CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 1, 2017

FINAL EXAMINATION	**DURATION**
ENG151 – Statics	Reading Time: **10** minutes Writing Time: **180** minutes

INSTRUCTIONS TO CANDIDATES

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	**EXAMINATION MATERIALS TO BE SUPPLIED**
No additional printed material is permitted	1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1. (20 marks)

1.1 (2 marks)

Figure 1 shows two objects resting on a surface. The coefficient of friction is the same for both cases. Both objects have the same mass, but one has twice the contact area with the supporting surface compared with the other. What is the difference in the maximum friction force that can be generated between the two objects and their supporting surfaces?

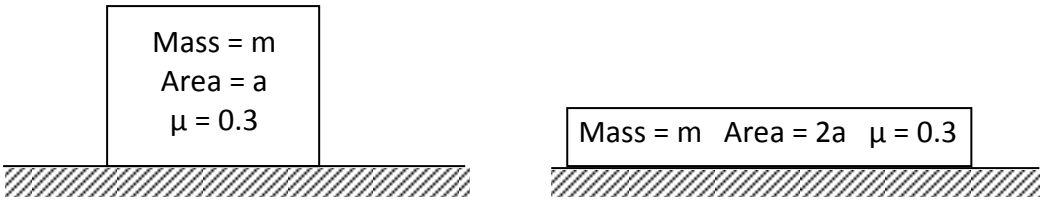


Figure 1

1.2 (2 marks)

What is the moment of a force about a point through which its line of action passes? Is moment a vector quantity?

1.3 (3 marks)

For a given force system, how many equivalent force-couple systems are there? For each of these equivalent systems:

Is the magnitude and direction of the resultant force the same?
Is the line of action of the resultant force the same?
Is the magnitude of the couple the same?

1.4 (2 marks)

Is the beam shown in Figure 2 below statically determinate? Explain your answer.

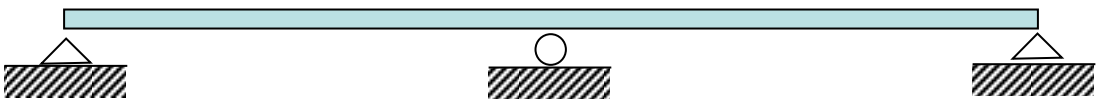


Figure 2

1.5 (1 mark)
Why does perpetual motion not exist?

1.6 (1 mark)
Explain why friction is important in how a wedge works.

1.7 (2 marks)
When analysing the forces in truss members, it can be useful to first identify any zero force members. Why are these zero force members present in trusses?

1.8 (6 marks)

Part of a backhoe is shown in Figure 3:

1.8.1 Which are the two force members?

1.8.2 For the system shown in Figure 3, draw the free body diagram for:

- the bucket DGA
- the arm H through to D
- the bucket and arm combined together (including parts EB, CB and AB)

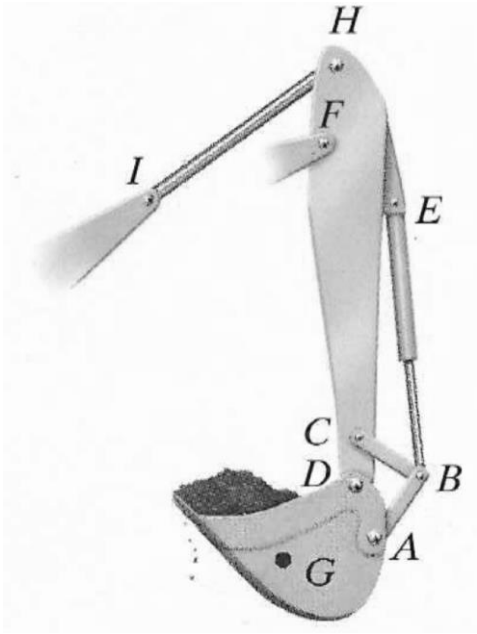


Figure 3

1.9 (1 mark)
What is the first step in solving a statics problem involving wedges?

Question 2. (12 marks)

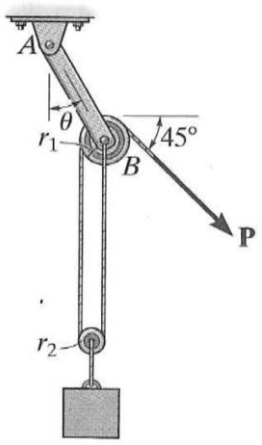


Figure 4

For the system shown in Figure 4, determine the force P on the cord, and the angle θ that the link AB makes with the vertical. Neglect the mass of the pulleys and the link.

The block has a mass of 100kg and the cord is attached to the pin at B.

The pulleys have radii of r_1 = 50mm and r_2 = 25mm.

Question 3. (16 marks)

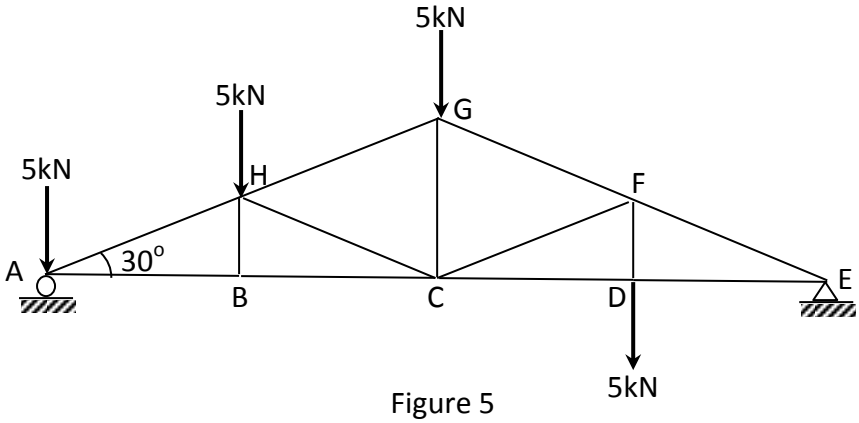


Figure 5

Determine the force in members HB and GC of the truss shown in Figure 5.

Question 4. (16 marks)

Draw the shear force and bending moment diagrams for the beam and loading shown in Figure 6. Include all maximum and minimum points and their locations.

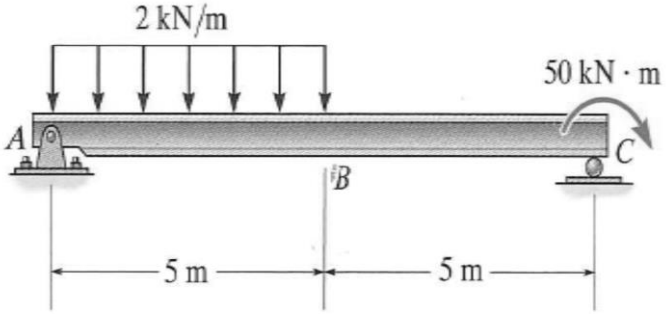


Figure 6

Question 5. (20 marks)

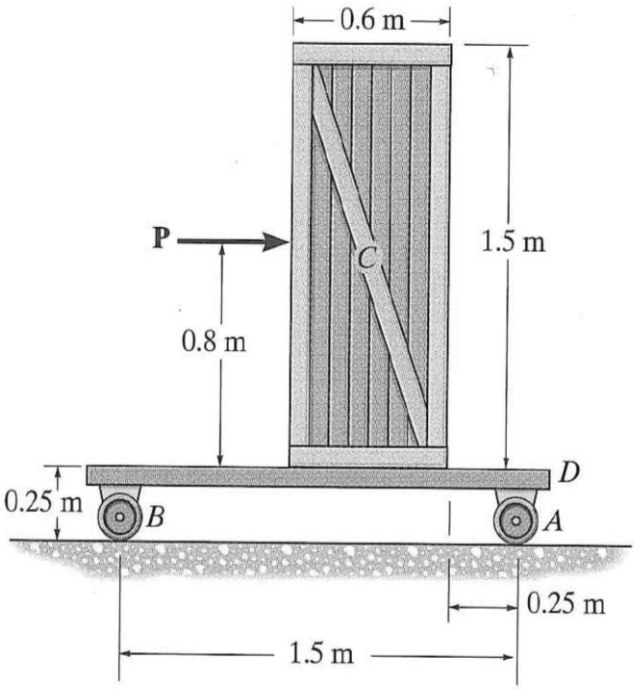


Figure 7

The uniform 60kg crate rests uniformly on a 10kg dolly, as shown in Figure 7. The front castors of the dolly (at A) are locked to prevent rolling, and the castors at B are free to roll.

Determine the maximum force P that can be applied without causing motion of the crate.

The coefficient of static friction between the castors and the floor is 0.35 and between the crate and the dolly 0.5.

Question 6. (16 marks)

The pliers shown in Figure 8 are used to place and remove circlips.

Determine the spreading force applied at G and H if P is 50N.

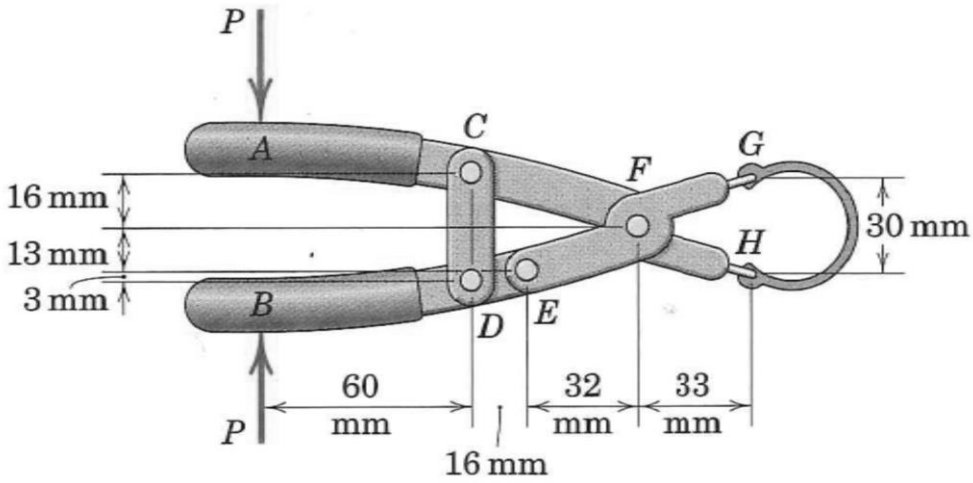


Figure 8

Figures 3, 4, 6 and 7 from RC Hibbler "Engineering Mechanics Statics" 13th ed
Figure 8 from Meriam & Kraige "Engineering Mechanics Statics" 6th ed
All other figures by the author

Formula Sheet

$$\Sigma M_O = 0$$
$$\Sigma F_V = 0$$
$$\Sigma F_H = 0$$

$$A\bar{y} = \int y dA$$
$$A\bar{x} = \int x dA$$

$$A\bar{y} = \Sigma A_n \bar{y}_n$$
$$A\bar{x} = \Sigma A_n \bar{x}_n$$

$$I_x = \bar{I}_x + Ad_x^2$$
$$I_y = \bar{I}_y + Ad_y^2$$

$$m + 3 \le 2j$$

$$dV = -wdx$$
$$dM = Vdx$$

raise

$$M = Wr\tan(\phi + \alpha)$$

lower

$$M = Wr\tan(\phi - \alpha)$$

$$\mu = \frac{F_{\max}}{N}$$
$$\varphi = \tan^{-1}\mu$$

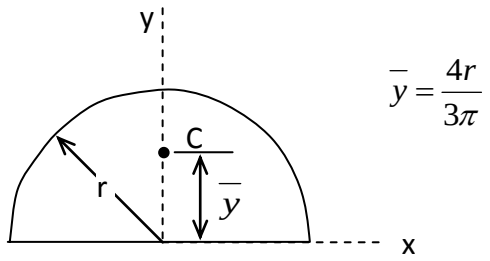
$$\tan\alpha = \frac{L}{2\pi r}$$

if $M_O = r \times F$

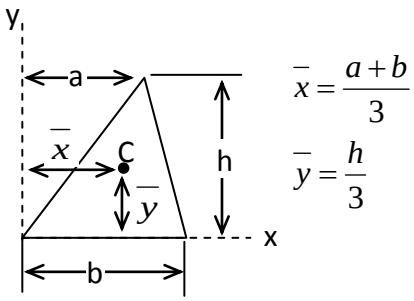
then

$$M_O = \begin{matrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{matrix}$$

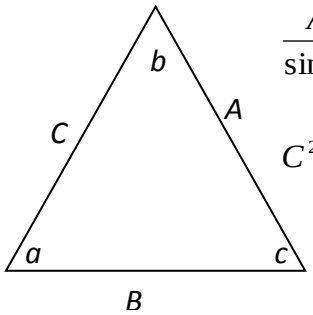
$$T_2 = T_1 e^{\mu\beta}$$



$$\bar{y} = \frac{4r}{3\pi}$$

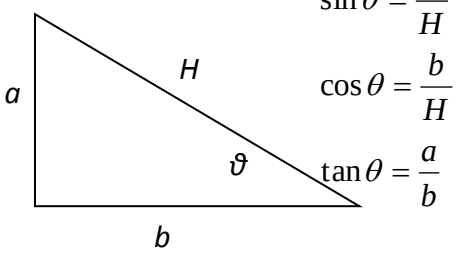


$$\bar{x} = \frac{a+b}{3}$$
$$\bar{y} = \frac{h}{3}$$



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

$$C^2 = A^2 + B^2 - 2AB\cos c$$



$$\sin\theta = \frac{a}{H}$$
$$\cos\theta = \frac{b}{H}$$
$$\tan\theta = \frac{a}{b}$$