Static Equilibrium*

A Mechatronics

Demonstration Project
By

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And

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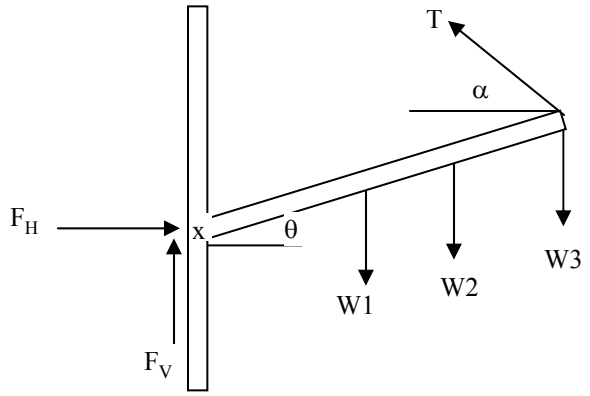
Abstract

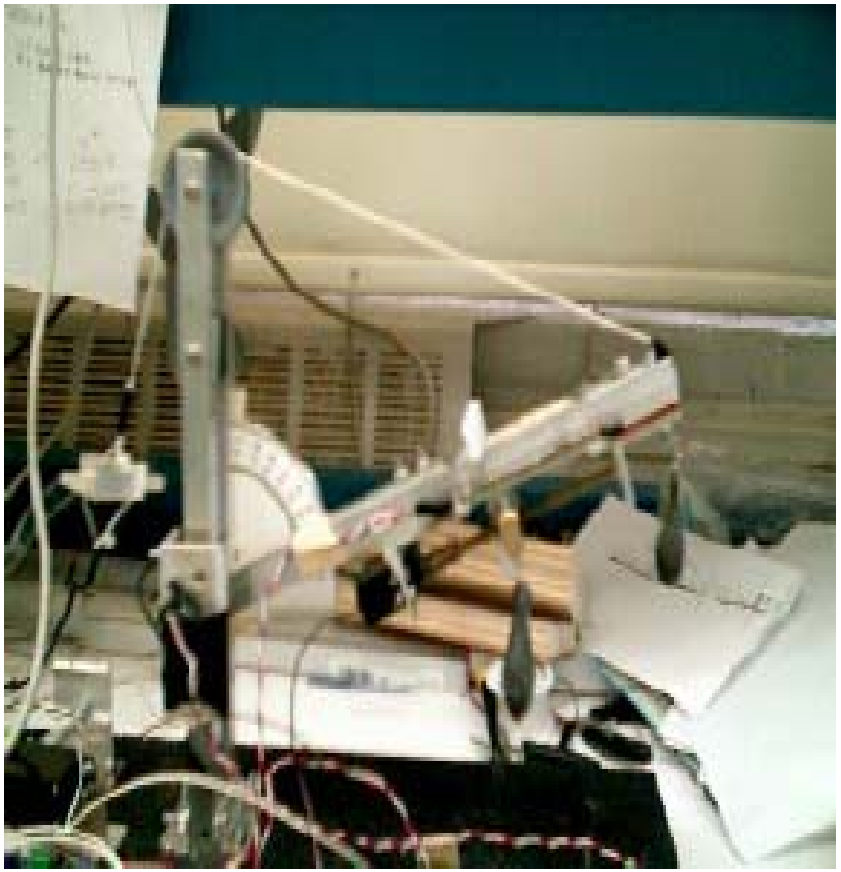
The intent of this project is to provide a visual demonstration of a standard static equilibrium problem that high school physics students are responsible for. The use of servomotors, sensors and basic programming further demonstrates how concepts of physics, mechanical engineering, electrical engineering and computer programming are interrelated and interdependent. This project provides students with a model of a real world problem in which concepts they are learning in school are applied.

STATIC EQUILIBRIUM



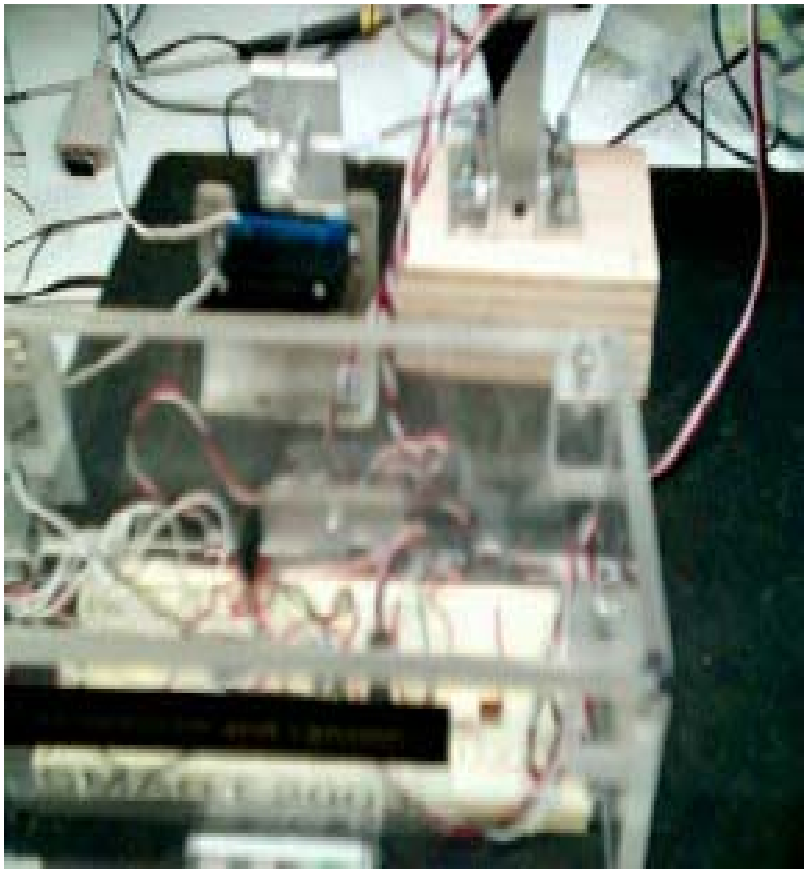
- STANDARD PHYSICS PROBLEM
- NO MOTION
- Σ FORCES = 0
- Σ TORQUE = 0

SENSORS & DRIVES



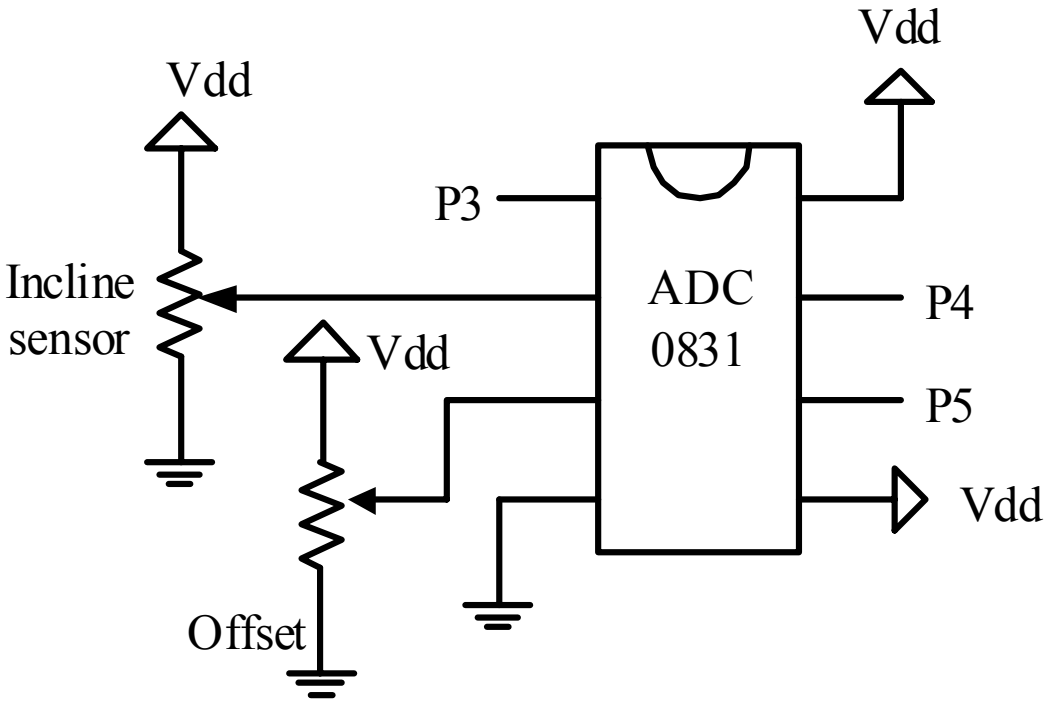
- TWO SERVO MOTORS
- ROTARY POTENTIOMETER
- SLIDE POTENTIOMETER
- LOAD CELL
- LEAD SCREW

ELECTRONICS

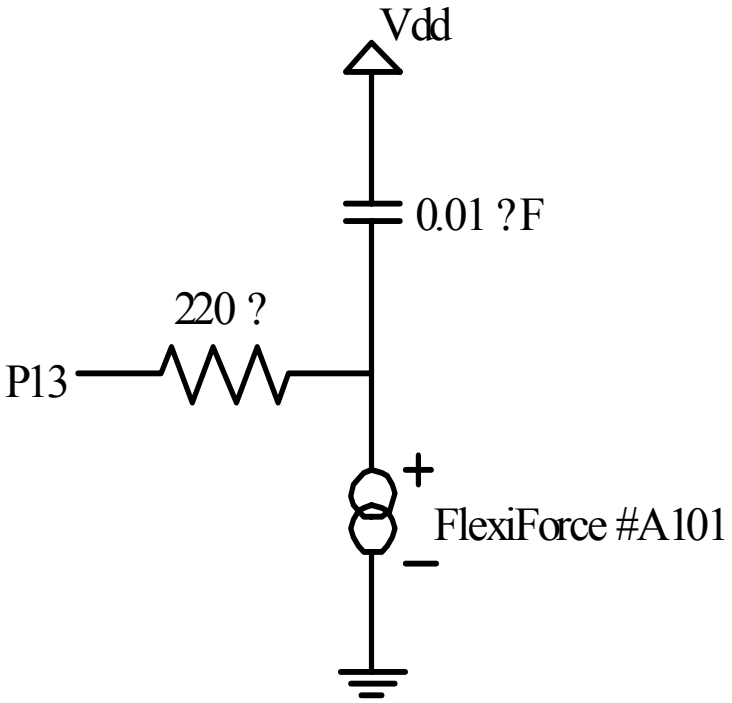


- TWO ADC 0831 CHIPS
  - SENSE VOLTAGE
- BREADBOARD
  - RESISTOR/CAPACITOR
- PARALLAX BS2 CHIP
- PBASIC CODE

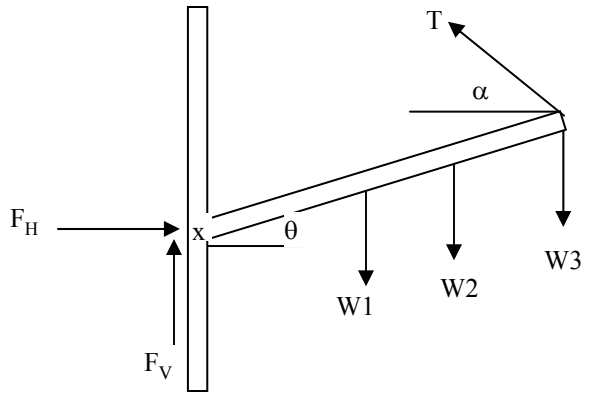
ELECTRICAL SCHEMATIC



LOAD CELL

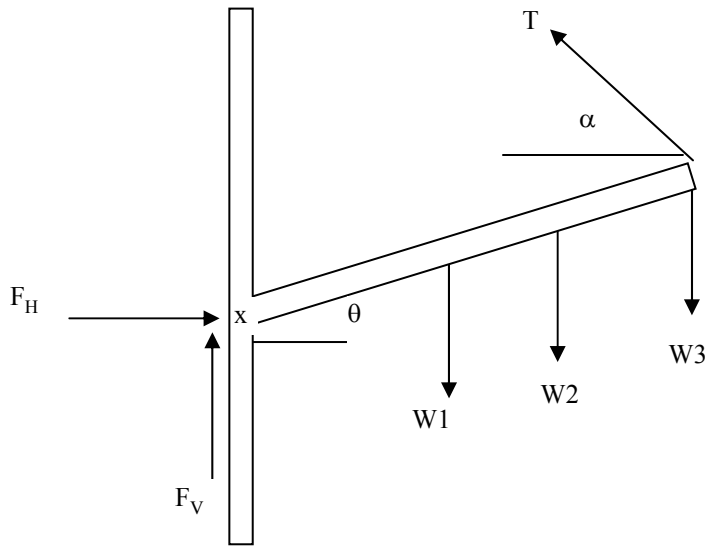


OPERATION



- INPUT
  - BOOM ANGLE θ (5 TO 55 DEG)
  - SLIDE WEIGHT POSITION
  - 17 TO 22 CM FROM PIVOT
- FEEDBACK
  - BOOM ANGLE
  - SLIDE POSITION
  - CABLE TENSION
- CALCULATE
  - CABLE ANGLE
  - REACTION FORCES

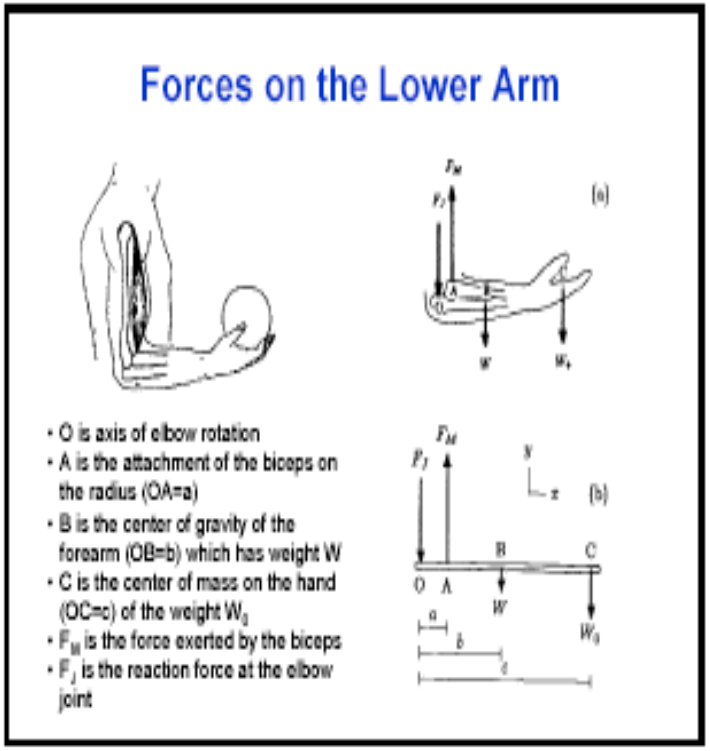
CALCULATIONS



- $\Sigma \tau = 0$
- $\Sigma \tau = T L_3 \sin(\alpha+\theta) - W_1 L_1 \cos\theta - W_2 L_2 \cos_\theta - W_3 L_3 \cos\theta$
- $\Sigma F_x = 0$
- $\Sigma F_x = F_H - T \cos\alpha$
- $\Sigma F_y = 0$
- $\Sigma F_y = F_V - W_1 - W_2 - W_2 + T \sin\alpha$

APPLICATIONS

- MODEL
  - ELBOW
  - KNEE
  - CRANE
  - BRIDGE
  - BACKHOE



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