Revision questions based on computation

List of topics:
- Hashing linear probing and separate chaining
- Computational count
- Linear regression
- Secant method (Secant) and Newton Raphson Iterative methods
- Analytical and Numerical Integration (Trap/Simpsons)
- Dijkstra's algorithm

1. A square matrix has the same number of rows and columns and its size is defined by the variable **n**. The code fragment below performs the multiplication of two square matrices **A** and **B** and stores the result in matrix **C**.

```
int i,j,k,n;
// process rows
for (i = 0, i < n; i++)
  // process columns
  for (j = 0; j < n; j++)
    {
    c[i][j] = 0.0;
    // process row-column interactions and sum them into array c
    for (k = 0; k < n; k++)
      {
      c[i][j] = c[i][j] + a[i][k] * b[k][j];
      }
    }
```

   What is the computational count *in terms of n* for the code. Do this for the case when
   i) you do **not** include the cost of the loop process
   ii) you do include the cost of the loop process

2. Show that a positive root exists for the function $f(x) = x^3 + x^2 + x - 1$. Use the secant method and Newton Raphson method to solve $f(x) = x^3 + x^2 + x - 1$ for a positive root with a stopping criteria of $|x_i - x_{i-1}| < 0.001$

3. An Egyptian village was used as the site of a study of nutrition in developing countries. The data were obtained by measuring the heights (cm) of all 161 children in the village each month over several years. The data shows the mean heights for each age.

```
age        height (cm)
18         76.1
19         77
20         78.1
21         78.2
22         78.8
23         79.7
24         79.9
25         81.1
26         81.2
27         81.8
28         82.8
29         83.5
```

   a. Obtain by hand, the equation of the least squares regression line.
   b. Plot the regression line and use it to determine the average height for an average 27 year old.
   c. Calculate the correlation coefficient for this data. What does it tell you about this data set?

4. Find the shortest path from A to F. Show all your working clearly identifying the path and the cost incurred.
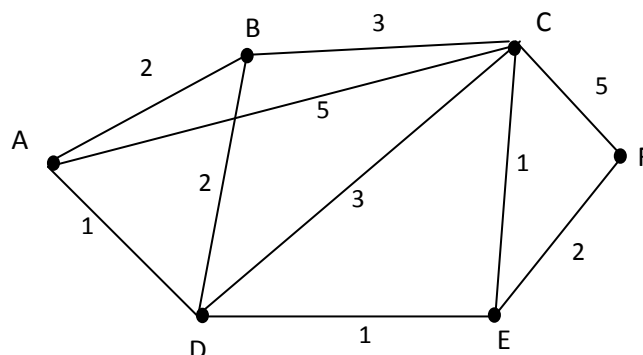
5. Use Simpsons Rule with 6 strips (n=6) to calculate by hand the area under the curve

$$f(x) = 10 x^2 - 6 x^3 - 90 x^4 + 400 x^5$$

from a lower limit a=1 to an upper limit b=3 .

Work out the analytical (exact answer) and then calculate the absolute relative true error for this numerical scheme.

6. Given a hash table of size $n = 10$ and two hash functions $h1$ and $h2$:

$h1(x)$ = (sum of the values of first and last letters of x) modulus of n

$h2(x)$ = ((value of the last letter of x) modulus of (n-1)) + 1

where the value of a letter is determined by its position in the alphabet (e.g. value(a)=1, value(b)=2, etc)

Here are some pre-computed hash values as an example

x	h1(x)	h2(x)
Pugh	4	9
Lai	1	1
Margo	8	7
Annie	6	6
Gonzales	6	2
Pam	9	5
Cherry	8	8
Lenon	6	6
Kiri	0	1
Barbara	3	2

For **each** hash function draw the resulting hash table after inserting, in order, the following words:

Barbara, Pam, Gonzales, Lai, Pugh, Annie, Kiri, Cherry, Lenon, Margo.
(i)   Use linear probing when collision occurs
(ii)   Using chaining when collision occurs