B.E. MECHANICAL ENGINEERING (PART TIME) FOURTH YEAR SECOND SEMESTER EXAMINATION, 2017 (OLD)

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

$$2x_1 + x_2 - x_3 \le 2$$
$$-2x_1 + x_2 - 5x_3 \ge -6$$
$$4x_1 + x_2 + x_3 \le 6$$
$$x_i \ge 0; \quad i = 1, 2, 3$$

.10+10=20

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 ω_1, ω_2, and ω_3 respectively, and the weights of the ropes are negligible.

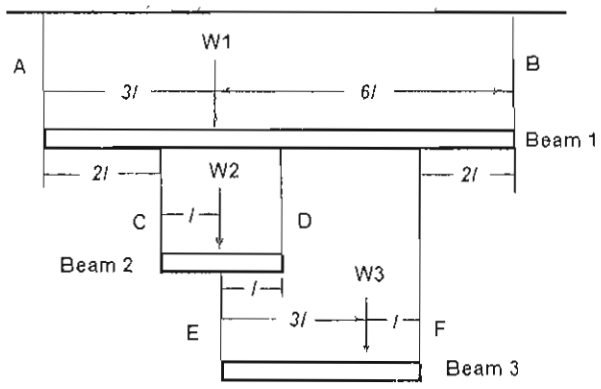

Fig. 1

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) How does the concept of fracture mechanics vary for LEFM and EPFM?
   b) Explain and derive Griffith's energy release rate as failure criteria and extend it as explained by Irwin.
   c) Explain stability in crack growth in displacement controlled loading and load controlled loading.
   d) A steel sheet having a central crack of size 50 mm is fractured at a stress level of 500 MPa. Calculate the fracture stress of a plate made of the same material and contains a central crack of 90 mm. Consider E = 210 GPa.

5+5+5+5=20

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.
   e) Write down the working principles of genetic algorithm.

4+4+4+4+4=20

5. 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, σ_y=2450 MPa, G_c=130 kJ/m^2. (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.

6+14=20

6. a) A 45 kg machine is placed at the end of a 1.6 m cantilever beam of elastic modulus of $200\times10^9\,N/m^2$ and cross sectional moment of inertia $1.6\times10^{-5}\,m^4$. As it operates, the machine produces a harmonic force of magnitude 125 N. At what operating speeds will the machine's steady state amplitude be less than 0.2 mm?
   b) Explain Feedback System for active vibration control.
   c) Define Global and local optimization.

10+5+5=20

7. 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=20

8. a) A 82 kg machine tool is placed on an elastic foundation. An experiment is run to determine the stiffness and damping properties of the foundation. When the tool is excited with a harmonic force of magnitude 8000 N at a variety of frequencies, the maximum steady state amplitude obtained is 4.0 mm at a frequency of 35 Hz. Use this information to estimate the stiffness and damping ratio of the foundation.

b) Define concave and convex functions.

14+6=20