INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR
M.E. 2nd SEMESTER (CE) EXAMINATIONS, 2014
Optimization of Structures (CE –1003)

Full Marks: 70 **Time: 3 hrs**

Answer any five questions.
Symbols have their usual meanings.
Assume reasonable values where necessary.

Q.1. Answer any four of the following:

(i) Differentiate between a Free point and a Bound point in the design space. Show the different types of Free and Bound points in a hypothetical 2-d design space.
(ii) Explain with examples:
Behaviour Constraints and Side Constraints
(iii) Write about five applications of linear programming.
(iv) What are the Kuhn-Tucker Conditions?
(v) What are the characteristics of a linear programming problem?
(vi) State and prove the sufficient condition for the extreme point of an unconstrained multivariable optimization problem.

(3.5 x 4 = 14)

Q.2. (a) Describe the Fibonacci Method for single variable unconstrained optimization. Explain the special consideration for locating the last numerical experiment.

(b) Write the Lagrange function for a multivariable optimization problem with inequality constraints. Show that for a constrained minimum point, the Lagrange multipliers have to be positive.

(8+6 = 14)

Q.3. a) Solve the following LP problem.

Maximize $F = x_1 - 2x_2$
subject to
$-2x_1 + x_2 \le 0$
$-2x_1 + 3x_2 \le 6$
$x_1, x_2 \ge 0$

b) Answer True or False:

(i) The feasible space of LP problems can be nonconvex.
(ii) The unique optimum solution of an LP problem always lies at a vertex.
(iii) The slack and surplus variables can be unrestricted in sign.
(iv) The infeasibility form in the Simplex Method can be negative.

c) Explain the basis for identifying the presence of multiple optima in the Simplex Method?

(8+2+4 = 20)

Q.5. a) Perform two sets of exploratory and pattern moves of the Hooke-Jeeves Pattern Search Method for the following problem.

Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$

starting from $X_1 = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$. Take $\Delta = \begin{Bmatrix} 0.6 \\ 0.6 \end{Bmatrix}$.

b) Write an algorithm for Cauchy's Method of Steepest Descent.

(8+6 = 14)

Q.5. Find the optimum solution for the following LP problem.

Maximize $F = y_1 + 2y_2$

subject to

$3y_1 + 2y_2 \leq 12$

$2y_1 + 3y_2 \geq 6$

$y_1 \geq 0, y_2$ is unrestricted in sign.

(14)

Q.6. a) Determine whether the following vectors serve as conjugate directions for minimizing the function $f = 2x_1^{\,2} + 16x_2^{\,2} - 2x_1x_2 - x_1 - 6x_2 - 5$

(i) $S_1 = \begin{Bmatrix} 15 \\ -1 \end{Bmatrix}, S_2 = \begin{Bmatrix} 1 \\ 1 \end{Bmatrix}$ (ii) $S_1 = \begin{Bmatrix} -1 \\ 15 \end{Bmatrix}, S_2 = \begin{Bmatrix} 1 \\ 1 \end{Bmatrix}$

b) Describe the Parallel Subspace Property and the Extended Parallel Subspace Property.

(8+6 = 14)

Q.7. Minimize $f = 2(x_2 - x_1^2)^2 + (1 - x_1)^2$

If a base simplex is defined by the vertices $X_1 = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}, X_2 = \begin{Bmatrix} 1 \\ 0 \end{Bmatrix}, X_3 = \begin{Bmatrix} 0 \\ 1 \end{Bmatrix},$

Find a sequence of three improved points (different from the base simplex) using reflection, expansion and/or contraction.

(b) What is a quadratically convergent method?

(10+4=14)

Q.8. a) What are Penalty Function methods also known as and why?

b) Explain clearly the difference between Exterior and Interior Penalty Function Methods.

c) Give an algorithm for the Interior Penalty Function method. What are the considerations for the choice of the initial value of the penalty parameter R?

(4+4+6 = 14)