P346/475 Computer Lab

Mid-Semester examination, 2025

NISER, Bhubaneswar

Full marks: 15 Time: 2 hours

Marks are given in bold along with the questions. Attempt all.

1. Using the LCG pRNG constructed in class ($a = 1103515245$, $c = 12345$, $m = 32768$), determine the area of an ellipse, centered at origin, having semi-minor and semi-major axis of 1 and 2 unit respectively. Choose the number of random points such that the result is within 5% of the analytical value. **[4]**

2. Wein's displacement law states that black body radiation for different temperatures peak at different wavelengths (λ_m) that are inversely proportional to the temperature T, *i.e.* $\lambda_m T = b$, where b is Wein's constant. It can be derived from the Planck's law for spectrum of black body radiation by solving

$$(x-5)\,e^x + 5 = 0, \quad \text{where } x = \frac{hc}{\lambda_m kT} > 0$$

   Solve the above equation using Newton-Raphson method and determine Wein's constant b in meter-Kelvin to a precision of 10^{-4}. Take $h = 6.626 \times 10^{-34}\, m^2 - kg/s$, $k = 1.381 \times 10^{-23}\, m^2 - kg/Ks^2$ and $c = 3 \times 10^8\, m/s$. **[4]**

3. Find the inverse of the following matrix (if exists) using **LU** decomposition

$$\begin{pmatrix} 0.2 & -5 & 3 & 0.4 & 0 \\ -0.5 & 1 & 7 & -2 & 0.3 \\ 0.6 & 2 & -4 & 3 & 0.1 \\ 3 & 0.8 & 2 & -0.4 & 3 \\ 0.5 & 3 & 2 & 0.4 & 1 \end{pmatrix}$$

   Round-off your results to 3 decimal places. **[4]**

4. Solve the linear system of equation $\mathbf{A}\,\mathbf{x} = \mathbf{b}$, where $\mathbf{A}$ and $\mathbf{b}$ are given in the file `msem_gs.txt` using Gauss-Seidel iterative methods to a precision of 10^{-6}. **[3]**