**Introduction to Solid Mechanics**
ME C85/CE C30

Midterm Exam 1

Fall, 2014

1. Do not open the exam until you are told to begin.

2. There is a separate answer booklet for each of the four problems of the exam. When you have finished the exam, please place each booklet in the appropriate box so that we can have them all separated once everyone is finished.

3. Put your name, SID and exam number on **every** page of your answer books.

4. You may not use a calculator, but you may use a straightedge to help you draw figures.

5. You may use one 8-1/2 x 11 sheet of notes, but not your book or any other notes.

6. Store everything else out of sight.

7. Turn off cell phones.

8. Please read the entire exam before starting work. You may solve the problems in any order you choose, of course, but pay attention to the clock so that you have sufficient time to work on all four problems.

9. There will be no questions during the exam. Write your concerns or alternative interpretations on your answer sheets.

10. Be concise and write clearly. Identify your answers by putting boxes around them.

11. Use only the front sides of the answer sheets for your answers. You may use the backs of pages for "scratch" paper, but if there is work that we should see, be sure to point that out in the main body of the exam.

12. You may leave the exam room when you are finished, but you may not leave and return during the exam. Please plan accordingly.

13. Time will be strictly enforced. At 9:00, you must put down your pencil or pen and immediately turn in your exam. Failure to do so may result in loss of points.

EXAM # 87

Problem 1. (15 points) A house painter weighing W pre-
pares to climb a ladder leaning against a house. The ladder
may be treated as being massless. The base of the ladder, A,
is a distance a from the wall, while the upper end of the lad-
der, B, makes contact with the house at height b. The coeffi-
cient of static friction between the base of the ladder and the
ground on which it rests is denoted μ. The house can be con-
sidered as smooth, so the contact between the ladder and the
house at point B may be treated as frictionless.
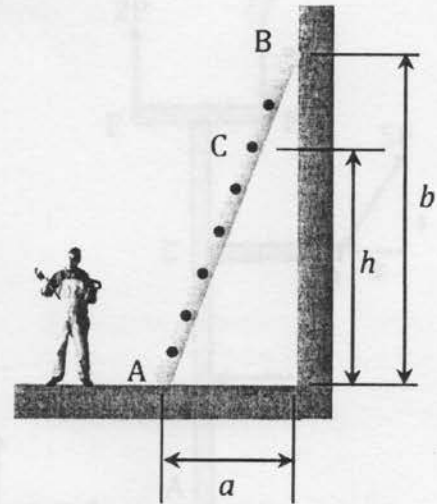
> Determine the minimum coefficient of friction μ_{min} that
> will allow the painter to stand on a rung at height h
> without the ladder slipping. Please express your solu-
> tion in terms of the parameters given.

Problem 2. (35 points total) The vertical and horizontal members of the structure shown are all
of length $2a$, and the member between A and B is at 45° to the horizontal. The structure supports
two forces P acting at joint F and at the midpoint between joints J and L.

 (a) (5 points) Identify the zero-force members in this structure.
 (b) (10 points) Determine the reaction forces at A and C. You should express the forces in
     terms of their horizontal and vertical components.
 (c) (10 points) Determine the forces in vertical members BC, FG, and JK. Be sure to indi-
     cate if the members are in tension (T) or compression (C).
 (d) (10 points) Determine the forces in horizontal members FH and GI. Again, be sure to in-
     dicate if the members are in tension (T) or compression (C).
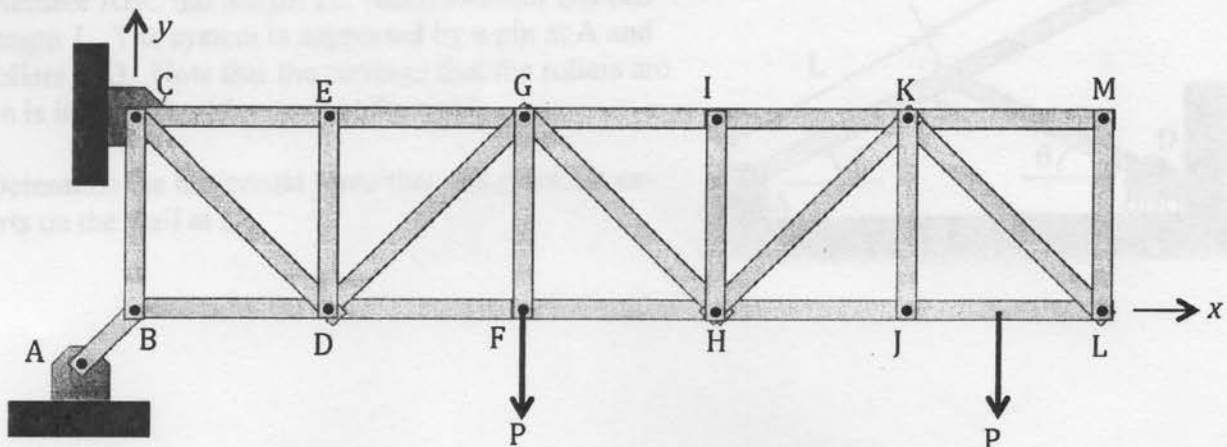
Problem 3. (30 points total) The structure shown is built into the ground at A and all structural elements are welded to one another so the entire structure may be treated as being rigid. The structure is loaded by forces at points B, D, E and F. The horizontal members CD and EF are of length L; the vertical member is of length $3L$. Point B is a distance L above A, and point C is a distance L above B.
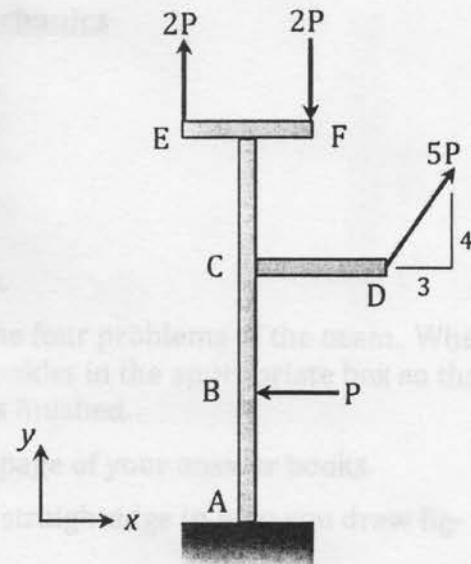
(a) (10 points) Replace the loading shown with an equivalent force-moment system at point C. Please resolve your force into x and y components, and indicate the direction of the moment (clockwise or counterclockwise).

(b) (10 points) Replace the loading shown with a single equivalent force acting at some location along the vertical member. For credit, you must identify both the force and the point at which it acts.

(c) (10 points) Determine the reaction forces and moment that the ground must exert on the structure at point A in order for it to be in equilibrium. Again, please resolve your force into x and y components, and indicate the direction of the moment (clockwise or counterclockwise).

Problem 4. (20 points) The machine shown, sometimes called a toggle vise, consists of a continuous member ABC that is pinned to member BD at B. Member ABC has length $2L$, while member BD has length L. The system is supported by a pin at A and rollers at D. Note that the carriage that the rollers are on is in contact with a wall at the right.

Determine the horizontal force that this machine exerts on the wall at D.