Design Optimization
Simulated Annealing HW

1. (25 pts) Execute 3 cycles of the Simulated Annealing algorithm to minimize the following function:

$f = 0.2 + x_1^2 + x_2^2 - 0.1\cos(6\pi x_1) - 0.1\cos(6\pi x_2)$, subject to variable bounds $-1 \le \mathbf{x} \le 1$.

The argument for cos is evaluated in radians. Take N = 6, Ps = 0.7, Pf = 0.001 and Δ = 0.5. At each temperature, evaluate three designs, where you perturb both variables for each design.

Perturb the variables using the following function:

$x_{new} = x_{old} + 2\Delta(\text{rand} - 0.5)$

The starting point, $x^T = [0.8, -0.5]$. Use the following random numbers, row by row, as needed by the algorithm.

0.797	0.137	0.056	0.197	0.419	0.465	0.878	0.628	0.933	0.885
0.765	0.337	0.837	0.303	0.035	0.829	0.360	0.684	0.583	0.620
0.617	0.269	0.409	0.547	0.612	0.779	0.934	0.777	0.728	0.424

Do your work on an Excel spreadsheet and show your work.

2. (25 pts) Minimize the function $f = 0.2 + x_1^2 + x_2^2 - 0.1\cos(6\pi x_1) - 0.1\cos(6\pi x_2)$, subject to variable bounds $-1 \le \mathbf{x} \le 1$, using the Genetic Algorithm. Besides the starting population, create two new generations (children and grandchildren). Since the genetic algorithm naturally maximizes, change the problem to a minimization problem by using the fitness function fit = 1.5 - f. The starting population of designs is given below:

$\mathbf{x}^1 = (-0.1406, 0.2031)$
$\mathbf{x}^2 = (0.5781, -0.1719)$
$\mathbf{x}^3 = (0.3594, 0.3906)$
$\mathbf{x}^4 = (-0.7656, -0.4219)$
$\mathbf{x}^5 = (0.6379, -0.9697)$
$\mathbf{x}^6 = (-0.7792, 0.5722)$

Each variable will be represented by 8 bits. Pair up the parents in the order they are chosen from the mating pool. We will use a strategy of *elitism*, whereby the best design of the current generation is automatically copied into the next generation. Thus the generations containing the children and grandchildren will have seven members instead of six. Choose random numbers from the following list (row-by-row) as needed. Use a probability of crossover of 0.9 and a probability of mutation of 0 (so no need to even check).

0.497, 0.250, 0.291, 0.681, 0.203, 0.107, 0.718, 0.212, 0.023, 0.533
0.144, 0.730, 0.641, 0.964, 0.074, 0.108, 0.807, 0.978, 0.597, 0.114
0.493, 0.885, 0.535, 0.338, 0.889, 0.919, 0.168, 0.319, 0.803, 0.496

Do your work on an Excel spreadsheet, and organize your work in the same way as the table shown in the notes. You should end up with three tables: one for the initial population, one for the children, and one for the grandchildren.