(void);
13 void fnFreeNode(NODEPTR x);
14 NODEPTR fnInsertFront(NODEPTR head, int iItem);
15 NODEPTR fnDeleteFront(NODEPTR head);
16 NODEPTR fnInsertRear(NODEPTR head, int iItem);
17 NODEPTR fnDeleteRear(NODEPTR head);
18 void fnDisplay(NODEPTR head);
19
20 int main()
21 {
22     NODEPTR head;
23     int iChoice, iItem;
24
25     head = fnGetNode();
26     head->rlink = head;
27     head->llink = head;
28
29     for(;;)
30     {
31         printf("\n1.Insert Front\n2.Insert Rear");
32         printf("\n3.Delete Front\n4.Delete Rear");
33         printf("\n5.Display\n6.Exit\n");
34         printf("\nEnter your Choice\n");
35         scanf("%d", &iChoice);
```

```

36
37     switch(iChoice)
38     {
39         case 1: printf("\nEnter the iItem to be inserted\n");
40                 scanf("%d",&iItem);
41                 head = fnInsertFront(head, iItem);
42                 break;
43
44         case 2: printf("\nEnter the iItem to be inserted\n");
45                 scanf("%d",&iItem);
46                 head = fnInsertRear(head, iItem);
47                 break;
48
49         case 3: head = fnDeleteFront(head);
50                 break;
51
52         case 4: head = fnDeleteRear(head);
53                 break;
54
55         case 5: fnDisplay(head);
56                 break;
57
58         case 6: exit(0);
59     }
60 }
61 return 0;
62 }
63
64 NODEPTR fnGetNode(void)
65 {
66     NODEPTR x;
67     x = ( NODEPTR ) malloc (sizeof(struct node));
68     if(x == NULL)
69     {
70         printf("\nOut of Memory");
71         exit(0);
72     }
73     return x;
74 }
75
76 void fnFreeNode(NODEPTR x)
77 {
78     free(x);
79 }
80
81 NODEPTR fnInsertFront(NODEPTR head, int iItem)
82 {
83     NODEPTR temp,cur;
84     temp = fnGetNode();
85     temp = fnGetNode();
86     temp->info = iItem;
87
88     cur = head->rlink;
89     head->rlink = temp;
90     temp->llink = head;
91     temp->rlink = cur;
92     cur->llink = temp;
93     return head;
94 }
95
96 NODEPTR fnInsertRear(NODEPTR head, int iItem)
97 {

```

```

98     NODEPTR temp, cur;
99     temp = fnGetNode();
100    temp = fnGetNode();
101    temp->info = iItem;
102
103    cur = head->llink;
104    head->llink = temp;
105    temp->rlink = head;
106    temp->llink = cur;
107    cur->rlink = temp;
108    return head;
109 }
110
111 NODEPTR fnDeleteFront(NODEPTR head)
112 {
113     NODEPTR second, first;
114     if(head->rlink == head)
115     {
116         printf("\nList is Empty\n");
117         return head;
118     }
119     first = head->rlink;
120     second = first->rlink;
121
122     head->rlink = second;
123     second->llink = head;
124     printf("\nElement deleted is %d\n", first->info);
125     fnFreeNode(first);
126     return head;
127 }
128
129 NODEPTR fnDeleteRear(NODEPTR head)
130 {
131     NODEPTR secondLast, last;
132     if(head->rlink == head)
133     {
134         printf("\nList is Empty\n");
135         return head;
136     }
137     last = head->llink;
138     secondLast = last->llink;
139
140     head->llink = secondLast;
141     secondLast->rlink = head;
142     printf("\nElement deleted is %d\n", last->info);
143     fnFreeNode(last);
144     return head;
145 }
146
147 void fnDisplay(NODEPTR head)
148 {
149     NODEPTR temp;
150     if(head->rlink == head)
151     {
152         printf("\nList is empty\n");
153         return;
154     }
155     printf("Contents of the List is\n");
156     for(temp = head->rlink; temp != head; temp = temp->rlink)
157         printf("%d\t", temp->info);
158     printf("\n");

```

159 }

Listing 11.1: 11DequeueDLL.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 11DequeueDLL.c
3  putta:Programs$ ./a.out
4
5  1.Insert Front
6  2.Insert Rear
7  3.Delete Front
8  4.Delete Rear
9  5.Display
10 6.Exit
11
12 Enter your Choice
13 5
14
15 List is empty
16
17 1.Insert Front
18 2.Insert Rear
19 3.Delete Front
20 4.Delete Rear
21 5.Display
22 6.Exit
23
24 Enter your Choice
25 3
26
27 List is Empty
28
29 1.Insert Front
30 2.Insert Rear
31 3.Delete Front
32 4.Delete Rear
33 5.Display
34 6.Exit
35
36 Enter your Choice
37 1
38
39 Enter the iItem to be inserted
40 3
41
42 1.Insert Front
43 2.Insert Rear
44 3.Delete Front
45 4.Delete Rear
46 5.Display
47 6.Exit
48
49 Enter your Choice
50 1
51
52 Enter the iItem to be inserted
53 2
54
55 1.Insert Front

```

```
56 2.Insert Rear
57 3.Delete Front
58 4.Delete Rear
59 5.Display
60 6.Exit
61
62 Enter your Choice
63 2
64
65 Enter the iItem to be inserted
66 4
67
68 1.Insert Front
69 2.Insert Rear
70 3.Delete Front
71 4.Delete Rear
72 5.Display
73 6.Exit
74
75 Enter your Choice
76 5
77 Contents of the List is
78 2 3 4
79
80 1.Insert Front
81 2.Insert Rear
82 3.Delete Front
83 4.Delete Rear
84 5.Display
85 6.Exit
86
87 Enter your Choice
88 2
89
90 Enter the iItem to be inserted
91 5
92
93 1.Insert Front
94 2.Insert Rear
95 3.Delete Front
96 4.Delete Rear
97 5.Display
98 6.Exit
99
100 Enter your Choice
101 2
102
103 Enter the iItem to be inserted
104 6
105
106 1.Insert Front
107 2.Insert Rear
108 3.Delete Front
109 4.Delete Rear
110 5.Display
111 6.Exit
112
113 Enter your Choice
114 5
115 Contents of the List is
116 2 3 4 5 6
117
```



```
118 1.Insert Front
119 2.Insert Rear
120 3.Delete Front
121 4.Delete Rear
122 5.Display
123 6.Exit
124
125 Enter your Choice
126 3
127
128 Element deleted is 2
129
130 1.Insert Front
131 2.Insert Rear
132 3.Delete Front
133 4.Delete Rear
134 5.Display
135 6.Exit
136
137 Enter your Choice
138 5
139 Contents of the List is
140 3 4 5 6
141
142 1.Insert Front
143 2.Insert Rear
144 3.Delete Front
145 4.Delete Rear
146 5.Display
147 6.Exit
148
149 Enter your Choice
150 4
151
152 Element deleted is 6
153
154 1.Insert Front
155 2.Insert Rear
156 3.Delete Front
157 4.Delete Rear
158 5.Display
159 6.Exit
160
161 Enter your Choice
162 5
163 Contents of the List is
164 3 4 5
165
166 1.Insert Front
167 2.Insert Rear
168 3.Delete Front
169 4.Delete Rear
170 5.Display
171 6.Exit
172
173 Enter your Choice
174 6
175
176 *****/
```

Listing 11.2: out11.c

Chapter 12

Binary Search Tree

Question

Write a C program to perform the following operations:

- a Construct a binary search tree of integers.***
- b Traverse the tree in inorder/ preorder/ postorder.***
- c Delete a given node from the BST.***

C Code

```
1  #include<stdio.h>
2  #include<stdlib.h>
3
4  struct node
5  {
6      int info;
7      struct node *lbranch;
8      struct node *rbranch;
9  };
10 typedef struct node* NODEPTR;
11
12 /* FUNCTION PROTOTYPES */
13 NODEPTR fnGetNode(void);
14 void fnFreeNode(NODEPTR x);
15 NODEPTR fnInsertNode(int, NODEPTR);
16 void fnInOrder(NODEPTR);
17 void fnPreOrder(NODEPTR);
18 void fnPostOrder(NODEPTR);
19 NODEPTR fnDeleteNode(NODEPTR, int);
20 NODEPTR fnMinValueNode(NODEPTR);
21
22 int main()
23 {
24     NODEPTR root = NULL;
25     int iChoice,iItem;
26     for(;;)
27     {
28         printf("\n1.Insert a node\n2.Inorder traversal\n3.Preorder traversal");
29         printf("\n4.Postorder traversal\n5.Delete a node\n6.Exit\n");
30         printf("\nEnter your choice");
31         scanf("%d",&iChoice);
32
33         switch(iChoice)
34         {
35             case 1: printf("Enter the item to be inserted \n");
```

```

36         scanf("%d",&iItem);
37         root = fnInsertNode(iItem,root);
38         break;
39
40     case 2: if(root ==NULL)
41     {
42         printf("\nTree is Empty\n");
43     }
44     else
45     {
46         printf("\nInorder Traversal is :\n");
47         fnInOrder(root);
48         printf("\n");
49     }
50     break;
51
52     case 3: if(root ==NULL)
53     {
54         printf("\nTree is Empty\n");
55     }
56     else
57     {
58         printf("\nPreorder Traversal is :\n");
59         fnPreOrder(root);
60         printf("\n");
61     }
62     break;
63
64     case 4: if(root ==NULL)
65     {
66         printf("\nTree is Empty\n");
67     }
68     else
69     {
70         printf("\nPostorder Traversal is :\n");
71         fnPostOrder(root);
72         printf("\n");
73     }
74     break;
75
76     case 5: printf("\nEnter node to be deleted : ");
77             scanf("%d", &iItem);
78             root = fnDeleteNode(root, iItem);
79             break;
80
81     case 6: exit(0);
82
83     default: printf("Wrong choice\n");
84             break;
85
86 }
87
88 }
89 return 0;
90 }
91
92 NODEPTR fnGetNode(void)
93 {
94     NODEPTR x;
95     x = ( NODEPTR ) malloc (sizeof(struct node));
96     if(x == NULL)
97     {

```

```

98     printf("\nOut of Memory");
99     exit(0);
100 }
101 return x;
102 }
103
104 void fnFreeNode(NODEPTR x)
105 {
106     free(x);
107 }
108
109 NODEPTR fnInsertNode(int iItem, NODEPTR root)
110 {
111     NODEPTR temp, prev, cur;
112
113     temp = fnGetNode();
114     temp->info = iItem;
115     temp->lbranch = NULL;
116     temp->rbranch = NULL;
117
118     if(root == NULL)
119         return temp;
120
121     prev = NULL;
122     cur = root;
123
124     while(cur != NULL)
125     {
126         prev = cur;
127
128         if(iItem == cur->info)
129         {
130             printf("\nDuplicate items not allowed\n");
131             fnFreeNode(temp);
132             return root;
133         }
134
135         cur = (iItem < cur->info)? cur->lbranch: cur->rbranch;
136     }
137
138     if(iItem < prev->info)
139         prev->lbranch = temp;
140     else
141         prev->rbranch = temp;
142
143     return root;
144 }
145
146
147 void fnPreOrder(NODEPTR root)
148 {
149     if(root != NULL)
150     {
151         printf("%d\t", root->info);
152         fnPreOrder(root->lbranch);
153         fnPreOrder(root->rbranch);
154     }
155 }
156
157 void fnInOrder(NODEPTR root)
158 {
159     if(root != NULL)

```

```

160     {
161         fnInOrder(root->lbranch);
162         printf("%d\t", root->info);
163         fnInOrder(root->rbranch);
164     }
165 }
166
167 void fnPostOrder(NODEPTR root)
168 {
169     if(root != NULL)
170     {
171         fnPostOrder(root->lbranch);
172         fnPostOrder(root->rbranch);
173         printf("%d\t", root->info);
174     }
175 }
176
177 NODEPTR fnDeleteNode(NODEPTR root, int iItem)
178 {
179     if(root == NULL)
180     {
181         printf("\nBST is empty, cannot delete");
182         return root;
183     }
184     // If the item to be deleted is smaller than the root's item,
185     // then it lies in left subtree
186     if (iItem < root->info)
187         root->lbranch = fnDeleteNode(root->lbranch, iItem);
188
189     // If the item to be deleted is greater than the root's item,
190     // then it lies in right subtree
191     else if (iItem > root->info)
192         root->rbranch = fnDeleteNode(root->rbranch, iItem);
193
194     // if item is same as root's item, then This is the node
195     // to be deleted
196     else
197     {
198         // node with only one child or no child
199         if (root->lbranch == NULL)
200         {
201             struct node *temp = root->rbranch;
202             free(root);
203             return temp;
204         }
205         else if (root->rbranch == NULL)
206         {
207             struct node *temp = root->lbranch;
208             free(root);
209             return temp;
210         }
211
212         // node with two children: Get the inorder successor (smallest
213         // in the right subtree)
214         NODEPTR temp = fnMinValueNode(root->rbranch);
215
216         // Copy the inorder successor's content to this node
217         root->info = temp->info;
218
219         // Delete the inorder successor
220         root->rbranch = fnDeleteNode(root->rbranch, temp->info);
221     }

```

```

222     return root;
223 }
224
225 NODEPTR fnMinValueNode(NODEPTR node)
226 {
227     NODEPTR current = node;
228
229     /* loop down to find the leftmost leaf */
230     while (current->lbranch != NULL)
231         current = current->lbranch;
232
233     return current;
234 }

```

Listing 12.1: 12BinarySearchTree.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 12BinarySearchTree.c
3  putta:Programs$ ./a.out
4
5  1.Insert a node
6  2.Inorder traversal
7  3.Preorder traversal
8  4.Postorder traversal
9  5.Delete a node
10 6.Exit
11
12 Enter your choice1
13 Enter the item to be inserted
14 6
15
16 1.Insert a node
17 2.Inorder traversal
18 3.Preorder traversal
19 4.Postorder traversal
20 5.Delete a node
21 6.Exit
22
23 Enter your choice1
24 Enter the item to be inserted
25 4
26
27 1.Insert a node
28 2.Inorder traversal
29 3.Preorder traversal
30 4.Postorder traversal
31 5.Delete a node
32 6.Exit
33
34 Enter your choice1
35 Enter the item to be inserted
36 8
37
38 1.Insert a node
39 2.Inorder traversal
40 3.Preorder traversal
41 4.Postorder traversal
42 5.Delete a node
43 6.Exit

```

```
44
45 Enter your choice1
46 Enter the item to be inserted
47 5
48
49 1.Insert a node
50 2.Inorder traversal
51 3.Preorder traversal
52 4.Postorder traversal
53 5.Delete a node
54 6.Exit
55
56 Enter your choice1
57 Enter the item to be inserted
58 1
59
60 1.Insert a node
61 2.Inorder traversal
62 3.Preorder traversal
63 4.Postorder traversal
64 5.Delete a node
65 6.Exit
66
67 Enter your choice2
68
69 Inorder Traversal is :
70 1  4  5  6  8
71
72 1.Insert a node
73 2.Inorder traversal
74 3.Preorder traversal
75 4.Postorder traversal
76 5.Delete a node
77 6.Exit
78
79 Enter your choice3
80
81 Preorder Traversal is :
82 6  4  1  5  8
83
84 1.Insert a node
85 2.Inorder traversal
86 3.Preorder traversal
87 4.Postorder traversal
88 5.Delete a node
89 6.Exit
90
91 Enter your choice4
92
93 Postorder Traversal is :
94 1  5  4  8  6
95
96 1.Insert a node
97 2.Inorder traversal
98 3.Preorder traversal
99 4.Postorder traversal
100 5.Delete a node
101 6.Exit
102
103 Enter your choice5
104
105 Enter node to be deleted : 5
```

```
106
107 1.Insert a node
108 2.Inorder traversal
109 3.Preorder traversal
110 4.Postorder traversal
111 5.Delete a node
112 6.Exit
113
114 Enter your choice3
115
116 Preorder Traversal is :
117 6 4 1 8
118
119 1.Insert a node
120 2.Inorder traversal
121 3.Preorder traversal
122 4.Postorder traversal
123 5.Delete a node
124 6.Exit
125
126 Enter your choice2
127
128 Inorder Traversal is :
129 1 4 6 8
130
131 1.Insert a node
132 2.Inorder traversal
133 3.Preorder traversal
134 4.Postorder traversal
135 5.Delete a node
136 6.Exit
137
138 Enter your choice3
139
140 Preorder Traversal is :
141 6 4 1 8
142
143 1.Insert a node
144 2.Inorder traversal
145 3.Preorder traversal
146 4.Postorder traversal
147 5.Delete a node
148 6.Exit
149
150 Enter your choice6
151
152 *****/
```

Listing 12.2: out12.c

Chapter 13

Expression Tree

Question

Write a C program to construct an expression tree for a given postfix expression and evaluate the expression tree.

C Code

```
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <stdbool.h>
4  #include <math.h>
5  #include <string.h>
6  #include <ctype.h>
7
8  // An expression tree node
9  struct ExpTree
10 {
11     char value;
12     struct ExpTree *lbranch, *rbranch;
13 };
14 typedef struct ExpTree* NODEPTR;
15
16 bool isOperator(char c);
17 void inorder(NODEPTR t);
18 NODEPTR newNode(int v);
19 NODEPTR constructTree(char postfix[]);
20 void push(NODEPTR[], NODEPTR, int*);
21 NODEPTR pop(NODEPTR[], int*);
22 float evalPost(NODEPTR);
23
24 int main()
25 {
26     char postfix[30];
27     float fResult;
28     printf("\nEnter a postfix expression\n");
29     scanf("%s", postfix);
30     NODEPTR et = constructTree(postfix);
31     printf("infix expression is \n");
32     inorder(et);
33     printf("\n");
34     fResult = evalPost(et);
35     printf("\nValue of Postfix Expression is : %g\n\n", fResult);
36     return 0;
37 }
38
```

```

39 // A utility function to check if 'c' is an operator
40 bool isOperator(char c)
41 {
42     if(c == '+' || c == '-' || c == '*' || c == '/' || c == '^')
43         return true;
44     return false;
45 }
46
47 // Utility function to do inorder traversal
48 void inorder(NODEPTR t)
49 {
50     if(t)
51     {
52         inorder(t->lbranch);
53         printf("%c ", t->value);
54         inorder(t->rbranch);
55     }
56 }
57
58 NODEPTR newNode(int v)
59 {
60     NODEPTR temp = (NODEPTR) malloc(sizeof(struct ExpTree));
61     temp->lbranch = temp->rbranch = NULL;
62     temp->value = v;
63     return temp;
64 }
65
66 NODEPTR constructTree(char postfix[])
67 {
68     NODEPTR stack[100];
69     int i, top = -1;
70     NODEPTR t, t1, t2;
71
72     // Traverse through every character of input expression
73     for(i=0; i<strlen(postfix); i++)
74     {
75         // If operand, simply push into stack
76         if(!isOperator(postfix[i]))
77         {
78             t = newNode(postfix[i]);
79             push(stack, t, &top);
80         }
81         else // operator
82         {
83             t = newNode(postfix[i]);
84             // Pop two top nodes
85             t1 = pop(stack, &top); // Remove top
86             t2 = pop(stack, &top);
87             // make them children
88             t->rbranch = t1;
89             t->lbranch = t2;
90             // Add this subexpression to stack
91             push(stack, t, &top);
92         }
93     }
94     // only element will be root of expression tree
95     t = pop(stack, &top);
96     return t;
97 }
98
99 void push(NODEPTR st[], NODEPTR p, int *t)
100 {

```

```

101     *t = *t + 1;
102     st[*t] = p;
103 }
104
105 NODEPTR pop(NODEPTR st[], int *t)
106 {
107     NODEPTR temp;
108     temp = st[*t];
109     *t = *t - 1;
110     return temp;
111 }
112
113 float evalPost(NODEPTR root)
114 {
115     float fNum;
116     switch(root->value)
117     {
118         case '+': return (evalPost(root->lbranch) + evalPost(root->rbranch));
119         case '-': return (evalPost(root->lbranch) - evalPost(root->rbranch));
120         case '*': return (evalPost(root->lbranch) * evalPost(root->rbranch));
121         case '/': return (evalPost(root->lbranch) / evalPost(root->rbranch));
122         case '^': return (pow(evalPost(root->lbranch), evalPost(root->rbranch)));
123     };
124     default: if(isalpha(root->value))
125     {
126         printf("\n%c = ", root->value);
127         scanf("%f", &fNum);
128         return(fNum);
129     }
130     else
131         return(root->value - '0');
132 }

```

Listing 13.1: 13ExpressionTree.c

Output

```

=====
1  /*****
2  putta:Programs$ gcc 13ExpressionTree.c -lm
3  putta:Programs$ ./a.out
4
5  Enter a postfix expression
6  45*35/+
7  infix expression is
8  4 * 5 + 3 / 5
9  Value of Postfix Expression is : 20.6
10
11 putta:Programs$ ./a.out
12
13 Enter a postfix expression
14 ab+cd/*
15 infix expression is
16 a + b * c / d
17 a = 1
18 b = 2
19 c = 3
20 d = 4
21 Value of Postfix Expression is : 2.25
22 *****/

```

Listing 13.2: out13.c