College of Engineering, Pune
B. Tech. – Mechanical Engineering

· Introduction to Optimum Design (ME-OE-14003)

Time: 3 hrs 2 to 5 pm

Academic Year: 2014 - 15

Max. Marks: 60

Semester I

28 NOV 2014

Instructions:

1. Answer all the questions.
2. Figures to right indicate full marks.
3. Assume suitable data, if required.

Q. 1		Four identical helical springs are used to support a milling machine weighing 2000 kg. Formulate the problem of finding the wire diameter (d), coil diameter (D), and number of turns (N) of each spring for minimum weight by limiting the deflection to 2.5 mm and shear stress to 77 N/mm^2 in the spring. In addition, the natural frequency of vibration of the spring is to be grater than 100Hz. The stiffness of the spring (k), the shear stress in the spring (τ), and the natural frequency of vibration of the spring is (f_n) are given by $K = (d^4G/8D^3N)$, $\tau = (K_s*8FD/\pi d^3)$, $f_n = \{(Ggd)^{1/2}/2(2\rho\pi D^2N)^{1/2}\}$ where G is the shear modulus, F is the compressive load on the spring, w is the weight of the spring, ρ is the weight density of the spring and K_s is the shear stress correction factor. Assume that the material is spring steel with G = 9.3×10^3 N/mm^2 and $\rho = 9.15 \times 10^{-3}$ Kg/cm^3 and shear stress correction factor $K_s = 1.05$.	10
Q. 2		A firm produces three products which are processed on three machines. The relevant data is given below:	10

Machine	Time per unit (min.)			Machine Capacity (min./day)
	Product A	Product B	Product C	
M_1	2	3	2	440
M_2	4	-	3	470
M_3	2	5	-	430

The profit per unit for product A, B and C is Rs. 4, Rs. 3 and Rs. 6, respectively. Determine the daily number of units of each product to be manufactured for maximum profit. Assume that all units produced are consumed in the market. Number of units manufactured can be any real number.

Q. 3		What are the differences between Cauchy's and Newton's search methods? Determine for what values of x_1 and x_2, Newton's method is guaranteed to be successful for the following unconstrained minimization problem: $F(x_1, x_2) = x_1^3 - 4x_1x_2 + x_2^2$.	10
Q. 4		Use two iterations of Genetic Algorithm with 4 bit binary representation of	10

		variables to Minimize $f(x) = 10 - x_2$ Subject to $g(x) = 26 - (x_1 - 5)^2 - x_2^2 \geq 0, \quad x_1, x_2 > 0.$	
Q. 5		Identify the optimality of the points (3, 2) for the NLP given below Minimize $f(x_1, x_2) = (x_1 - 3)^2 + (x_2 - 2)^2$ subject to $26 - (x_1 - 5)^2 - x_2^2 \geq 0$ $20 - 4x_1 - x_2 \geq 0$ $x_1, x_2 \geq 0$	10
Q. 6		Write short notes on any two of the following: (i) Sensitivity analysis (ii) Duality in linear programming (iii) Penalty function method for constrained optimization	10