MCL735
MINOR I

CAD & FEA
August 29, 2017

MAX MARKS: 60

MAX TIME: 60 MINS.

Note:

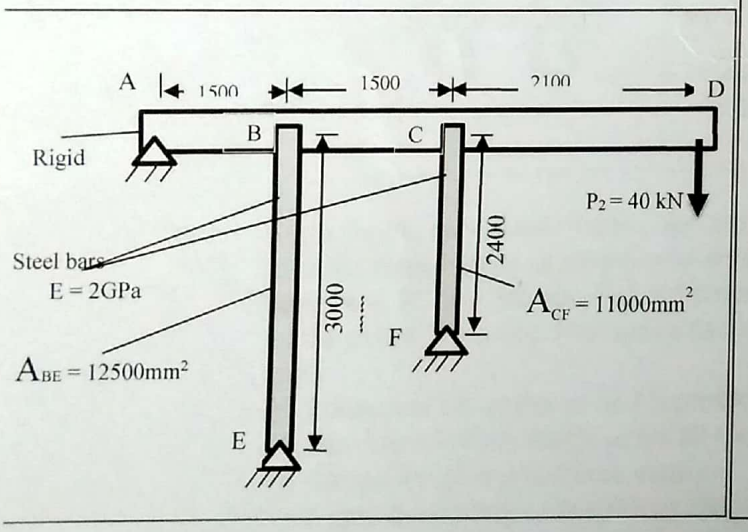
1. Answers should be **brief and to the point.**
2. **Marks shall be deducted for unnecessarily long answers.**

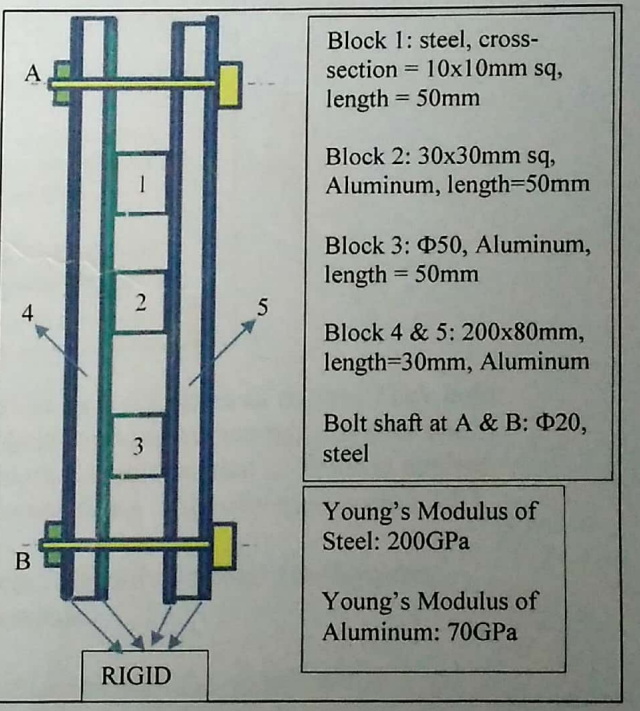
Q 1 Given that potential energy is given by $\prod = \frac{1}{2} Q^T K Q - Q^T F$, Derive how displacements can be found in a FE problem by applying multi point boundary conditions using the penalty approach. (15 marks)

Q 2 In a 2 noded 1D element (nodes 1 and 2 having displacements x_1 & x_2) a point force is applied at an arbitrary point with coordinate x_p. Find out the equivalent forces at nodes 1 & 2 such that the potential energy in the system remains same. (10 marks)

Q 3 (15 marks)

i) Formulate the problem in the first figure as a 1D FE problem





Q 4 In the second figure, two blocks 4 and 5 are backed by rigid plates as shown. They hold together three blocks as shown, and are held together by two pairs of nuts and bolts, A & B. The nuts are first tightened on the bolts so that no force is applied on the plates. They are then turned two revolutions. The bolts have a pitch of 1 mm.

i) Formulate the above as an FE problem. Use only 2 noded 1D elements.
ii) Develop stiffness matrices for all elements.
iii) Obtain the global stiffness matrix.
iv) Apply the boundary conditions (BCs) and modify the global stiffness and force matrices using the penalty approach.
v) As an alternate approach, formulate the BCs for the Lagrangian multiplier approach and develop the solution matrices using Lagrangian multipliers.

(20+5+10+10+15)