Indian Institute of Technology, Kharagpur

Department of Mechanical Engineering

Date: ; Time: 2 hours; Full Marks: 30; No. of students:48

Autumn Sem. 2011-2012 (Mid. Sem.); Subject No.MF41601

3-rd and 4-th Year B. Tech. and DD students; Subject Name: Soft Computing

Instructions: Answer all the questions. Assume suitable data, if necessary.

Marks:=11(2+1+2+2+1+1+1+1)+4+15=30

Q. 1

(a) How does a Genetic Algorithm (GA) maintain a proper balance between selection pressure (exploitation) and population diversity (exploration) in its search?

(b) Determine whether there exists either an optimum or an inflection point of the function $f(x) = x^5$.

(c) Explain the method of implementing "ranking selection" in the computer program of a GA.

(d) Why do we select a high value of crossover probability (p_c) and low value of mutation probability (p_m) in GA-search?

(e) When and why do we prefer a real-coded GA to a binary-coded GA?

(f) Why do we expect Visualized Interactive GA (VIGA) to be faster than the simple GA?

(g) Why do we need a special type of crossover operator in a scheduling GA?

(h) Define Pareto-optimal front of solutions in connection with multi-objective optimization.

Q. 2

$$\text{Minimize } f(x_1, x_2) = -x_1 + x_2 + x_1^2 - x_2^2 + 8x_1x_2$$
$$\text{subject to } 2.0 \leq x_1, x_2 \leq 10.0$$

Use Random Walk method. Assume step length $\lambda = 1.0$. Start with a random initial solution: $X_1 = \{0.0, 0.0\}^T$. Show one iteration only.

Q. 3

In order to minimize the objective function in the above range, as given in Q. 2, let us consider the following two functional constraints to make it a constrained optimization problem:

$$x_1^2 + 3x_2^2 > 90.0,$$
$$5x_1 - 3x_2 < 12.0.$$

Use a binary-coded GA to solve it utilizing any one of the penalty function approaches. Assume suitable data related to the penalty function approach used by you. Select the number of bits to represent each variable, in order to ensure an accuracy level of 0.125. Use two-point crossover with a probability of $p_c = 1.0$; bit-wise mutation with a probability of $p_m = 0.02$; tournament selection scheme. Take a random population of size $N = 6$. Show only one iteration of the GA-run by hand calculations.