

B. MECH. ENGG. 4TH YEAR 1ST SEM. SUPPLE EXAMINATION, 2017**MACHINE DESIGN IV**

Time: 3 hours

Full Marks: 100

(Answer any five)

(Assume data if required)

1. a) Find the maximum of the function $f(x) = 2x_1 + x_2 + 10$ subject to $g(x) = x_1 + 2x_2^2 = 3$ using the Lagrange Multiplier method. Also find the effect of changing the right side of the constraint by 2 units on the optimum value of f .
- b) Define concave and convex functions.

12+8

2. a) A scaffolding system shown in fig. 1 consists of three beams and six ropes as shown. Formulate the problem of finding the maximum external load that can be supported by the system. Each of the top ropes A and B can carry a load of T_1 , each of the middle ropes C and D can carry a load of T_2 , and each of the bottom ropes E and F can carry a load of T_3 . Assume that weights of the beams 1, 2, and 3 are w_1 , w_2 , and w_3 respectively, and the weights of the ropes are negligible.

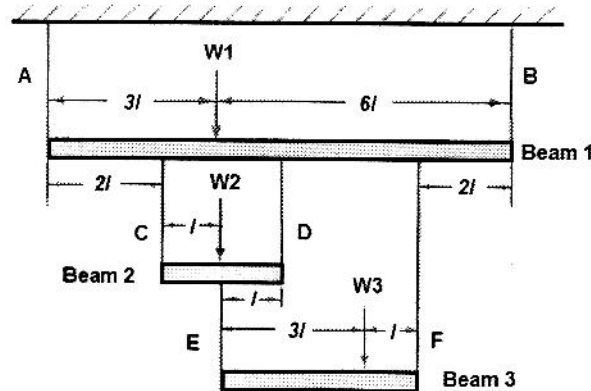


Fig. 1

- b) What are the characteristics of linear programming (LP) problem? Write down the steps for solving a LP problem by Simplex method?

10+10

3. a) Using Simplex method, Maximize $F = x_1 + 2x_2 + x_3$ subject to

$$\begin{aligned} 2x_1 + x_2 - x_3 &\leq 2 \\ -2x_1 + x_2 - 5x_3 &\geq -6 \\ 4x_1 + x_2 + x_3 &\leq 6 \\ x_i &\geq 0, \quad i = 1, 2, 3 \end{aligned}$$

- b) Write down the working principles of genetic algorithm.
- c) Define fitness function, mutation and cross over.

10+4+6

4. a) What is unimodal function?
b) Write down the fundamental rules of region elimination methods.
c) What are the differences between bounding phase and exhaustive search methods?
d) Explain point estimation method.

5+5+5+5

5. a) Distinguish three different design philosophies: 'Safe life', 'Fail safe' and 'Damage tolerance'.
b) What are the different types of fracture modes?
c) What is Irwin's correction as an extension of Griffith's theory?
d) What are the conditions for stable crack growth for fixed load and fixed displacement conditions?

5+5+5+5

6. a) What are the different types of fracture modes?
b) A cylindrical pressure vessel with a diameter of 6.0 m and wall thickness 25 mm, underwent catastrophic fracture when the internal pressure reached 18.5 MPa. The properties of the vessel material are $E=207$ GPa, $\sigma_y=2450$ MPa, $G_c=130$ kJ/m². (a) Show that the failure is not because of design based on von Mises yield criterion. (b) Determine the crack size based on Griffith's analysis that caused failure.

8+12

7. a) A 120 kg machine is mounted at the mid span of a 1.5 m long simply supported beam of elastic modulus $E = 2 \times 10^{11}$ N/m² and cross section moment of inertia $I = 1.53 \times 10^{-6}$ m⁴. An experiment is run on the system during which the machine is subjected to a harmonic excitation of magnitude 2000 N at a variety of excitation frequencies. The largest steady state amplitude recorded during the experiment is 2.5 mm. Estimate the damping ratio of the system.
b) Define K_{IC} and K_I and how those are applied in design?
c) Explain the different parameters on which K_{IC} of a component depends on.

12+4+4

8. a) State the different types of monitoring systems.
b) What are the steps to be followed for establishing the condition monitoring program?
c) What is false alarm? How this can be avoided?
d) What are the advantages of envelope detection?

5+5+5+5
