بسم الله الرحمن الرحيم

(STRUCTURES 1)

LECTURE #1

Course Description and Introduction

By

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About the Instructor

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- Mechanics
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- Units

Course Description

- Force systems; vector analysis, moments and couples in 2D and 3D
- Equilibrium of force systems
- Distributed force system
- Centroid of simple and composite bodies
- Area moments of inertia
- Analysis of beams
- Stresses and strain

Course Learning Outcomes

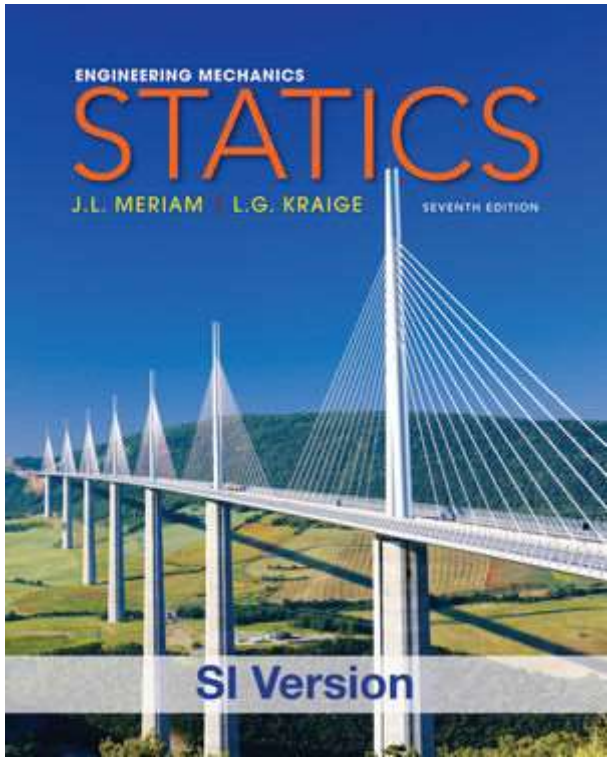
Students completing this course will be able to

- Analyze 2D and 3D force system and calculate moment in a 2D and 3D structures
- Analyze beam, and frame structures using equilibrium equations
- Locate centroid of regular and composite cross sections
- Evaluate area moment of inertia of engineering cross sections about different axes.
- Analyze and solve stresses and strains

Text Book

STATICS

- **Authors:** ***JL Meriam & LG Kraige***
- ***Publisher: John Wiley & Sons.***
- ***Edition: Seventh (in SI Units)***



Outcome Assessment

- Two Midterm Exams 15%
- Tutorial and Homework 15%
- Final Exam 70%

Midterm Exams

- **First Midterm**
  - **Date**
  - **Day: Tuesday**
  - **Time:**
  - **Second Midterm**
  - **Date:**
  - **Day:**
  - **Time:**

Objectives of the Present lecture

- *To explain what the "Statics" is.*
- *To provide an overview of the course contents*
- *To explain the learning outcomes of the present course*

Engineering Mechanics

A branch of science concerned with the action of forces on material bodies in rest or in motion

- Categories of Mechanics:
  - -Rigid bodies
    - -Statics (deals with equilibrium of bodies at rest)
    - -Dynamics (deals with the accelerated motion of bodies)
  - -Deformable bodies
  - -Fluids

A Real Life Application

Engineering Design of a building is an application of Statics knowledge.

Design of its various components are primarily based on the Principles of Static equilibrium and Strain compatibility.

Newton's Laws

- **Law I:** If the resultant force on a particle is zero, the particle will remain at rest (if originally at rest) or will move with constant speed in a straight line (if originally in motion).

- **Law II:** The acceleration of a particle is proportional to the resultant force acting on it in the direction of this force.
  - If above Law (II law) is applied to a particle of mass *m*, it may be stated as

$$\mathbf{F} = m\mathbf{a} \quad \text{where } \mathbf{F} = \text{resultant force; } \mathbf{a} = \text{resulting acceleration.}$$

- **Law III:** The forces of action and reaction between interacting bodies are equal in magnitude, opposite in direction, and collinear.

Weight of the body

- The gravitational attraction of the earth on a body is known as the weight of the body. This force exists whether the body is at rest or in motion.

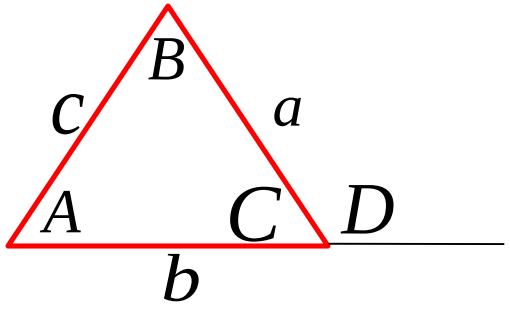
$$W = mg$$

- Since this attraction is a force, the weight of a body should be expressed in Newtons (N) in SI units and in pounds (lb) in U.S. customary units.

- Note: *Unfortunately in common practice the mass unit kilogram (kg) has been frequently used as a measure of weight.* This usage should disappear in time because in SI units the kilogram is used exclusively for mass and the Newton is used for force, including weight.

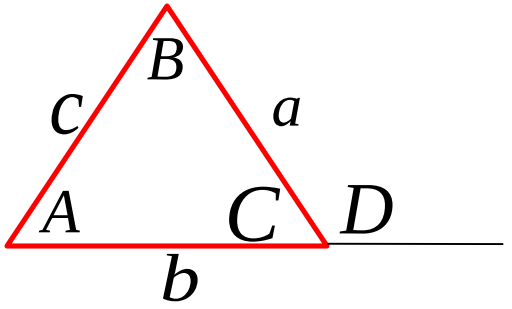
Law of sines and cosines

Law of sines



$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Law of cosines



$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$c^2 = a^2 + b^2 + 2ab\cos D$$

Systems of Units

- ***International System of Units*** **(SI) or Metric System :**

The basic units of length, time, and mass which are defined as meter (m), second (s), and kilogram (kg).

- The unit of Force is derived as below,

$$F = ma$$

$$1\text{N} = (1\text{kg})\left(1\frac{\text{m}}{\text{s}^2}\right)$$

$$W = mg \qquad g = 9.81\ \text{m/s}^2$$

QUANTITY	DIMENSIONAL SYMBOL	SI UNITS		
		UNIT		SYMBOL
Mass	M	Base units	kilogram	kg
Length	L		meter	m
Time	T		second	s
Force	F		newton	N

U. S. Customary UNITS

- U.S. Customary units (or foot-pound-second (FPS) units):
  - Mass : slugs (*No symbol*)
  - Length: foot (symbol ft)
  - Time: second (symbol sec)
  - Force: pound (symbol lb)

- Note: In U.S. units the pound is also used on occasion as a unit of mass. When distinction between the two units is necessary, the force unit is frequently written as lbf and the mass unit as lbm.
- Other units of force in the U.S. system which are in frequent use, are the *kilopound* (= 1000 lb), and the *ton* (= 2000 lb)

Thank You For Your Attention

Questions