- **Tables of Steel Sections and Egyptian Code of Practice (ECP) are allowed.**
- **Any sketches should be neat, detailed and fully dimensioned.**
- **Any missing data may be reasonably assumed.**
- **Read carefully the given data and solve the required questions. (Total Marks: 100)**

Answer the following questions

Question 1: (60 Marks)

The frame **ABCDE** shown in **Figure (1)** is supported at **A** and **E** by two hinged supports at **A & E**. The frame is regularly spaced at 6.0 m and the roof purlins are spaced at 1.50 m.

For the given Loads and Reactions it is required to:

1. Sketch with suitable scale all necessary views of the bracing system required for the stability of the structure. [10 marks]

2. Draw the B.M, S.F and N.F diagrams for the frame for the given loads. [10 marks]

3. Design the rafter and the column of the frame (critical ones). [20 marks]

4. Design and draw joints **B** and **C** showing all details. [20 marks]

Given:

- Steel to be used   = ST. 37 (F_y=2.4 t/cm^2 & F_u=3.60 t/cm^2)
- Bolts used   = M22
- (Type (10.9), For M22, A = 3.80 cm^2, A_s = 3.03 cm^2, T_o = 19.08 t, and P_s = 6.10 t)

Question 2: (40 Marks)

1. Discuss briefly the following points

   a. Types of bracing systems used in portal frames and discuss the function and design force of each type (Use illustrations). [10 marks]

   b. Definition of the base plates and different types of column's base plates according to the forces required to be transferred to the foundations. [10 marks]

2. For the connection shown in **Figure (2)**, it is required to determine the number of bolts required (n1,n2 and n3) for the connection, Assuming the bolts to be used are high strength bolts with following specifications;

   (Type 10.9, For M20, A = 3.14 cm^2, A_{net} = 2.45 cm^2, T_o = 15.43 t, and P_s = 4.9 t) [20 marks]

With my best wishes,,,,

Dr. Maher Elabd

Figure (1)

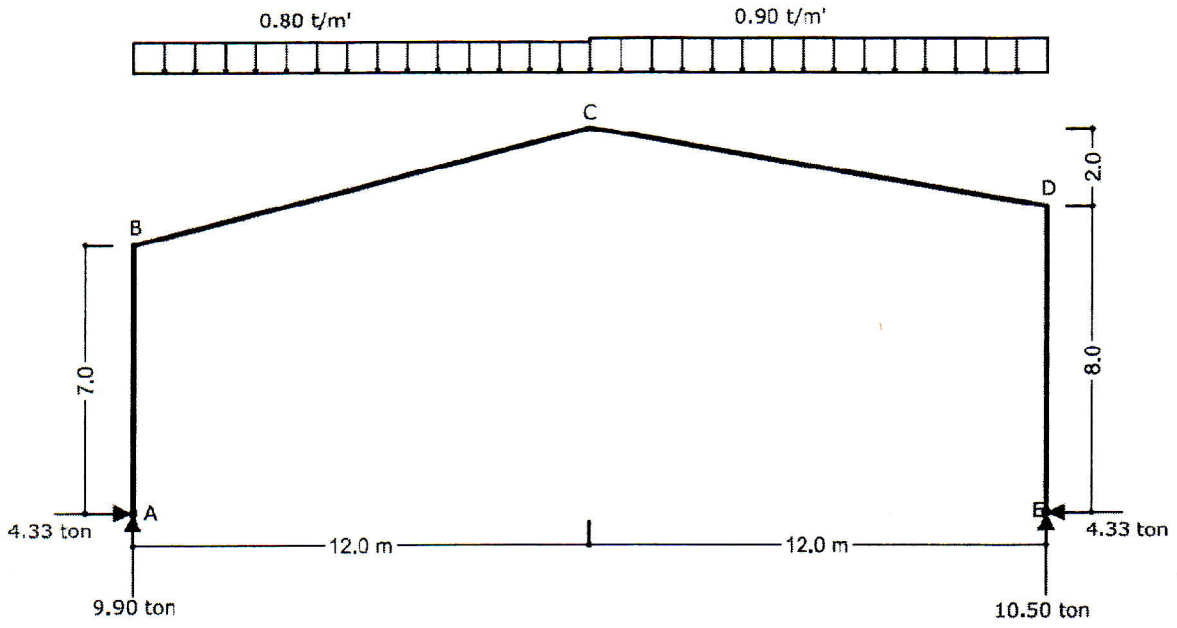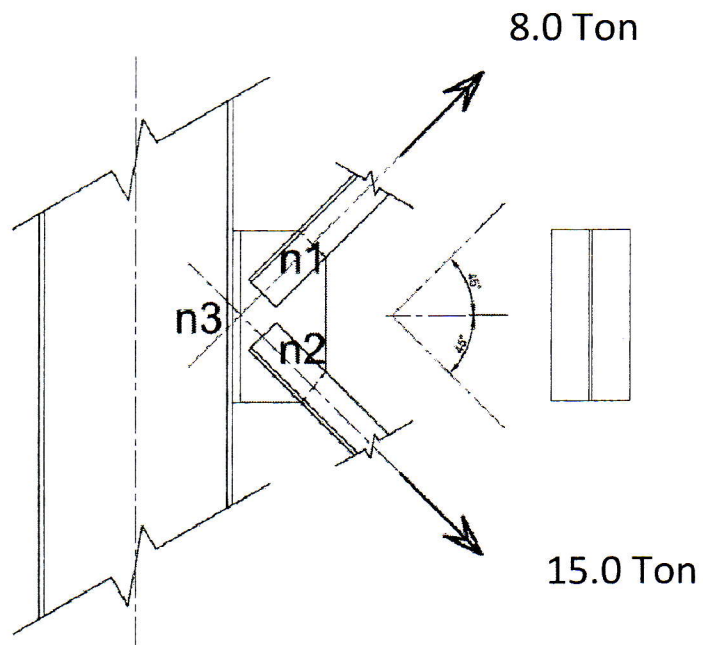0.80 t/m' 0.90 t/m'

C

B

D

2.0

8.0

7.0

4.33 ton   A

12.0 m   12.0 m

E   4.33 ton

9.90 ton   10.50 ton

8.0 Ton

n1

n3

n2

15.0 Ton

Figure (2)