



# Board/Authority Authorised Course Civil Engineering – Introduction to Structural Analysis - Statics

School District/Independent School Authority Name	Kamloops/Thompson
School District/Independent School Authority Number	#73
Developed by	Briar Beers
Date Developed	December 2013
School Name	NorKam Secondary School
Principal's Name (District)	Sheryl Lindquist
Superintendent Approval Date (for School Districts only)	
Superintendent Signature (for School Districts only)	
Board/Authority Approval Date	
Board/Authority Chair Signature	
Course Name	Civil Engineering – Introduction to Structural Analysis - Statics
Grade Level of Course	11 and 12
Number of Course Credits	4
Number of Hours of Instruction	120
Prerequisite(s)	Completion of Grade 10

## Synopsis

This course has been developed to support and provide students with an opportunity to explore the basic concepts that would be studied and used in practice by students and graduates of the Civil Engineering Technology and Civil Engineering Degree programs. The sampler is used to allow students to understand what these programs will be like, what type of work is available in these professions. In the



Introduction to Structural Analysis – Statics course, the students will develop some techniques that will give them some base knowledge of topics they will expand on in both the degree and diploma program. This course touches on the basics of Statics and allows the students to see what they would be more exposed to in these programs. By taking this course, the students will be more prepared for post-secondary education in these fields.

## Rationale

This course will:

1. Provide students with a review of some fundamental math skills as a base for statics.
2. Provide students with a good understanding of vectors so that they can continue to learn and understand the principals of statics.
3. Provide students with an overview of the three basic equilibrium equations in two-dimensional statics, as that is a fundamental building block for all statics.
4. Provide students with knowledge of how this is applicable to structural design and analysis so that the information they are learning is relevant and practical.

Unit/Topic	Title	Time
Unit 1	Introduction to Statics/Review	10 hours
Unit 2	Vectors – The Basics in Statics	20 hours
Unit 3	Vectors – Forces and Moments	30 hours
Unit 4	Free Body Diagrams (FBD)	15 hours
Unit 5	Equilibrium	15 hours
Unit 6	Analyzing Trusses	15 hours
	Total Hours	120

## Unit 1 – Introduction to Statics/Review

**Objective:** The first unit is designed to be a refresher for most in basic physics and math skills that will create a base for learning statics.

### Prescribed Learning Outcomes

At the completion of this unit, students should be able to:

- Understand and state the differences between accuracy and significance
- Use and understand scientific notation



- Understand and demonstrate basic algebra, such as rearranging and solving for a variable, slopes of lines, and sigma notation
- Understand and demonstrate trigonometry, including finding angles in polygons, Pythagorean theorem, SOH CAH TOA
- Understand and recognize common statics units and abbreviations

## Unit 2 – Vectors – The Basics in Statics

**Objective:** This unit will provide students with the general principals of vectors, how to complete mathematical computations with vectors, and how to turn multiple vectors into one vector and how to turn one vector into multiple vectors. Vectors are the foundation of statics and structural analysis.

### Prescribed Learning Outcomes

At the completion of this course, students should be able to:

- Define a vector and understand the difference between a vector and a scalar
- Draw vectors
- Use the Cartesian coordinate system to draw and locate vectors
- Understand and define:
  - Axis
  - Coordinate
  - Origin
  - Scale
- Create a position vector
- Calculate magnitude of position vector
- Perform vector addition and subtraction
- Construct resulting vectors graphically
- Use vectors to calculate resultant vectors
- Break down vectors into x and y components

## Unit 3 – Vectors – Forces and Moment

**Objective:** This unit will give students an understanding of forces acting on rigid bodies including external and internal forces. They will begin to analyze how forces affect rigid bodies.

### Prescribed Learning Outcomes

At the completion of this unit the students will be able to:

- Define and understand the following;
  - Internal Forces
  - External Forces
  - Concentrated Forces
  - Normal Forces
  - Friction
  - Moments
  - Support Reactions



- Be able to state the difference between internal and external forces
- Understand and explain:
  - Internal axial loads
  - Internal shear loads
  - Internal moments
- Be able to define and account for self weight into analysis, including:
  - Gravity
  - Mass
- Calculate mass using density and volume
- Define distributed load and understand its properties
- Define and understand the difference between uniformly distributed loads and linearly distributed loads
- Calculate resultant forces from distributed loads (uniformly and linearly distributed)
- Calculate the location of the resultant force (rectangles and triangles)
- Understanding moments, including the difference in:
  - Torque moments
  - Bending moments
- Understanding the Right Hand Rule for moments

#### **Unit 4 –Free Body Diagrams (FBD)**

**Objective:** In this unit, students will learn how to set up Free Body Diagrams (FBD), which allow them to include all internal, external, and self-weight forces and loads to help solve statics problems.

#### **Prescribed Learning Outcomes**

At the end of this unit, students will be able to:

- Understand what a free body diagram is
- How to show all forces on the diagram including:
  - External forces
  - Internal forces
  - Support reactions
  - Self-weight
- Be able to show the three basic requirements of a force on the FBD:
  - Magnitude
  - Sense
  - Point of Application (location)
- Understand and be able to identify the forces on the three most common support reactions:
  - Roller supports
  - External pinned support
  - Fixed support
- Set up the complete FBD so that it is ready to solve
- Learn how to isolate a section of the diagram



## Unit 5 – Equilibrium

**Objective:** In this unit, students will learn the equilibrium equations so that they are able to solve for unknown forces. Equilibrium is one of the single most important concepts in statics.

### Prescribed Learning Outcomes

In this unit, the students will be able to:

- Define the term “equilibrium” as it relates to statics
- Define and understand motion in terms of:
  - Translation
  - Rotation
- Review and understand Newton’s three laws and use Newton’s Third Law to show how it relates to drawing FBD.
- Understand the three equilibrium equations for a 2-Dimensional system:
  - $\Sigma F_x=0$
  - $\Sigma F_y=0$
  - $\Sigma M_z=0$
- Understand and complete the three steps to solving a 2-Dimensional scalar problem:
  - Draw FBD
  - Write equations of equilibrium – calculate as many external support reaction forces as possible
  - Calculate any necessary internal forces
- Understand the best place to take moment calculations

## Unit 6 – Analyzing Trusses

**Objective:** In this unit, students will take everything they have been learning in the course to learn how to analyze trusses. They will learn to use two types of analysis; method of joints and method of sections. They will also be able to identify zero force members.

### Prescribed Learning Outcomes

At the completion of this unit, students will be able to:

- Define and understand the following
  - Truss
  - Internal truss forces
  - End connections
  - Load locations
- Identify a truss
- Solve trusses using the Method of Joints by isolating and drawing FBD for each joint
- Understand the drawbacks from Method of Joints
- Solve trusses using the Method of Sections and learn the following rules:
  - Cut the member that your interested in
  - Cut the truss into two parts



- Cut a maximum of three members
- Locate Zero-Force Members

### Instructional Component

- Direct instruction
- Indirect instruction
- Interactive instruction
- Modeling
- Group work

### Assessment Component

Each unit will have components of assignments/projects, quizzes, and tests. The grading will be based on the following percentages per unit:

Unit	Title	Assessment Components	Percentage
Unit 1	<b>INTRODUCTION TO STATICS/REVIEW</b>	<ul style="list-style-type: none"> <li>● Quizzes</li> <li>● Assignments</li> <li>● Unit Test</li> </ul>	10%
Unit 2	<b>VECTORS – THE BASICS IN STATICS</b>	<ul style="list-style-type: none"> <li>● Quizzes</li> <li>● Assignments</li> <li>● Unit Test</li> </ul>	20%
Unit 3	<b>VECTORS – FORCES AND MOMENTS</b>	<ul style="list-style-type: none"> <li>● Quizzes</li> <li>● Assignments/Projects</li> <li>● Unit Test</li> </ul>	20%
Unit 4	<b>FREE BODY DIAGRAMS (F.B.D)</b>	<ul style="list-style-type: none"> <li>● Quizzes</li> <li>● Assignments/Projects</li> <li>● Unit Test</li> </ul>	15%
Unit 5	<b>EQUILIBRIUM</b>	<ul style="list-style-type: none"> <li>● Quizzes</li> <li>● Assignments</li> <li>● Unit Test</li> </ul>	15%
Unit 6	<b>ANALYZING TRUSSES</b>	<ul style="list-style-type: none"> <li>● Quizzes</li> <li>● Assignments/Projects</li> <li>● Unit Test</li> </ul>	20%
	<b>Total</b>		<b>100%</b>

### Facility Requirements

#### Classroom Area

- Comfortable seating and tables suitable for learning.
- Compliance with the Local and National Fire Code and occupational safety requirements.
- Meets applicable municipal zoning bylaws for technical instruction and education facilities.



- Overhead and multimedia projectors with a projection screen and associated computer tablet equipment capable of a Bluetooth connection (i.e. , no cable connection required, tablet can be used anywhere in the classroom).
- Whiteboard with marking pens and erasers.
- Lighting controls to allow easy visibility of the projection screen while allowing students to take notes.
- Windows must have shades or blinds to adjust sunlight.
- Heating/air conditioning for comfort all year round.
- Acoustics in the room must allow audibility of the instructor.

#### **Student Facilities**

- Adequate eating area as per WorkSafeBC requirements (4.84 OHS Regulation and Guidelines)
- Adequate washroom facilities as per WorkSafeBC requirements (4.85 OHS Regulation and Guidelines)
- Minimum 10 cu. ft. personal storage lockers

#### **Instructor's Office Space**

- Adequate office space for student consultation
- Desk and filing space
- Computer
- Internet access
- Printer access
- Adequate storage facilities for material and training aids
- Access to photocopier/scanner
- Telephone