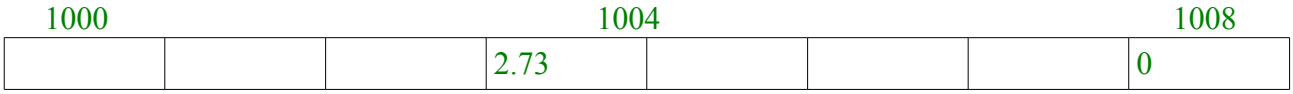
Indian Institute of Technology Mandi
IC150: Computation for Engineering
Tutorial 4

1) Draw a neat diagram showing the memory allocated, with values, after execution of the lines labelled (A) and (B) in the following sequence:

```
typedef struct node {
          float val;
          struct node *next;
} * NodeType;

NodeType p, head;
p = malloc(sizeof struct node); p->val=2.73; p->next=NULL;
head = p; // Line (A)
p = malloc(sizeof struct node); p->val=-32; p->next=head;
head = p; // Line (B)
```

Solution:



A

B

2) A linked list is represented by a single pointer NodeType head.

a) Write a recursive function PrintList() in which each call prints one element. The call PrintList(head) should result in the entire list being printed in order.

b) [Difficult] Write a function RevPrint() that prints the elements in reverse order.

c) [More Difficult] If the list size is n, what is the time complexity of your function RevPrint()? Modify the function so that its time complexity is O(n).

Solution:

a)

```
void PrintList(NodeType list)
{
  if(!list)
    {
      printf("%f\n",current->val);
      PrintList(list->next);
    }
}
```

b)

```
void RevPrint(NodeType list)
{
  if(!list)
    {
      RevPrint(list->next);
      printf("%f\n", list->val);
    }
}
```

c) Time complexity of function RevPrint() is O(n) time and O(n) space for the stack of call frames

For O(n) time and O(1) space:

1. Traverse list reversing the links
2. Print the list using iteration
3. Traverse list reversing the links to restore the original list

3) Write a C function char *GenString(char ch, int len). This function allocates storage for a string of len characters each having value ch. It returns the new string. Eg. GenString('a', 3) returns the string “aaa” and GenString('z', 0) returns the empty string “”.

Solution:

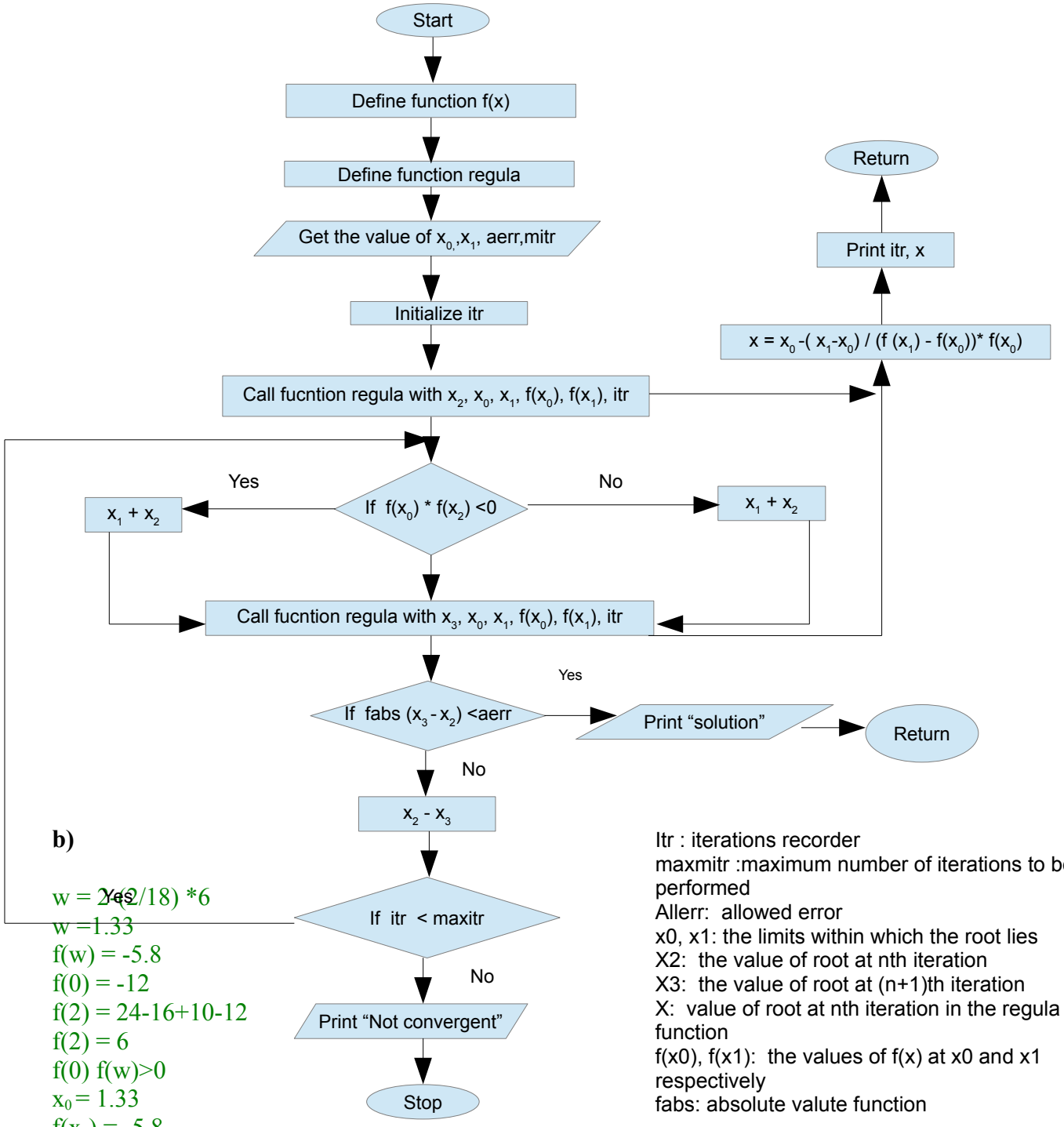
```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>

char *GetString(char ch, int len)
{
     int i;
     char *p = (char *) malloc((len+1)*sizeof(char));
     for (i=0; i<len; i++)
          p[i] = ch;
     p[len]='\0';
     return p;
}
```

4) (a) Draw a neat flow-chart for the Regula-Falsi method of finding the roots of an equation.

(b) Given the initial inerval $[x_0, x_1] = [0, 2]$, what is the new interval after one iteration of the Regula-Falsi method?

Solution:

a)



b)

w = 2-(2/18) *6
w =1.33
f(w) = -5.8
f(0) = -12
f(2) = 24-16+10-12
f(2) = 6
f(0) f(w)>0
x_0 = 1.33
$f(x_0)$ = -5.8
w = 2 – (0.66 / 11.8) * 6
w= 2- 0.35
w =1.65
f(w) = f = -1.163
$f_0 f > 0$
x_0 = 1.65

Itr : iterations recorder
maxmitr :maximum number of iterations to be performed
Allerr: allowed error
x0, x1: the limits within which the root lies
X2: the value of root at nth iteration
X3: the value of root at (n+1)th iteration
X: value of root at nth iteration in the regula function
f(x0), f(x1): the values of f(x) at x0 and x1 respectively
fabs: absolute valute function

5) Derive an expression for the minimum number of iterations required in the bisection method, with initial interval [a, b] bracketing the root, to get a root within an interval of

length e.

Solution:

Given initial interval [a, b]
interval length = e

The interval length after N iterations = $\frac{b-a}{2^N}$

To obtain an accuracy of e,

We have, $\frac{b-a}{2^N} \leq e$

That is,

$2^{-N}(b-a) \leq e$

or $2^{-N} \leq \frac{e}{b-a}$

or $-N \log_{10} 2 \leq \log_{10} \frac{e}{b-a}$

or $N \log_{10} 2 \geq -\log_{10} \frac{e}{b-a}$

or $N \geq -\log_{10} \frac{e}{b-a} / \log_{10} 2$

or $N \geq [\log_{10}(b-a) - \log_{10}(e)] / \log_{10} 2$

6) It is desired to find the root of the function $f(x) = 5x^2 + 3x - 6$ using the Newton-Raphson method. Given $x_0 = 0$, compute x_1 and x_2

Solution:

$f(x) = 5x^2 + 3x - 6$
$x_0 = 0$
$f'(x) = 10x+3$
$x'_0 = 3$
$x_1 = x_0 - f_0/f'_0 = 0-(-6)/3$
$x_1 = 2$

$f(x_1) = 20$
$f'(x_1) = 23$
$x_2 = x_1 - f_1/f'_1 = 2 - 20/23$
$x_2 = 1.1304$