DEPARTMENT OF ELECTRICAL ENGINEERING
BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
DATA STRUCTURE LAB (EE-453) **4th SEMESTER ELECTRICAL**

Problem sheet on tutorial class: C Programming & Numerical methods

(A) General Problems:

Problem 1:
- **(a):** Write a C program to obtain the *greatest* of a set of n numbers.
- **(b):** Write a C program to obtain the *smallest* of a set of n numbers.

Problem 2: Write a C program to find the *sum of squares* of first n natural numbers.

Problem 3:
- **(a):** Write a C program to arrange a set of n numbers in *ascending* order.
- **(b):** Write a C program to arrange a set of n numbers in *descending* order.

Problem 4: Write a C program to find the *factorial* of a number using *function*.

Problem 5: Write a C program to compute the first 20 *Fibonacci numbers* and their cumulative sums.

Problem 6:
- **(a):** Write a C program to calculate the value of $\sin x$, correct to five decimal places using the series,
$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots\cdots = \sum_{n=0}^{\infty}(-1)^n \frac{x^{2n+1}}{(2n+1)!}$$
- **(b):** Write a C program to calculate the value of $\cos x$, correct to five decimal places using the series,
$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \cdots\cdots = \sum_{n=0}^{\infty}(-1)^n \frac{x^{2n}}{(2n)!}$$

Problem 7:
- **(a):** Write a C program to find the *determinant* of a 2×2 matrix.
- **(b):** Write a C program to find the *determinant* of a 3×3 matrix.
- **(c):** Write a C program to find the *determinant* of a $n \times n$ matrix using *Gauss elimination* technique.

Problem 8:
- **(a):** Write a C program to *add two matrices*.
- **(b):** Write a C program to *subtract two matrices*.
- **(c):** Write a C program to *multiply two matrices*.

Problem 9: Write a C program to *reverse* a five digit number.

Problem 10: Write a C program to *invert* a given square matrix.

(B) Problems on Numerical Methods:

Problem 11: Write C program for **Bisection Method**.
Find one positive root of $f(x) = x^3+x^2-3x-3 = 0$ using the program. Take $|f(x)| \leq 0.001$. Count the number of iterations. [Ans: $x = 1.7320557$]

Problem 12: Write C program for the **Method of false position**.
Find one negative root of $f(x) = x^3 - x + 1 = 0$. Take $|x_{i+1} - x_i| \leq 0.001$. Count the number of iterations. Use the program. [Ans: $x = -1.3248292$]

Problem 13: Write C program for **Secant Method**.
Find one positive root of $f(x) = x^3 - x^2 - 2x + 1 = 0$. Take $|x_{i+1} - x_i| \leq 0.001$. Count the number of iterations. Use the program. [Ans: $x = 1.8018581$]

Problem 14: Write C program for **Newton-Raphson Method**.
Using the program find one positive root less than $+1$ of $f(x) = 3x + \sin x - e^x = 0$. Show that it has another positive root in between $+1$ and $+2$. Take $|f(x)| \leq 0.0001$ and count the number of iterations in each case. [Ans: $x = 0.3604, 1.89$]

Problem 15: Write C program for **Lagrangian Interpolation**.
Using the program interpolate for $f(2.3)$ from the table:

x	$f(x)$
1.1	10.6
1.7	15.2
3.0	20.3

[Ans: $f(2.3) = 18.38$]

Problem 16: Write C program for **Trapezoidal Rule**.
Using the program find the integral of the function $f(x)$ tabulated below.

x	$f(x)$	x	$f(x)$
1.6	4.953	2.8	16.445
1.8	6.050	3.0	20.086
2.0	7.389	3.2	24.533
2.2	9.025	3.4	29.964
2.4	11.023	3.6	36.598
2.6	13.464	3.8	44.701

[Ans: $\int_{1.8}^{3.4} f(x)\,dx = 23.9944$]

The data in the table are for $f(x) = e^x$. Hence verify the result with $\int_{1.8}^{3.4} e^x\,dx$.

Problem 17: Write C program for **Runge - Kutta Method**.
Solve $\frac{dy}{dx} = x + y,\ y(0) = 1$, taking $h = 0.1$ and using the program for fourth-order Runge-Kutta method. [Ans: $y(0.1) = 1.11034$]

Problem 18: Write C program for **Gaussian Elimination Technique**.
Solve the following set of linear algebraic equations using the program.

$$\begin{aligned}
475x_1 - 316x_2 - 407x_3 + 253x_4 &= 521 \\
296x_1 - 482x_2 - 395x_3 + 242x_4 &= 720 \\
364x_1 - 421x_2 - 643x_3 + 342x_4 &= 634 \\
282x_1 - 286x_2 - 315x_3 + 448x_4 &= 266
\end{aligned}$$

[Ans: $x_1 = 0.29177,\ x_2 = -1.4835,\ x_3 = -0.21593,\ x_4 = -0.68877$]

Problem 19: Write C program for **LU Factorization**.
Write a C program to factorize a given square matrix into the lower and upper *triangular matrices*. Hence solve the following set of linear algebraic equations using the program.

$$\begin{aligned}
2.63x_1 + 5.21x_2 - 1.694x_3 + 0.938x_4 - 4.230 &= 0 \\
3.16x_1 - 2.95x_2 + 0.813x_3 - 4.210x_4 + 0.716 &= 0 \\
5.36x_1 + 1.88x_2 - 2.150x_3 - 4.950x_4 - 1.280 &= 0 \\
1.34x_1 + 2.98x_2 - 0.432x_3 - 1.768x_4 - 0.419 &= 0
\end{aligned}$$

[Ans: $x_1 = 1.038335,\ x_2 = 0.208898,\ x_3 = 0.22636,\ x_4 = 0.846775$]

Problem 20: Write C program for **Crout Method**.
Solve the following set of linear algebraic equations using the program.

$$\begin{aligned}
0.89x_1 + 4.32x_2 - 0.47x_3 + 0.95x_4 &= 3.36 \\
1.13x_1 - 0.89x_2 + 0.61x_3 + 5.63x_4 &= 4.27 \\
6.32x_1 - 0.73x_2 - 0.65x_3 + 1.06x_4 &= 2.95 \\
0.74x_1 + 1.01x_2 + 5.28x_3 - 0.88x_4 &= 1.97
\end{aligned}$$

[Ans: $x_1 = 0.444,\ x_2 = 0.563,\ x_3 = 0.324,\ x_4 = 0.723$]