

1.6 Structures – trusses and frames

Name: _____ Class: _____ Date: _____

Total: 25 marks

KEY WORDS truss • tension • compression • method of joints
 • method of sections • zero-force member

Objective

Solve trusses by the method of joints and the method of sections, identify zero-force members by inspection, and extend the same dismembering discipline to frames and machines. Every member force is checked through a second joint or an unused section.

1 Key knowledge and worked examples

■ A truss is a collection of two-force members

A **truss** is straight members joined at frictionless pins, loaded only at the joints – so every member is a **two-force member** carrying pure **tension** or **compression** along its axis. Solve the support reactions first, then work joint by joint.

Method of joints : at each joint, two force equations solve two unknown member forces. Start where only two members meet.

Worked example. A joint at the wall carries a 3.6 kN hanging load, held by a horizontal member and an inclined member rising on 3-4-5 geometry. Vertically: $F_{inclined} \times (3/5) = 3.6 \rightarrow F_{inclined} = 6kN$ (tension). Horizontally: the horizontal member takes $6 \times (4/5) = 4.8kN$ compression. Every joint is this step.

■ Method of sections: cut for the member you want

Method of sections slices through at most three members and takes moments or forces on one piece – ideal for one member deep inside a long truss. Choose the moment centre where two cut members cross, and the third solves alone.

■ Zero-force members and the frame extension

Zero-force members : at an unloaded joint with exactly two non-collinear members, both carry zero; at an unloaded three-member joint where two are collinear, the third carries zero. Finding them first shrinks the arithmetic – they are not wasted metal; they stabilise the truss during construction.

Frames and machines have multi-force members: dismember, draw each member's FBD with joint forces equal and opposite on the neighbour, and solve piece by piece – the same discipline, one more layer.

2 Practice

2.1 At a truss joint, a 4.5 kN load hangs and one member rises at 3-4-5 geometry (3 vertical, 4 horizontal) while a horizontal member completes the joint. Find both member forces, stating tension or compression. [4]

2.2 An unloaded joint has exactly two non-collinear members and no external load. State both member forces and the reasoning in one sentence. [2]

2.3 A simply supported roof truss carries 10 kN at its apex through symmetric members at 45° . Find the force in each apex member by the method of joints, and state tension or compression. [4]

3 Exam-style questions

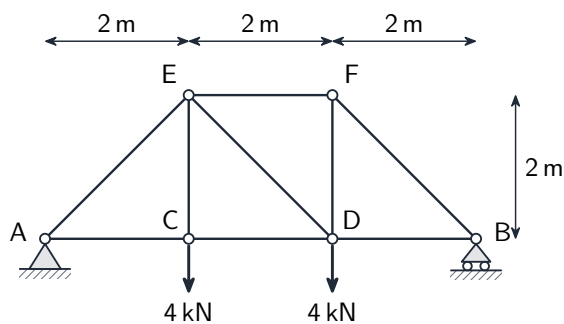
3.1 The Pratt truss shown has a span of 6 m in three 2 m panels and a height of 2 m. It rests on a pin at A and a roller at B. The bottom joints are A, C, D and B; the top joints E and F sit above C and D. The members are AC, CD, DB, EF, CE, DF, AE, FB and the interior diagonal ED. A load of 4 kN hangs at C and another at D.

(a) Find the support reactions at A and B. [2]

(b) Use the method of joints, at A and then at C, to find the forces in members AE, AC and CE. State tension or compression for each. [4]

(c) Cut the truss through EF, ED and CD and keep the left piece. Use moments about suitable points to find the forces in CD and EF, stating tension or compression. [3]

(d) Explain, without solving any joint, why member ED carries no force. [1]



3.2 A frame consists of a two-force strut and a multi-force horizontal member. Explain, in two or three sentences each, (a) why the method of joints cannot solve the frame as if it were a truss, and (b) how the dismembering procedure recovers the solution, naming where the equal-and-opposite pairs act. [5]