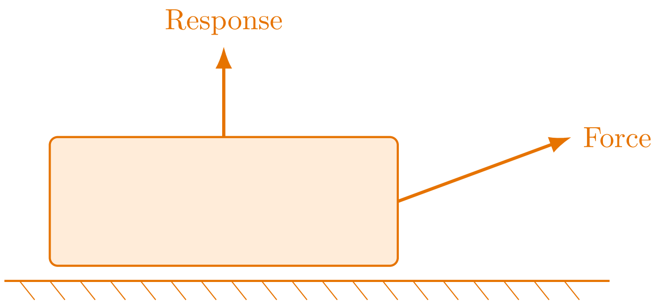
Summit ENGR 210: Statics

Summit fully illustrated textbook edition



Original Summit-authored instructional text generated from the live course runtime, bibliography layer, and assessment structure.

March 22, 2026

@@TOKEN_0@@ Summit first edition draft @@TOKEN_1@@ college @@TOKEN_2@@ 3 @@TOKEN_3@@ 14 weeks @@TOKEN_4@@ 9.6 hours/week

Originality note

This textbook is a Summit-authored instructional text. It is informed by the course bibliography in @@TOKEN_0@@ and by open academic references used elsewhere in Summit, but it does not copy or restate any single commercial textbook.

How this textbook was built

This book was generated from the live Summit course runtime for Statics: the syllabus, lesson sequence, reading chapters, guided practice, homework sets, quizzes, mastery exam, and workload standard. The design goal is to give a student a usable, course-complete book while preserving original Summit wording and sequencing.

An original Summit statics course for engineering students focused on equilibrium, support reactions, trusses, frames, distributed loading, shear and moment, friction, centroids, and structural reasoning.

Mechanics chapters should be driven by structure, load path, constraint, and response. The reader should always know what is being modeled and where the forces or deformations are going.

This volume is structured as a teaching book rather than a bare note pack. Every chapter contains explanation, worked examples, guided practice, chapter homework, and a rear answer key so the student can study independently and still get disciplined feedback.

Course use guide

- Read one chapter at a time in sequence; each chapter is aligned to a live lesson block in the course workspace.
- Rebuild the worked examples before attempting the graded homework or quiz material.
- Keep a scratch notebook beside the text and write down assumptions, diagrams, and the points where you usually get stuck.
- Use the course tutor, guided practice, and homework only after you can explain the chapter in your own words.

Contents

Course map

- 4 live lesson chapters
- 2 graded homework checkpoints
- 2 timed quizzes
- 1 cumulative mastery exam
- 5 declared course outcomes

Prerequisite and readiness position

Course prerequisites: calculus-i, physics-i. Readiness clearances: calc-i-credit, physics-mechanics-ready.

Summit Statics begins after students can already work with vector decomposition, forces, and basic mechanics. The course assumes that Newtonian force models are familiar so the focus can shift to equilibrium and structural load paths.

Semester workload standard

Summit models this course as @@TOKEN_0@@ across a 14-week term plus final assessment window. The expected distribution is:

- Contact-equivalent instruction: 42 hours
- Reading: 16 hours
- Practice and problem solving: 40 hours
- Homework: 22 hours
- Lab, design, and reporting: 0 hours
- Exam preparation: 15 hours

Expected volume:

- 120-150 equilibrium, truss, frame, centroid, and friction problems with disciplined diagram setup.
- 8-10 graded sets totaling 28-38 multistep problems with defended assumptions and notation.
- No standalone lab or design-report block; formal written reasoning is folded into homework, diagrams, and exam review.

Reference basis

Primary synthesis anchors from the bibliography for this course (50 listed references total):

1. Engineering Mechanics: Statics
2. Engineering Mechanics: Dynamics
3. Mechanics of Materials
4. Engineering Mechanics
5. Structural Analysis
6. Engineering Mechanics
7. Engineering Mechanics
8. Engineering Mechanics

Chapter 1

Chapter 1 Particles, rigid bodies, and equilibrium

Chapter purpose

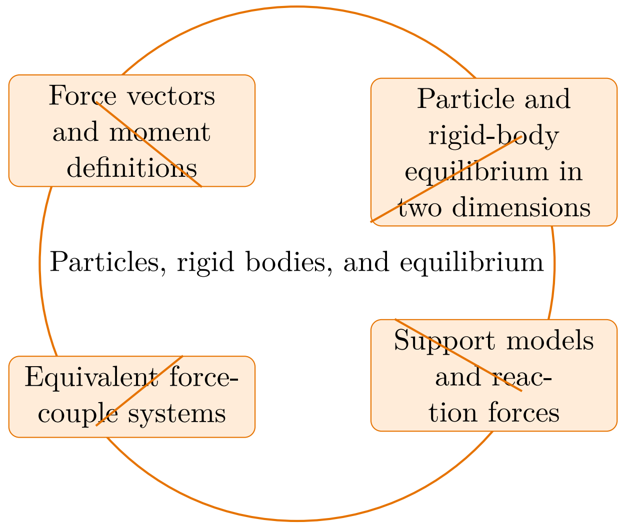
Statics starts with disciplined isolation. Students learn to separate particles from rigid bodies, forces from couples, and geometry from equilibrium. The first test of maturity is whether a free-body diagram is complete before equations appear.

This chapter sits at the opening of Statics. It develops Force vectors and moment definitions, Particle and rigid-body equilibrium in two dimensions, Support models and reaction forces, and Equivalent force-couple systems so that the student can move from explanation to execution without losing the thread of the course.

In this family, the text should be read with a strong visual habit. Free-body diagrams, section cuts, deformation pictures, and compatibility statements are not optional decoration; they are the language of the subject. Every chapter therefore emphasizes the relationship between the drawing and the equation set.

Core ideas

- Force vectors and moment definitions
- Particle and rigid-body equilibrium in two dimensions
- Support models and reaction forces
- Equivalent force-couple systems



How to think through this chapter

The student should begin each problem by isolating the body or member, naming the governing assumptions, and selecting the smallest equation set that still captures the response. Symbolic work matters, but interpretation of support conditions, internal force flow, and design implications matters just as much.

When working this chapter, keep the following question active: @@TOKEN_0@@ A good student answer should connect setup, assumptions, and conclusion instead of only chasing a final number or sentence.

Statics begins with a deceptively simple idea: nothing accelerates. The challenge is that many hidden forces can still be present inside that calm picture.

Equilibrium is a modeling claim

To say a body is in equilibrium is to say the net force and net moment are both zero. That does not mean the body is force-free. It means the forces and moments balance perfectly. Students who remember that distinction stop being surprised by large reactions in systems that are not moving.

This is why statics feels different from physics mechanics. The course is less about predicting motion and more about uncovering hidden balances.

Moments are how structures whisper their load paths

A moment equation often reveals more than a force equation. By taking moments about a carefully chosen point, a student can eliminate unknowns and expose how the loads really travel through the structure.

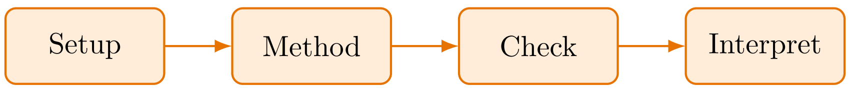
That is not just an algebra trick. It is an engineering reading skill. Good structural analysts ask where the load is trying to rotate the system and what resists that rotation.

Support models matter

A pin, roller, fixed support, or cable does not merely hold the structure in place. Each support model permits some motions and resists others. Reaction forces arise from those constraints.

Many statics mistakes come from using the wrong support model or forgetting a reaction component the support can supply.

Worked example



@@TOKEN_0@@ A simply supported beam 6 m long carries a 12 kN point load 2 m from the left support. Find the support reactions.

1. Call the reactions at the left and right supports Ay and By.
2. Use vertical-force equilibrium: Ay + By = 12.
3. Take moments about the left support: 6By - 12(2) = 0, so By = 4 kN.
4. Then Ay = 12 - 4 = 8 kN.

Read this example twice: once for the flow of ideas and once for the technical structure of the solution.

Worked-through guided example

@@TOKEN_0@@ A 4 m beam carries a 16 kN point load 1 m from the left support. Find the right reaction.

1. Write M_left = 0.
2. Set 4By - 16(1) = 0.
3. Solve for By.

From 4By = 16, the right reaction is 4 kN.

Instructor commentary

Students should annotate this chapter for structure, not just facts. Mark where the argument changes direction, where the method requires a hidden assumption, and where the conclusion becomes more general than the worked example. If the chapter feels easy while you are reading it but difficult when you close the page, you have not yet converted recognition into mastery.

The recommended pattern is draw first, label second, solve third, and explain last. Repetition should focus on varied diagrams rather than on memorizing one template.

Practice while you read

Practice Set: Equilibrium and reactions

Strengthen free-body diagrams, support reactions, and moment equations.

@@TOKEN_0@@ A 4 m beam carries a 16 kN point load 1 m from the left support. Find the right reaction.

- Hint: A moment equation about the left support removes the left reaction immediately.
- Step 1: Write M_left = 0.
- Step 2: Set 4By - 16(1) = 0.
- Step 3: Solve for By.
- Checkpoint: Right reaction = 4 kN

@@TOKEN_0@@ A 10 kN force acts 3 m from a point. What is the moment magnitude about that point if the force is perpendicular to the lever arm?

- Hint: Use the basic scalar moment relation when the force is perpendicular.
- Step 1: Write M = Fd.
- Step 2: Substitute F = 10 kN and d = 3 m.
- Step 3: Keep the kNům units.
- Checkpoint: Moment = 30 kNům

Chapter homework

@@TOKEN_0@@ Support reactions, free-body diagrams, concurrent-force systems, and basic truss or frame reasoning.

1. A 5 m simply supported beam carries an 18 kN point load located 1.5 m from the left support. Find both reactions.

2. A bracket is held by a horizontal pin reaction and a cable at 30 degrees above horizontal. If the bracket supports a 9 kN vertical load, find the cable tension and pin reaction components.
3. A pin joint is connected to two identical members at 60 degrees to the horizontal and supports a 12 kN downward load. Find the axial force in each member.
4. Reduce a uniform 4 kN/m load acting over 3 m of beam length to a single resultant and location.

Answers for these homework problems appear in the back-of-book answer key.

Chapter summary and study notes

- Include all external forces and reactions in a free-body diagram.
- Take moments about points chosen for strategic simplification.
- Use a consistent sign convention throughout an equilibrium solution.

Study tips

- Write the support model before writing the reaction unknowns.
- Choose moment points strategically, not randomly.
- Treat the free-body diagram as the real start of the solution.

Common traps

- Leaving out a reaction component from the support model.
- Using inconsistent sign conventions for moments.
- Forgetting that equilibrium requires zero net moment as well as zero net force.

Family-level errors to watch for

- Skipping or under-labeling the diagram that controls the problem.
- Mixing sign conventions or coordinate assumptions across solution steps.
- Reporting a number without interpreting what it says about force, stress, or stability.

Chapter 2

Chapter 2 Trusses, frames, and internal force paths

Chapter purpose

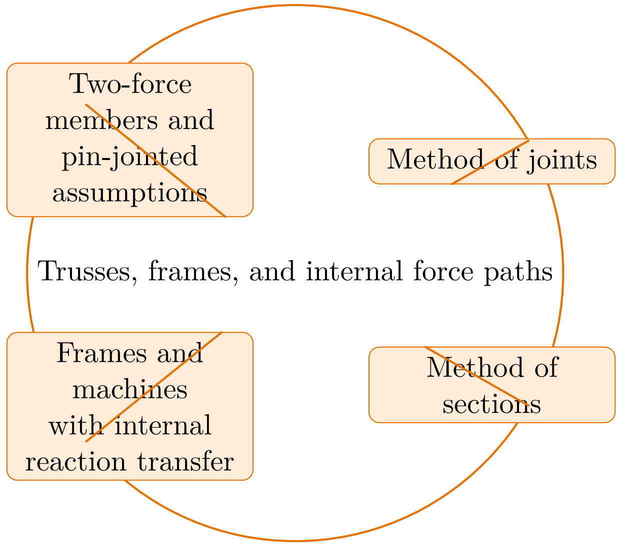
Students move from single-body equilibrium to connected systems. The lesson emphasizes method of joints, method of sections, and the difference between two-force members and general frame members. Load path becomes a central idea.

This chapter sits in the middle of Statics. It develops Two-force members and pin-jointed assumptions, Method of joints, Method of sections, and Frames and machines with internal reaction transfer so that the student can move from explanation to execution without losing the thread of the course.

In this family, the text should be read with a strong visual habit. Free-body diagrams, section cuts, deformation pictures, and compatibility statements are not optional decoration; they are the language of the subject. Every chapter therefore emphasizes the relationship between the drawing and the equation set.

Core ideas

- Two-force members and pin-jointed assumptions
- Method of joints
- Method of sections
- Frames and machines with internal reaction transfer



How to think through this chapter

The student should begin each problem by isolating the body or member, naming the governing assumptions, and selecting the smallest equation set that still captures the response. Symbolic work matters, but interpretation of support conditions, internal force flow, and design implications matters just as much.

When working this chapter, keep the following question active: @@TOKEN_0@@ A good student answer should connect setup, assumptions, and conclusion instead of only chasing a final number or sentence.

Connected structures force students to think about equilibrium locally and globally at the same time.

Trusses carry load through member direction

In an ideal truss, the members transmit load primarily through axial forces. That means the geometry of the structure matters enormously. A small change in angle can change how much force a member must carry in order to support the same external load.

This is one reason truss analysis teaches more than a solving technique. It teaches students to see geometry as part of structural logic.

Tension and compression are physical statements

A positive number is not enough. Students should be able to say whether a member is in tension or compression and what that means physically. Tension pulls. Compression pushes. The sign convention is useful only if it ultimately returns to this physical story.

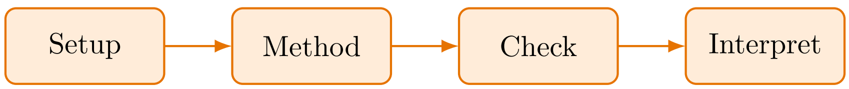
That habit becomes more important later when material failure modes depend strongly on the type of internal force.

Sections are a strategic shortcut

Method of sections rewards planning. Instead of solving the entire structure, the student cuts through exactly the members of interest and writes equilibrium for one side. It is a tactical decision that saves time when used well.

The trick is not cutting anywhere. The trick is cutting somewhere intelligent.

Worked example



@@TOKEN_0@@ At a pin joint, a 6 kN downward load is resisted by two symmetric members each making a 45 degree angle with the horizontal. Find the force in each member.

1. Symmetry implies the axial forces in the two members are equal.
2. Resolve the vertical components: 2F sin 45ř = 6 kN.
3. Solve F = 6 / (2 sin 45ř) 4.24 kN.
4. Because the members push upward on the joint, each member is in compression.

Read this example twice: once for the flow of ideas and once for the technical structure of the solution.

Worked-through guided example

@@TOKEN_0@@ A pin joint supports a 10 kN downward load with two identical members at 45 degrees to the horizontal. Find the force in each member.

1. Let each member force be F.
2. Write 2F sin 45ř = 10.
3. Solve for F.

F = 10 / (2 sin 45ř) 7.07 kN.

Instructor commentary

Students should annotate this chapter for structure, not just facts. Mark where the argument changes direction, where the method requires a hidden assumption, and where the conclusion becomes more general than the worked example. If the chapter feels easy while you are reading it but difficult when you close the page, you have not yet converted recognition into mastery.

The recommended pattern is draw first, label second, solve third, and explain last. Repetition should focus on varied diagrams rather than on memorizing one template.

Practice while you read

Practice Set: Trusses and member forces

Practice symmetry, method-of-joints thinking, and tension/compression labeling.

@@TOKEN_0@@ A pin joint supports a 10 kN downward load with two identical members at 45 degrees to the horizontal. Find the force in each member.

- Hint: The members share the vertical support job equally through their vertical components.
- Step 1: Let each member force be F.
- Step 2: Write 2F sin 45ř = 10.
- Step 3: Solve for F.
- Checkpoint: Each member force 7.07 kN

@@TOKEN_0@@ Why is a classic two-force member idealized as carrying only axial force?

- Hint: Think about where the forces act and what must be true for equilibrium with only two external forces.
- Step 1: Note that the member has only two external forces applied at its ends.
- Step 2: For equilibrium, those forces must be equal, opposite, and collinear.
- Step 3: Conclude what kind of internal response remains.
- Checkpoint: Only axial tension or compression remains

Chapter homework

@@TOKEN_0@@ Support reactions, free-body diagrams, concurrent-force systems, and basic truss or frame reasoning.

1. A 5 m simply supported beam carries an 18 kN point load located 1.5 m from the left support. Find both reactions.

2. A bracket is held by a horizontal pin reaction and a cable at 30 degrees above horizontal. If the bracket supports a 9 kN vertical load, find the cable tension and pin reaction components.
3. A pin joint is connected to two identical members at 60 degrees to the horizontal and supports a 12 kN downward load. Find the axial force in each member.
4. Reduce a uniform 4 kN/m load acting over 3 m of beam length to a single resultant and location.

Answers for these homework problems appear in the back-of-book answer key.

Chapter summary and study notes

- Identify when a member is in tension or compression from the force direction at a joint.
- Choose a section cut that exposes the needed unknowns without overcomplicating the algebra.
- Track action-reaction force pairs correctly across connected members.

Study tips

- Use symmetry whenever the structure and loading justify it.
- Always translate member-force signs back into tension or compression language.
- For sections, aim to expose only as many unknowns as the equilibrium equations can handle efficiently.

Common traps

- Losing track of action-reaction pairs between connected members.
- Calling a member force positive without interpreting tension or compression.
- Choosing a section cut that introduces too many unknowns at once.

Family-level errors to watch for

- Skipping or under-labeling the diagram that controls the problem.
- Mixing sign conventions or coordinate assumptions across solution steps.
- Reporting a number without interpreting what it says about force, stress, or stability.

Chapter 3

Chapter 3 Distributed loads, shear, and bending moment

Chapter purpose

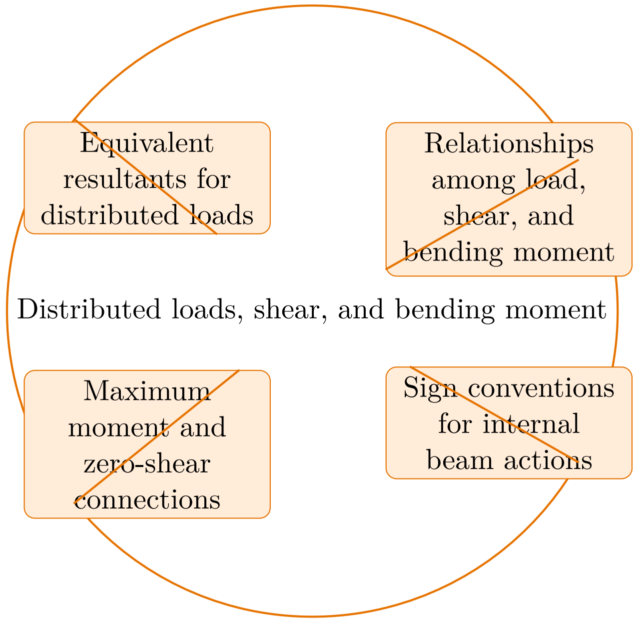
This lesson turns beam loading into internal actions. Students reduce distributed loads to resultants, build shear and moment diagrams, and learn to read those diagrams as structural narratives rather than detached graphs.

This chapter sits in the middle of Statics. It develops Equivalent resultants for distributed loads, Relationships among load, shear, and bending moment, Sign conventions for internal beam actions, and Maximum moment and zero-shear connections so that the student can move from explanation to execution without losing the thread of the course.

In this family, the text should be read with a strong visual habit. Free-body diagrams, section cuts, deformation pictures, and compatibility statements are not optional decoration; they are the language of the subject. Every chapter therefore emphasizes the relationship between the drawing and the equation set.

Core ideas

- Equivalent resultants for distributed loads
- Relationships among load, shear, and bending moment
- Sign conventions for internal beam actions
- Maximum moment and zero-shear connections



How to think through this chapter

The student should begin each problem by isolating the body or member, naming the governing assumptions, and selecting the smallest equation set that still captures the response. Symbolic work matters, but interpretation of support conditions, internal force flow, and design implications matters just as much.

When working this chapter, keep the following question active: @@TOKEN_0@@ A good student answer should connect setup, assumptions, and conclusion instead of only chasing a final number or sentence.

Beam diagrams can look like a separate art form, but they are really equilibrium and calculus living side by side.

Distributed load to resultant is the first compression step

A distributed load is often easier to reason about after it has been compressed into an equivalent resultant with a line of action at the load centroid. This does not erase the distributed nature of the load forever. It simply makes the global equilibrium stage cleaner.

Students should treat this as a legitimate change of representation, not a shortcut that loses meaning.

Shear and moment diagrams are structural narratives

A shear diagram tells how the internal transverse force changes along the beam. A bending-moment diagram tells how the beams internal bending response accumulates from that shear. Seen this way, the diagrams are not arbitrary graphs. They are a running account of what the beam feels internally.

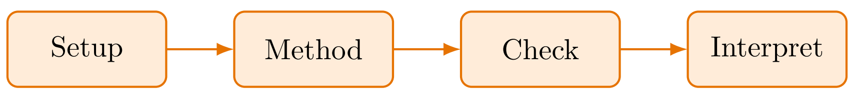
Once students adopt that viewpoint, rules about slope changes and jumps stop feeling mysterious.

Maximum moment is usually a story about zero shear

Because the derivative of bending moment is shear, the bending moment reaches an extremum where the shear crosses zero. This is a perfect example of mathematics serving engineering interpretation directly.

Students who connect those two diagrams conceptually work faster and make fewer sign errors.

Worked example



@@TOKEN_0@@ A simply supported 4 m beam carries a uniform load of 5 kN/m over the full span. Find the reactions and the maximum bending moment.

1. Replace the distributed load with its resultant: 20 kN acting at midspan.
2. By symmetry, each support reaction is 10 kN upward.
3. The shear crosses zero at midspan, where the bending moment is maximum.
4. The maximum moment is wL^2/8 = 5(4^2)/8 = 10 kNům.

Read this example twice: once for the flow of ideas and once for the technical structure of the solution.

Worked-through guided example

@@TOKEN_0@@ Replace a uniform load of 3 kN/m over 4 m with a single resultant and location.

1. Compute the resultant magnitude as intensity times length.
2. Locate the centroid at the midpoint of the loaded region.
3. State the equivalent force and its line of action.

The equivalent resultant is 3 Œ 4 = 12 kN acting at the midpoint of the uniformly loaded 4 m span.

Instructor commentary

Students should annotate this chapter for structure, not just facts. Mark where the argument changes direction, where the method requires a hidden assumption, and where the conclusion becomes more general than the worked example. If the chapter feels easy while you are reading it but difficult when you close the page, you have not yet converted recognition into mastery.

The recommended pattern is draw first, label second, solve third, and explain last. Repetition should focus on varied diagrams rather than on memorizing one template.

Practice while you read

Practice Set: Distributed loads and beam diagrams

Move from loading to resultants to shear and bending-moment interpretation.

@@TOKEN_0@@ Replace a uniform load of 3 kN/m over 4 m with a single resultant and location.

- Hint: A uniform rectangular load acts through its centroid.
- Step 1: Compute the resultant magnitude as intensity times length.
- Step 2: Locate the centroid at the midpoint of the loaded region.
- Step 3: State the equivalent force and its line of action.
- Checkpoint: Resultant = 12 kN at the midpoint of the 4 m region

@@TOKEN_0@@ A beam segment has positive shear of 6 kN over the next small interval. What does that imply about the slope of the bending-moment diagram there?

- Hint: Remember the derivative relationship between bending moment and shear.
- Step 1: Recall that dM/dx = V.
- Step 2: Substitute the sign of the shear.
- Step 3: Translate that sign into diagram behavior.
- Checkpoint: The bending-moment diagram has positive slope

Chapter homework

@@TOKEN_0@@ Internal beam actions, friction thresholds, composite-area centroids, and model-based statics interpretation.

1. A simply supported beam of span 8 m carries a uniform load of 6 kN/m over the full span. Find the reactions and the maximum bending moment.
2. A 25 kg toolbox rests on a truck bed with coefficient of static friction 0.40. What is the maximum horizontal acceleration of the truck before the toolbox slips?
3. Find the x-coordinate of the centroid of a composite area made from a 6 m by 2 m rectangle with a 2 m by 2 m square removed from the far right side.
4. A beam section has positive shear just to the left of a point load. Describe what happens to the shear and moment diagrams as you cross the point load.

Answers for these homework problems appear in the back-of-book answer key.

Chapter summary and study notes

- Replace a distributed load with the correct magnitude and line of action.
- Move from loading diagram to shear diagram to moment diagram without mixing sign conventions.
- Explain what changes in slope and curvature mean physically in the diagrams.

Study tips

- Reduce the distributed load correctly before solving reactions.
- Carry one sign convention all the way from load to shear to moment.
- Use the relationship $dM/dx = V$ as a check on your diagram shapes.

Common traps

- Placing the distributed-load resultant at the wrong location.
- Drawing jumps in moment where only shear should jump.
- Treating the diagrams as memorized shapes instead of consequences of equilibrium.

Family-level errors to watch for

- Skipping or under-labeling the diagram that controls the problem.
- Mixing sign conventions or coordinate assumptions across solution steps.
- Reporting a number without interpreting what it says about force, stress, or stability.

Chapter 4

Chapter 4 Friction, centroids, and applied statics judgment

Chapter purpose

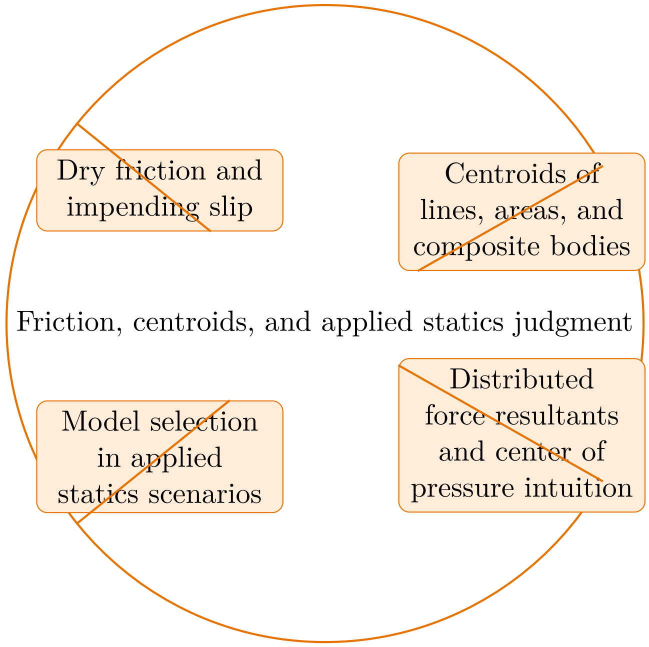
The closing lesson broadens the statics toolset. Students analyze impending motion with friction, compute centroids and distributed-resultant locations, and practice choosing the right model for a practical engineering setup.

This chapter sits at the end of Statics. It develops Dry friction and impending slip, Centroids of lines, areas, and composite bodies, Distributed force resultants and center of pressure intuition, and Model selection in applied statics scenarios so that the student can move from explanation to execution without losing the thread of the course.

In this family, the text should be read with a strong visual habit. Free-body diagrams, section cuts, deformation pictures, and compatibility statements are not optional decoration; they are the language of the subject. Every chapter therefore emphasizes the relationship between the drawing and the equation set.

Core ideas

- Dry friction and impending slip
- Centroids of lines, areas, and composite bodies
- Distributed force resultants and center of pressure intuition
- Model selection in applied statics scenarios



How to think through this chapter

The student should begin each problem by isolating the body or member, naming the governing assumptions, and selecting the smallest equation set that still captures the response. Symbolic work matters, but interpretation of support conditions, internal force flow, and design implications matters just as much.

When working this chapter, keep the following question active: @@TOKEN_0@@ A good student answer should connect setup, assumptions, and conclusion instead of only chasing a final number or sentence.

The last statics lesson teaches restraint. Not every contact is slipping, and not every area centroid can be guessed by eye.

Impending motion is a boundary condition

Static friction is not always equal to sN. It rises only as high as needed, up to a maximum of sN. When a problem says motion is about to start, the model is at that threshold. That is why impending-motion problems feel special: they pin the friction at its maximum allowed value.

Students who remember this avoid one of the most common statics mistakes in the course.

Centroids reward bookkeeping

Centroid problems look visual, but they are solved reliably through organized bookkeeping. Break the shape into pieces, assign areas and centroid locations, and then build the weighted average.

The method is dull in the best possible way: it protects accuracy.

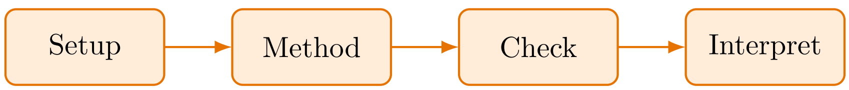
This kind of patient structure is part of engineering maturity. Not every problem should be attacked with cleverness first.

Applied statics is about choosing the right idealization

Real surfaces deform, friction changes, and loads spread through materials. The statics course teaches idealized models that are still powerful when chosen carefully. The key is knowing what the model is assuming and when those assumptions are acceptable.

That habit of model awareness matters later in structural design and mechanical analysis.

Worked example



@@TOKEN_0@@ A 40 kg crate is pushed on a horizontal floor. If the coefficient of static friction is 0.35, what horizontal force is required to start motion?

1. On a horizontal floor, the normal force is N = mg = 40(9.8) = 392 N.
2. The maximum static friction is Fs,max = sN = 0.35(392) = 137.2 N.
3. Impending motion begins when the applied force reaches that threshold.
4. So the minimum force required is approximately 137 N.

Read this example twice: once for the flow of ideas and once for the technical structure of the solution.

Worked-through guided example

@@TOKEN_0@@ A 20 kg box rests on a horizontal surface with s = 0.25. Find the maximum static-friction force.

1. Compute N = mg.
2. Use Fs,max = sN.
3. Evaluate numerically with g = 9.8 m/s^2.

N = 20(9.8) = 196 N, so Fs,max = 0.25(196) = 49 N.

Instructor commentary

Students should annotate this chapter for structure, not just facts. Mark where the argument changes direction, where the method requires a hidden assumption, and where the conclusion becomes more general than the worked example. If the chapter feels easy while you are reading it but difficult when you close the page, you have not yet converted recognition into mastery.

The recommended pattern is draw first, label second, solve third, and explain last. Repetition should focus on varied diagrams rather than on memorizing one template.

Practice while you read

Practice Set: Friction and centroids

Reinforce threshold models for impending motion and systematic centroid work.

@@TOKEN_0@@ A 20 kg box rests on a horizontal surface with s = 0.25. Find the maximum static-friction force.

- Hint: Start with the normal force, then multiply by the coefficient of static friction.
- Step 1: Compute N = mg.
- Step 2: Use Fs,max = sN.
- Step 3: Evaluate numerically with g = 9.8 m/s^2.
- Checkpoint: Maximum static friction = 49 N

@@TOKEN_0@@ Find the x-coordinate of the centroid of a 4 m by 2 m rectangle measured from the left edge.

- Hint: For a rectangle, the centroid is at the geometric center.
- Step 1: Identify the width in the x-direction.
- Step 2: Take half of that width.
- Step 3: State the coordinate from the left edge.
- Checkpoint: x = 2 m

Chapter homework

@@TOKEN_0@@ Internal beam actions, friction thresholds, composite-area centroids, and model-based statics interpretation.

1. A simply supported beam of span 8 m carries a uniform load of 6 kN/m over the full span. Find the reactions and the maximum bending moment.

2. A 25 kg toolbox rests on a truck bed with coefficient of static friction 0.40. What is the maximum horizontal acceleration of the truck before the toolbox slips?
3. Find the x-coordinate of the centroid of a composite area made from a 6 m by 2 m rectangle with a 2 m by 2 m square removed from the far right side.
4. A beam section has positive shear just to the left of a point load. Describe what happens to the shear and moment diagrams as you cross the point load.

Answers for these homework problems appear in the back-of-book answer key.

Chapter summary and study notes

- Separate actual friction from maximum available friction.
- Build composite-area centroids systematically rather than by visual guesswork.
- Explain what centroid location means for load transfer or stability.

Study tips

- Do not set friction equal to sN unless the problem is at the threshold of slip or asks for the maximum.
- Use negative area for holes in centroid calculations.
- State the modeling assumption when turning a physical contact problem into a statics idealization.

Common traps

- Assuming static friction is always at its maximum value.
- Guessing centroids by symmetry when the shape is not symmetric.
- Forgetting that model assumptions are part of the engineering answer.

Family-level errors to watch for

- Skipping or under-labeling the diagram that controls the problem.
- Mixing sign conventions or coordinate assumptions across solution steps.
- Reporting a number without interpreting what it says about force, stress, or stability.

Chapter 5

Quiz review and official exam preparation

Homework structure

- Homework Set 1: Reactions, moments, and joint equilibrium: 4 graded problems attached to chapter 1.
- Homework Set 2: Shear, moment, friction, and centroids: 4 graded problems attached to chapter 2.

Quiz structure

- Quiz 1: Equilibrium and support reactions: 3 questions, timed, and single-attempt in the live course. Quiz 1 should be taken only after you can solve the chapter homework without outside prompts.
- Quiz 2: Internal forces, friction, and centroids: 3 questions, timed, and single-attempt in the live course. Quiz 2 should be taken only after you can solve the chapter homework without outside prompts.

Official mastery exam

- Statics mastery exam: 5 major questions, Engineering standard, cumulative, and diagram driven rigor, first official attempt locks the course grade.

Statics mastery exam preparation checklist

- Redraw every beam, bracket, and joint problem with clean support models and sign conventions.
- Practice choosing moment points strategically before writing equations.

- Rebuild the relationship among distributed load, shear, and moment without relying on memory alone.
- Review friction and centroid formulas only after you can explain what each quantity means physically.

How to use this book before assessment

- Read the relevant chapter and rebuild both worked examples without looking.
- Solve the guided practice in the chapter before attempting the graded homework.
- Check your chapter-homework answers only after you complete a full written attempt.
- Review the quiz answer key after each chapter block and classify your errors by concept, setup, algebra, or interpretation.
- Before the official exam, revisit the chapter purposes, homework corrections, and answer-key notes rather than rereading formulas only.

Chapter 6

Course vocabulary index

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Chapter 7

Back-of-book answers and solution outlines

Guided practice answer key

Chapter 1: Particles, rigid bodies, and equilibrium

@@TOKEN_0@@

1. A 4 m beam carries a 16 kN point load 1 m from the left support. Find the right reaction.

- Checkpoint answer: Right reaction = 4 kN - Solution note: From 4By = 16, the right reaction is 4 kN.

1. A 10 kN force acts 3 m from a point. What is the moment magnitude about that point if the force is perpendicular to the lever arm?

- Checkpoint answer: Moment = 30 kNům - Solution note: The moment magnitude is 10 Œ 3 = 30 kNům.

Chapter 2: Trusses, frames, and internal force paths

@@TOKEN_0@@

1. A pin joint supports a 10 kN downward load with two identical members at 45 degrees to the horizontal. Find the force in each member.

- Checkpoint answer: Each member force 7.07 kN - Solution note: F = 10 / (2 sin 45ř) 7.07 kN.

1. Why is a classic two-force member idealized as carrying only axial force?

- Checkpoint answer: Only axial tension or compression remains - Solution note: With only two end forces, equilibrium requires the forces to be collinear, so the member carries only axial tension or compression in the ideal model.

Chapter 3: Distributed loads, shear, and bending moment

@@TOKEN_0@@

1. Replace a uniform load of 3 kN/m over 4 m with a single resultant and location.

- Checkpoint answer: Resultant = 12 kN at the midpoint of the 4 m region - Solution note: The equivalent resultant is 3 Œ 4 = 12 kN acting at the midpoint of the uniformly loaded 4 m span.

1. A beam segment has positive shear of 6 kN over the next small interval. What does that imply about the slope of the bending-moment diagram there?

- Checkpoint answer: The bending-moment diagram has positive slope - Solution note: Since dM/dx = V and V is positive, the moment diagram is increasing over that interval.

Chapter 4: Friction, centroids, and applied statics judgment

@@TOKEN_0@@

1. A 20 kg box rests on a horizontal surface with s = 0.25. Find the maximum static-friction force.

- Checkpoint answer: Maximum static friction = 49 N - Solution note: N = 20(9.8) = 196 N, so Fs,max = 0.25(196) = 49 N.

1. Find the x-coordinate of the centroid of a 4 m by 2 m rectangle measured from the left edge.

- Checkpoint answer: x = 2 m - Solution note: The centroid of a rectangle lies at mid-width, so x = 4 / 2 = 2 m.

Homework answer key

Homework Set 1: Reactions, moments, and joint equilibrium

1. A 5 m simply supported beam carries an 18 kN point load located 1.5 m from the left support. Find both reactions.

- Answer / solution summary: Taking moments about the left support gives 5By = 18(1.5), so By = 5.4 kN. Then Ay = 18 - 5.4 = 12.6 kN.

1. A bracket is held by a horizontal pin reaction and a cable at 30 degrees above horizontal. If the bracket supports a 9 kN vertical load, find the cable tension and pin reaction components.

- Answer / solution summary: Vertical equilibrium gives T sin 30ř = 9, so T = 18 kN. Horizontal equilibrium then gives the pin reaction magnitude in x as 18 cos 30ř 15.6 kN opposite the cable pull.

1. A pin joint is connected to two identical members at 60 degrees to the horizontal and supports a 12 kN downward load. Find the axial force in each member.

- Answer / solution summary: 2F sin 60ř = 12, so F = 12 / (2 sin 60ř) 6.93 kN. Each member is in compression if it pushes upward on the joint.

1. Reduce a uniform 4 kN/m load acting over 3 m of beam length to a single resultant and location.

- Answer / solution summary: The resultant magnitude is 12 kN, located at the midpoint of the 3 m loaded region, 1.5 m from either end of that region.

Homework Set 2: Shear, moment, friction, and centroids

1. A simply supported beam of span 8 m carries a uniform load of 6 kN/m over the full span. Find the reactions and the maximum bending moment.

- Answer / solution summary: The total load is 48 kN, so each reaction is 24 kN. The maximum bending moment is wL^2/8 = 6(64)/8 = 48 kNům.

1. A 25 kg toolbox rests on a truck bed with coefficient of static friction 0.40. What is the maximum horizontal acceleration of the truck before the toolbox slips?

- Answer / solution summary: Maximum friction is sN = 0.40mg. Setting ma = 0.40mg gives a = 0.40g 3.92 m/s^2.

1. Find the x-coordinate of the centroid of a composite area made from a 6 m by 2 m rectangle with a 2 m by 2 m square removed from the far right side.

- Answer / solution summary: The full rectangle area is 12 with centroid at x = 3. The removed square area is 4 with centroid at x = 5. The composite centroid is (12ů3 - 4ů5)/(12 - 4) = 2 m from the left edge.

1. A beam section has positive shear just to the left of a point load. Describe what happens to the shear and moment diagrams as you cross the point load.

- Answer / solution summary: The shear diagram jumps downward by the magnitude of the point load. The bending-moment diagram stays continuous, but its slope changes because slope equals shear.

Quiz answer key

Quiz 1: Equilibrium and support reactions

1. For a rigid body in planar equilibrium, which set of equations must be satisfied?

- Answer key: Fx = 0, Fy = 0, and M = 0. Planar rigid-body equilibrium requires zero net force in x and y and zero net moment.

1. A 10 kN downward point load acts at the center of a simply supported beam. What is each support reaction?

- Answer key: Accepted answer(s): 5, 5.0, 5 kn, 5kN. By symmetry, the reactions are equal and must sum to 10 kN, so each is 5 kN.

1. A two-force member can carry which kind of internal force in the ideal model?

- Answer key: Only axial tension or compression. An ideal two-force member carries only axial force, either tension or compression.

Quiz 2: Internal forces, friction, and centroids

1. A uniform distributed load is replaced by a single resultant acting at:

- Answer key: The centroid of the load distribution. The equivalent resultant acts at the centroid of the load distribution.

1. If s = 0.30 for a block on a horizontal surface, what is the maximum static-friction force as a multiple of the normal force N?

- Answer key: Accepted answer(s): 0.3n, 0.30n, 0.3 n, 0.30 n. Maximum static friction is Fs,max = sN = 0.30N.

1. Where does the maximum bending moment occur on a beam segment carrying smooth distributed load?

- Answer key: Where shear equals zero. Because dM/dx = V, the bending moment is extremized where the shear crosses zero.

Mastery exam solution outlines

Statics mastery exam

1. Solve a multi-step support-reaction problem from a complete rigid-body free-body diagram.

- What to show: Correct reactions and equilibrium equations; A consistent sign convention - Solution outline: Review the full course methods and connect setup to interpretation.

1. Determine unknown member force or load path information in a connected structural system.

- What to show: Joint or section isolation; A defensible tension or compression conclusion - Solution outline: Review the full course methods and connect setup to interpretation.

1. Reduce distributed loading and determine an internal shear or moment result.

- What to show: Equivalent resultant; Correct internal-force logic - Solution outline: Review the full course methods and connect setup to interpretation.

1. Solve a friction or centroid problem where model choice matters.

- What to show: A correct limiting model; Interpretation of the computed threshold or location - Solution outline: Review the full course methods and connect setup to interpretation.

1. Synthesize equilibrium, geometry, and load transfer in a cumulative statics scenario.

- What to show: Method choice and load path explanation; A complete solution - Solution outline: Review the full course methods and connect setup to interpretation.

Reference note

For the full bibliography behind this textbook, use @@TOKEN_0@@. The answer key in this book is Summit-authored and aligned to the live course runtime.