Labs 5 and 6 (Week 3: 1/6/15 to 7/6/15)

(For this lab you can use functions from the C library math.h)

`Total marks:160`

1. Write a program that uses `getchar()` to read a real number and prints twice the number using `putchar()`. You cannot use `scanf` or `printf` to read the number or write out twice the number. Look at the ASCII code tables to convert characters to integers. For information about the ASCII code see `http://en.wikipedia.org/wiki/ASCII` - look at the printable ASCII character set.

   Example:
   If input is
   -32.47
   output is
   -64.94

   [30]

2. Computing the roots of an equation is often needed in engineering calculations. You are given a function $f(x)$ and you have to find values of x for which $f(x) = 0$. There are many methods to do this. We study the *bisection method* here. In this method we start with two values of x, say c and d such that $f(c)$ and $f(d)$ have complementary signs (i.e. one is positive and the other negative). Then assuming $f(x)$ is continuous at all points between c and d there must be at least one point x between c and d where $f(x) = 0$. We approach the root by successively calculating $e = \frac{c+d}{2}$ and updating either c (i.e. `c=e`) or d (i.e. `d=e`) such that $f(c)$ and $f(d)$ continue to have opposite signs. We repeat this until we reach the needed accuracy which can be done in two ways: a) relative difference between c and d is less than some threshold ϵ (that is $|\frac{|c|-|d|}{|c|} < \epsilon$ or b) the absolute value of $f(x)$ at the mid-point of c and d is less than some threshold ϵ (that is $|f(\frac{c+d}{2})| < \epsilon$).

   Write a program to find and print all roots of the following polynomial function: $f(x) = x^5 - 6.55x^4 - 26.2x^3 + 88.8x^2 - 74.4x$. All the roots of this polynomial lie between -10 and 10. Choose $\epsilon = 10^{-4}$. Your program should read 'a' or 'b' as input and use the stopping criterion a) or b) above depending on this input. Your program should print out the 5 roots of the polynomial above.

Be careful about structuring your program properly.

[50]

3. You want to find the area under the curve for the function $f(x) = x^2 - 2x + 5$ between the points $x = -5$ and $x = 5$. First find the exact value by calculating $\int_{-5}^{5}(x^2-2x+5)dx$ (do this by hand). Then find the area under the curve by approximating it with a sequence of rectangles of width w (use a starting value for w of 0.5). Now repeat this process by halving the width w in every iteration until two successive values of the area are less than a threshold ϵ. Print out a) the value of w when your program stops b) the area under the curve and c) the difference between your answer and the value calculated by hand. Use $\epsilon = 10^{-5}$.

[40]

4. In this problem you have to check whether an expression which has three different kinds of opening and closing brackets: '(', ')', '[', ']', '{', '}' are properly nested. A nesting is proper if both properties below hold when the expression is scanned from left to right:

   a) An opening bracket of any type always precedes a closing bracket of the same type.

   b) For the most recently seen opening bracket of a particular type a closing bracket of the same type is encountered before a closing bracket of any other type.

   c) We ignore characters other than brackets of the above three types.

   Your program should read an input expression which is a sequence of characters and then write YES if the expression is properly bracketed and NO if it is not. The examples below will make this more clear.

   Examples:

```
(a)(([{xy+uv}+z])-a*b)        YES
c([xyz]{[jf+k}])        NO
```

[40]