The University of Melbourne
Semester 1 Assessment, 2007

Department: MECHANICAL AND MANUFACTURING ENGINEERING

Subject Number: 436-202

Subject Title: MECHANICS 1

Exam Duration: Three (3) hours

Reading Time: 15 minutes

This paper has 8 pages

Authorised Materials:

- Electronic calculators may be used.

Instructions to Invigilators:

- Two 14 page script books designated A and B

Instructions to Students:

- Candidates should attempt sections A and B of the paper in **separate designated script books**
- Candidates should attempt **three of the four questions of Section A** to total 90 marks for this section
- Candidates should attempt **two of the three questions of Section B**
- Please tick the questions you have answered at the front of each script book

Paper to be lodged with Baillieu Library

Section A

- End of sectionA -

Section B

Answer 2 out of the 3 questions supplied in a separate script book labeled "B"
Each question is of the same weight

Question B1

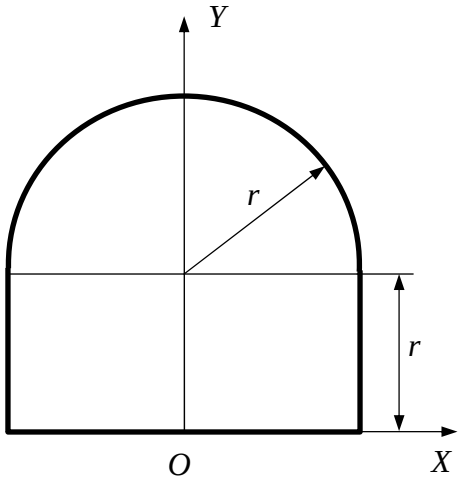
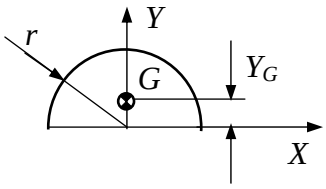


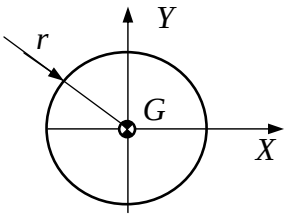
Fig. B1

The body shown in figure B1 possesses mass *m*. Produce the moment of inertia of this body about the axis through its centre of gravity and parallel to the axis *Z* of the system of coordinates *XYZ*.



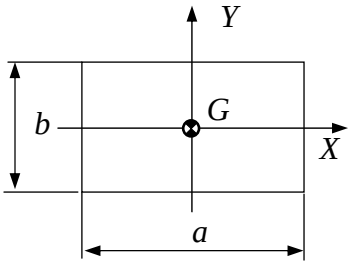
The coordinate Y_G of a semicylinder of mass *m* and radius *r* is

$$Y_G = \frac{4r}{3\pi}$$



The moment of inertia of a cylinder of mass *m* and radius *r* about axis *Z* through its centre of gravity *G* is

$$I_{ZG} = \frac{mr^2}{2}$$



The moment of inertia of a rectangular block of mass *m* about axis *Z* through its centre of gravity *G* is

$$I_{ZG} = \frac{m}{12}(a^2 + b^2)$$

Question B2

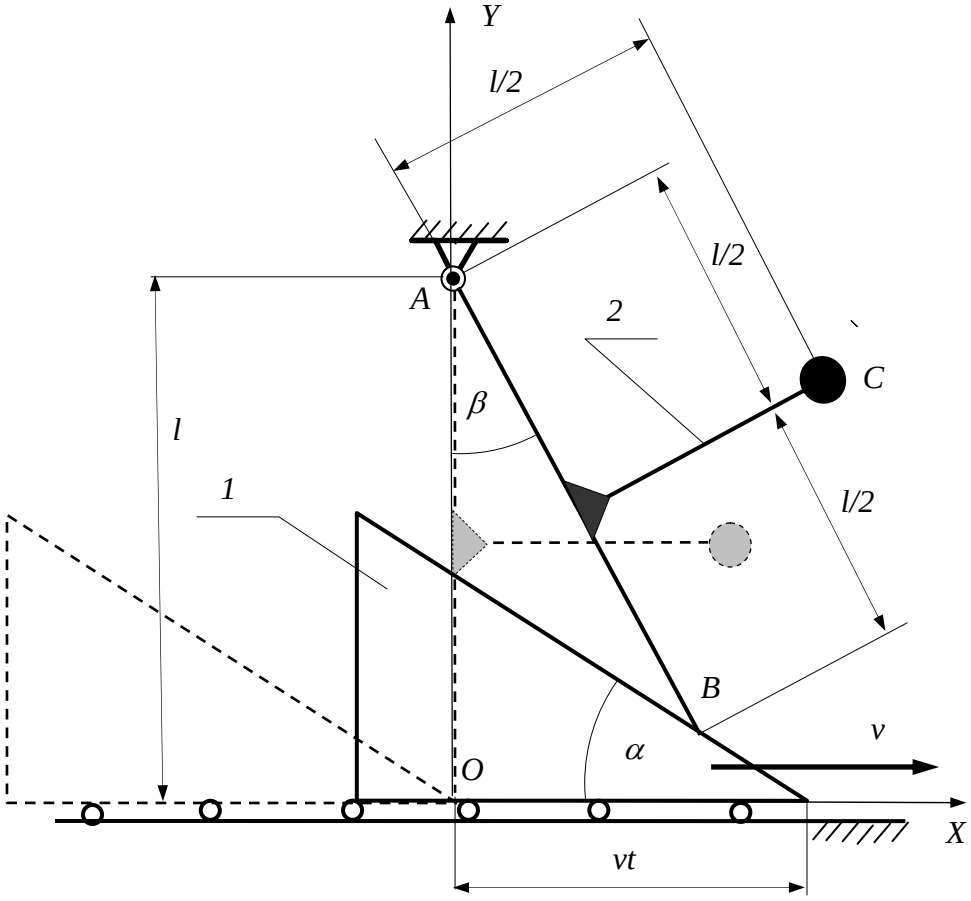


Fig. B2

The mechanism shown in Fig.B2 operates in the vertical plane *XY* of the inertial space *XYZ*. Two massless rods of length *l* and *l/2* are joined together to form the link *2* of this mechanism. There is an element attached to the link *2* at the point *C*. This element can be treated as a particle of mass *m*. The link *2* is hinged at the point *A* to the inertial space *XYZ*. Its point *B* is supported by the prism *1* that is moving along the horizontal axis *X* with a constant velocity *v*. The instantaneous angular position of the link 2 is denoted by *β*.

Produce:

1. The mobility of the mechanism and its number of degrees of freedom
2. The expression for the moment of inertia of the link *1* about the axis through the point of rotation *A*
3. The expression for the components of the absolute velocity of the point *C* on the link *2* along the inertial system of coordinates *XYZ*
4. The expression for the kinetic energy of the link *2*
5. The free body diagrams for the link *2*
6. The equations for determination of the interaction forces at the point *A* and *B*
7. Prove that the angular position of the link *2* is

$$\beta = \arccos(\cos\alpha - \frac{vt}{l}\sin\alpha) - \alpha$$

Question B3

B3a. Produce the mobility of the mechanism shown in Figure B3a assuming that at the constrain *H* slipping is allowed.

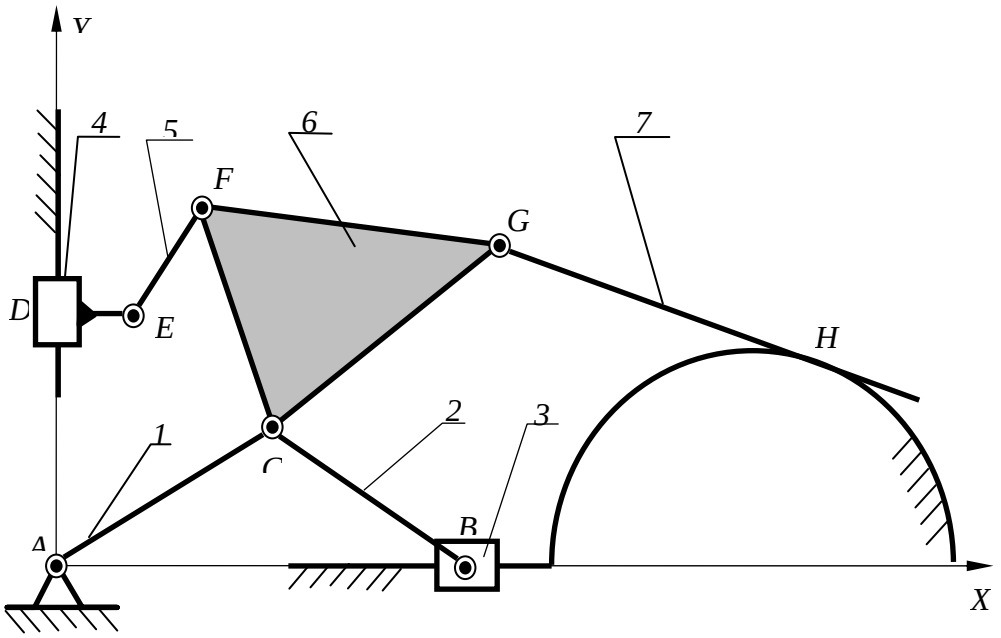


Fig. B3a

B3b. Derive the formula for the kinetic energy of a rigid body performing a general motion in an inertial plane.

B3c. Derive the expressions for the tangental, normal and binormal unit vectors of the intrinsic system of coordinates associated with a trajectory in a three dimenentional inertial space as a function of the absolute position vector ***r***.

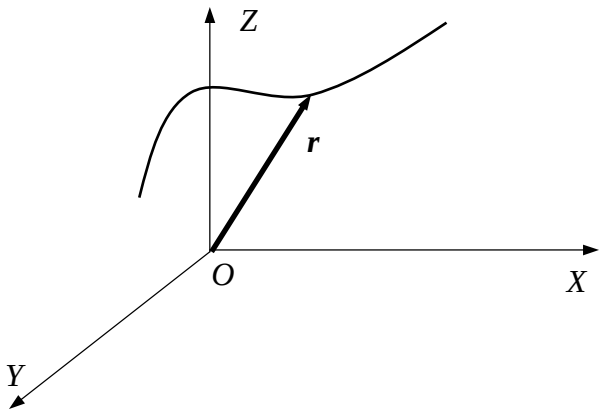


Fig. B3c

- End of Section B –

- End of Examination -