McGill

December 2009
Final Examination

Mechanics 1

MECH 210 Sec.1

FRIDAY, DECEMBER 10, 2-5PM

Examiner: Francois Barthelat Assoc Examiner: Larry Lessard

Student Name:		McGill ID:									

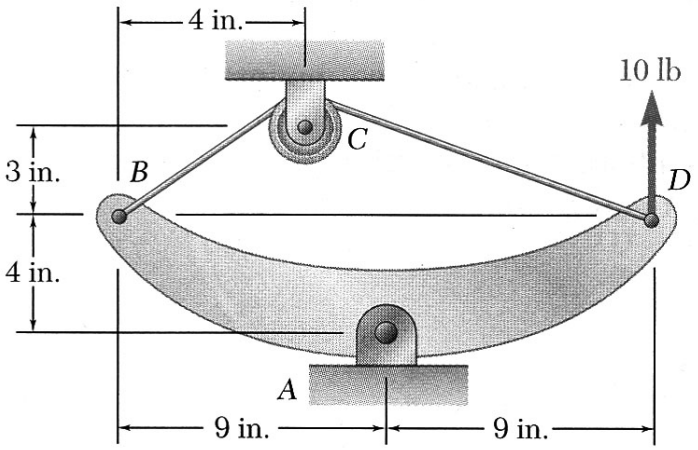
INSTRUCTIONS:

- This is a **CLOSED BOOK** examination.
- **STANDARD CALCULATOR** permitted ONLY.
- There are **5 pages** (including cover)
- **The exam has 5 problems (100 points total)**
- Each useful free body diagram is worth points.
- Indicate units in your results
- $g = 9.81\ m/s^2$ for all problems.
- This examination paper **MUST BE RETURNED**

Problem 1: A boomerang and a cable (15 points)

Component *ABD* is attached to a pin at point *A* and a cable attached at *B* and *D* as showed. The cable goes though a frictionless pulley at point *C* (neglect the size of the pulley). A vertical 10 lb force is applied at point *A* as shown.

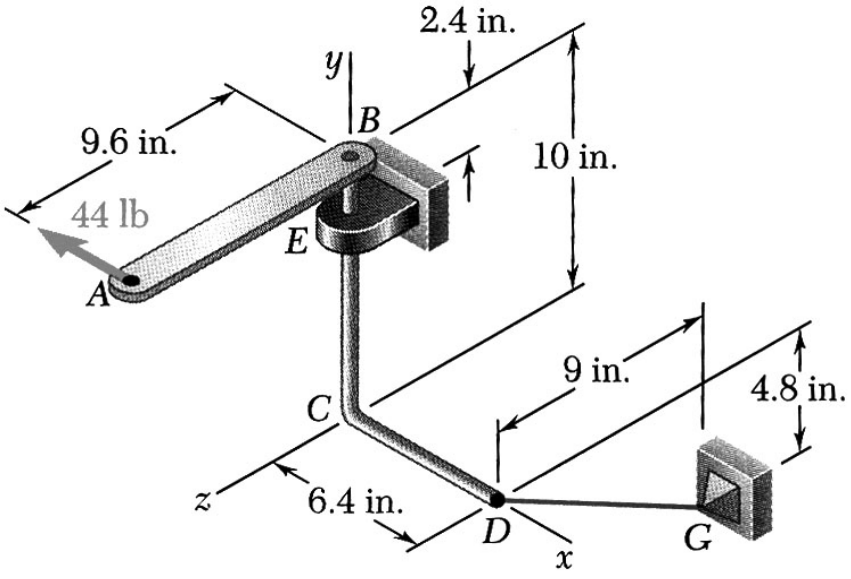
1) Compute the tension in the cable.
2) Compute the reaction forces at *A*.



Problem 2: 3D system (20 points)

In this 3D system lever *AB* is welded to the bent rod *BCD*, which is supported by bearing *E* and cable *DG*. This bearing only allows rotation about axis *y* and prevents translation along *y*. A 44 lb force is applied as shown.

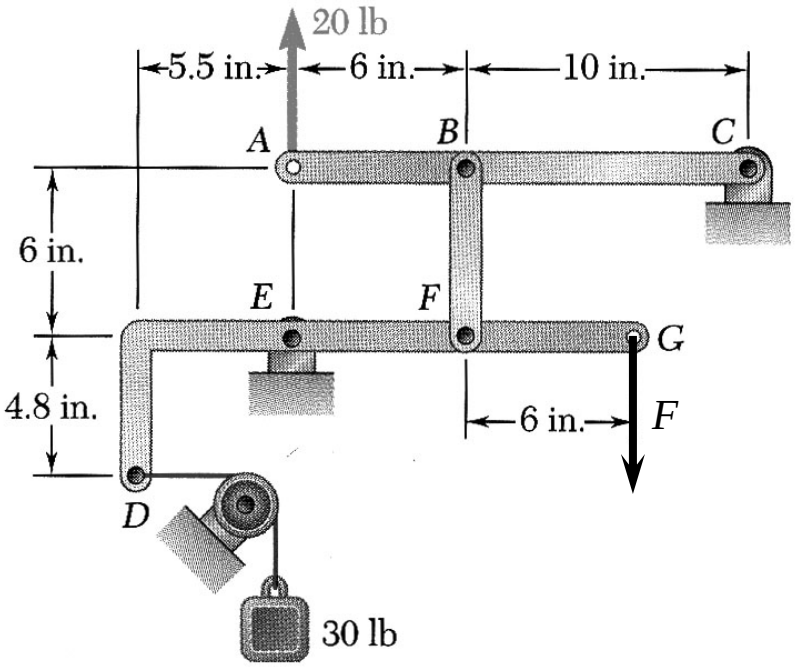
Compute the support reactions at *E* and the tension in cable *DG*.



Problem 3: Mechanism (20 points)

This articulated mechanism is loaded by a mass of 30 lb through a pulley and a force of 20 lb, as shown. Determine the force *F* that should be applied at point *G* to maintain equilibrium in that position.

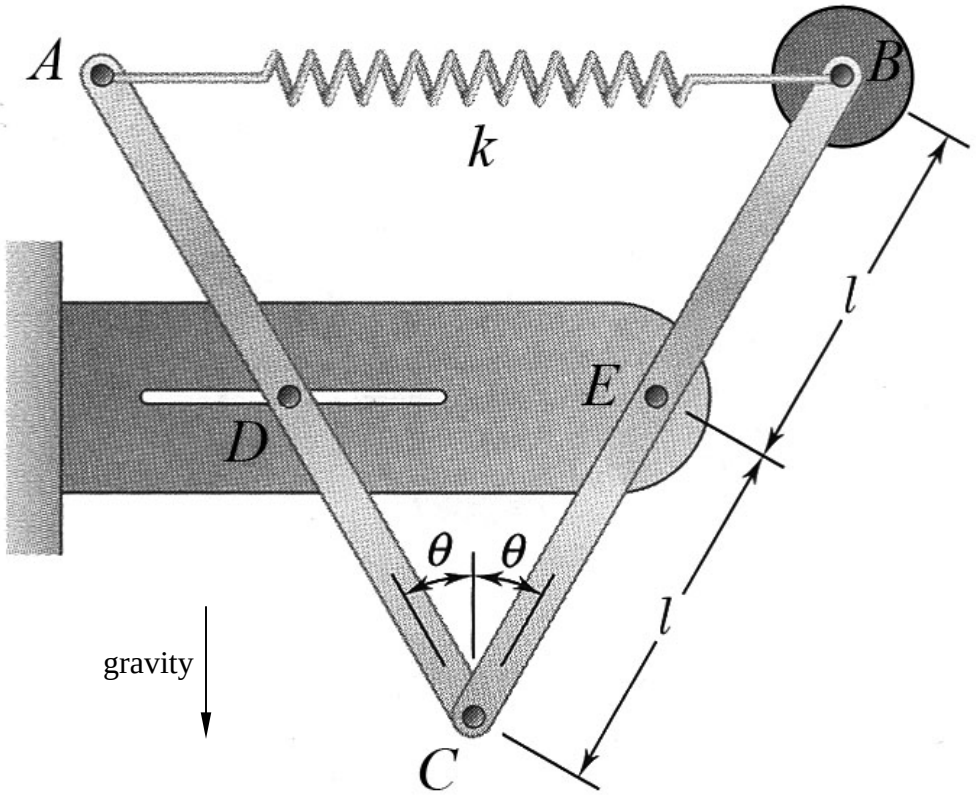
a) Use standard machine analysis
b) Use virtual work (*assume BF remains vertical*)



Problem 4: Stability (15 Points)

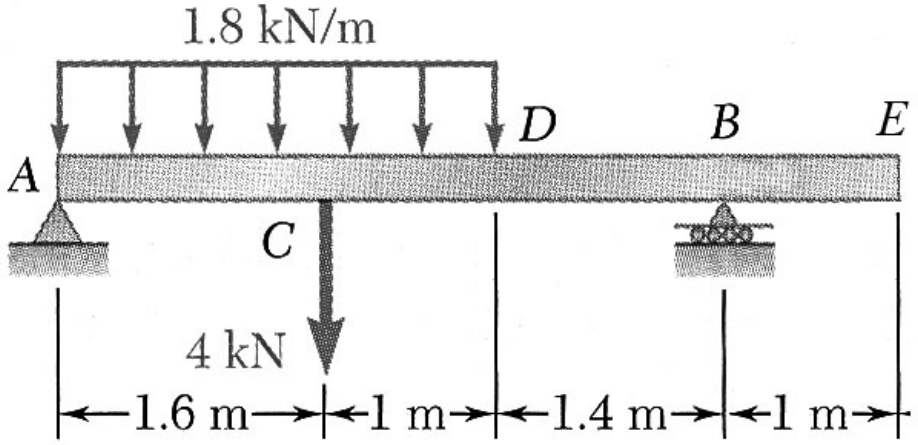
The following system is composed of 2 articulated bars *ADC* and *BCE*, each having a mass *m*. An additional mass *M* is attached at point *B*. A spring of stiffness *k* connects points *A* and *B*. The spring is a rest when $\theta = 0$.

1) Show that the position $\theta = 0$ is an equilibrium solution.
2) Is the position $\theta = 0$ stable?
3) Is the position $\theta = 0$ physically acceptable?
4) Are there other equilibrium positions?



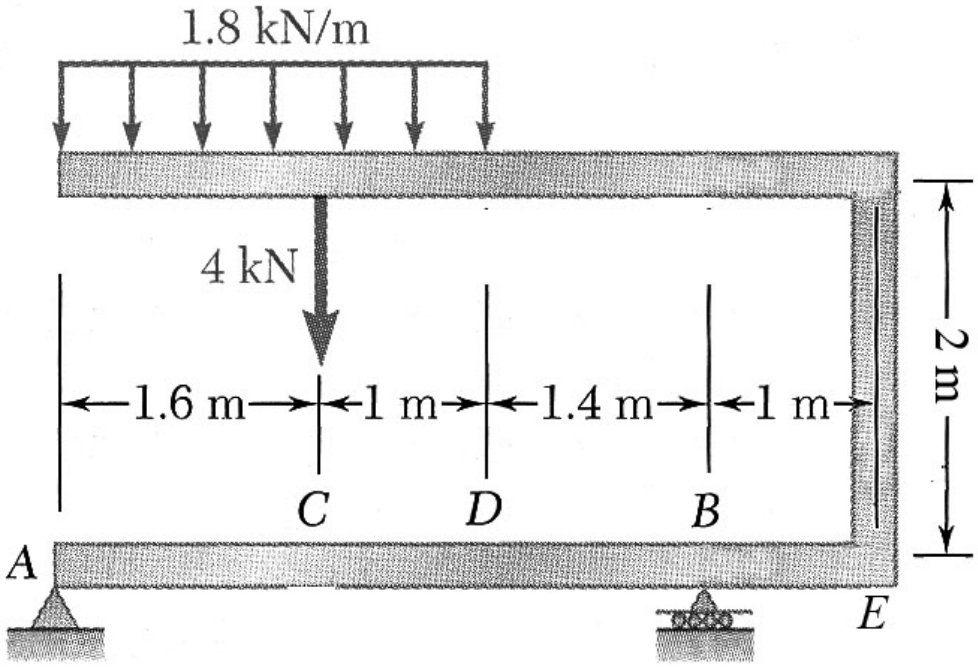
Problem 5: Beam analysis (30 points)

Part I: Consider the beam below:



1) Is this a) a cantilever beam, b) a simply supported beam or c) something else?
2) Determine the shear and bending moment diagram along *AE*.
3) Determine the maximum bending moment

Part II: The design of the system was changed. The loads are now applied onto a second beam 2 meters above the first one, connected by a vertical beam welded at point E.



1) Determine the shear and bending moment diagram along AE.
2) Determine the maximum bending moment