THE UNIVERSITY OF ADELAIDE
DEPARTMENT OF MECHANICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF B.E.

4103: MACHINE DYNAMICS

NOVEMBER, 1999

TIME: 3 HOURS

[In addition, candidates are allowed ten minutes before the exam begins to read the paper.]

[The use of notes, textbooks and calculating devices is permitted in the examination room.]

Attempt **ALL FOUR** questions.

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1. By the analytical method determine the equations of unbalance of the reciprocating masses for the two-cylinder engine of Figure 1 in which the cranks are at 90 degrees.

   a) Determine equations for the shaking force S and its moment C and the distance of its line of action z from cylinder 1 in terms of θ_1.

   [20 marks]

   b) Determine S, C and z for $\theta_1 = -30$ degrees given that $MR\omega^2 = 8900$ N, $R/L = 0.25$ and $a = 100$ mm, where M is the total equivalent mass of the reciprocating parts for each cylinder, R is the crank radius, and L the connecting rod length.

   [5 marks]

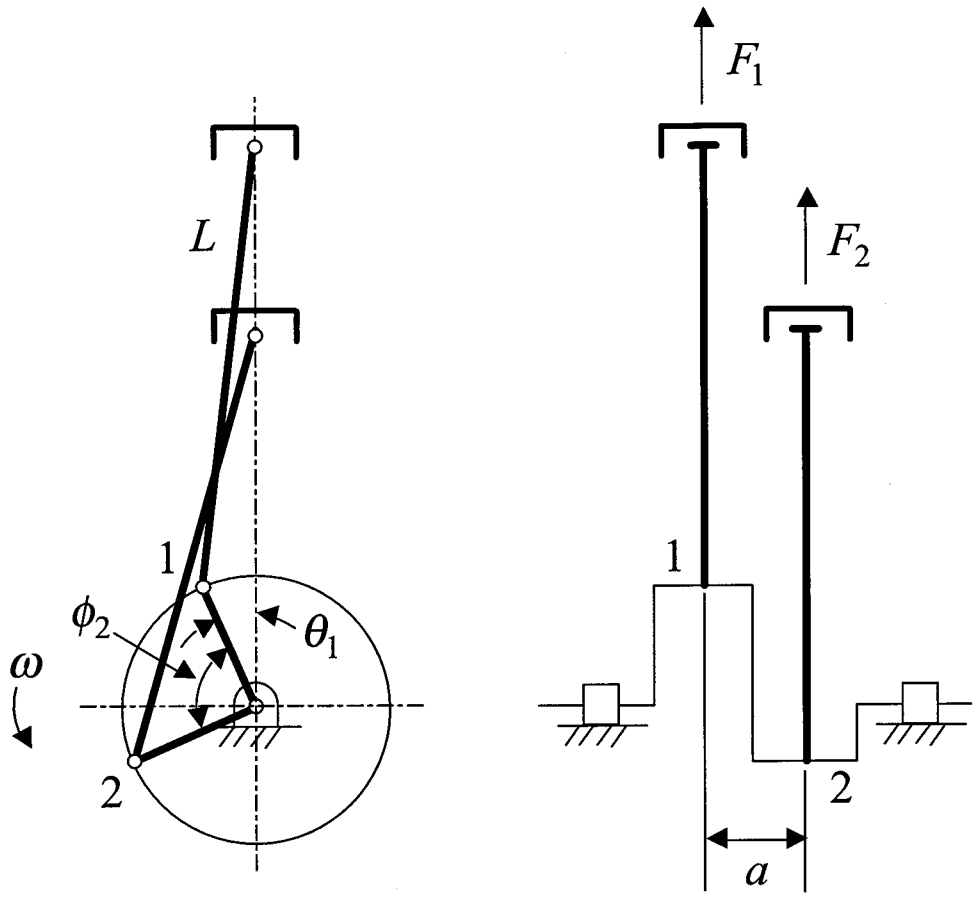

Figure 1

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2. The angular velocity of link 2 of the mechanism shown in Figure 2 is 20 rad/s, and the angular acceleration is 100 rad/s^2 at the instant being considered.

   a) Determine the linear velocity of point F.

   [5 marks]

   b) Determine the angular velocity of link 3.

   [5 marks]

   c) Determine the linear acceleration of point F.

   [10 marks]

   d) Determine the angular acceleration of link 3.

   [5 marks]

   Compute the quantities graphically, and properly label all terms.

EF = 63.5 mm
CD = 24 mm
AB = 13 mm
BC = 51 mm
CE = 61 mm
BE = 46 mm

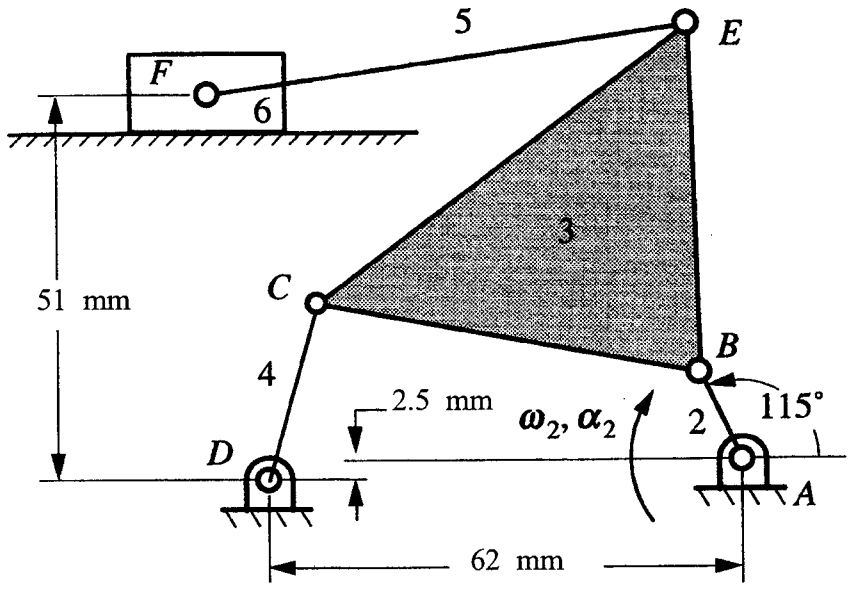

Figure 2

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3. Determine the force F_B given that point B has a constant velocity $v_B = 13$ m/s for the mechanism shown in Figure 3. The linkage is in the vertical plane. Include the effects of gravity, and assume no friction. The mass moment of inertia of link 3 is 0.03 kg.m^2, and the mass centre of link 3 is 300 mm from A.

[25 marks]

$AB = 800$ mm. $m_2 = 2$ kg, $m_3 = 1$ kg, and $m_4 = 3$ kg.

Sketch all vector polygons used to obtain the solution, and properly label all terms.

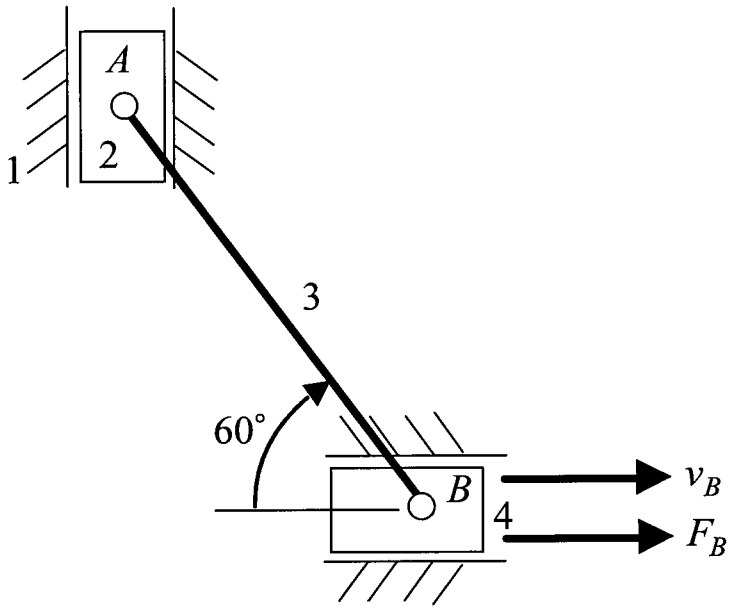

Figure 3

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4. Figure 4 shows an epicyclic hoist in which the carrier 4 is integral with a sprocket wheel that carries the load chain. The sun gear 1 is keyed to a sprocket wheel that carries the hand chain. The number of teeth on each gear is shown in brackets.

   a) Find the velocity ratio ω_1/ω_4. [10 marks]

   b) Find the velocity ratio ω_4/ω_2. [5 marks]

   c) If when viewed from the left-hand side of the hoist, ω_1 is clockwise, does the load (which is on the segment of the load chain behind the sprocket wheel 4) rise or fall?

   [5 marks]

   d) What is the ideal mechanical advantage (ratio of chain speeds) of the hoist if the sprocket wheels have a ratio R/r = 2?

   [5 marks]

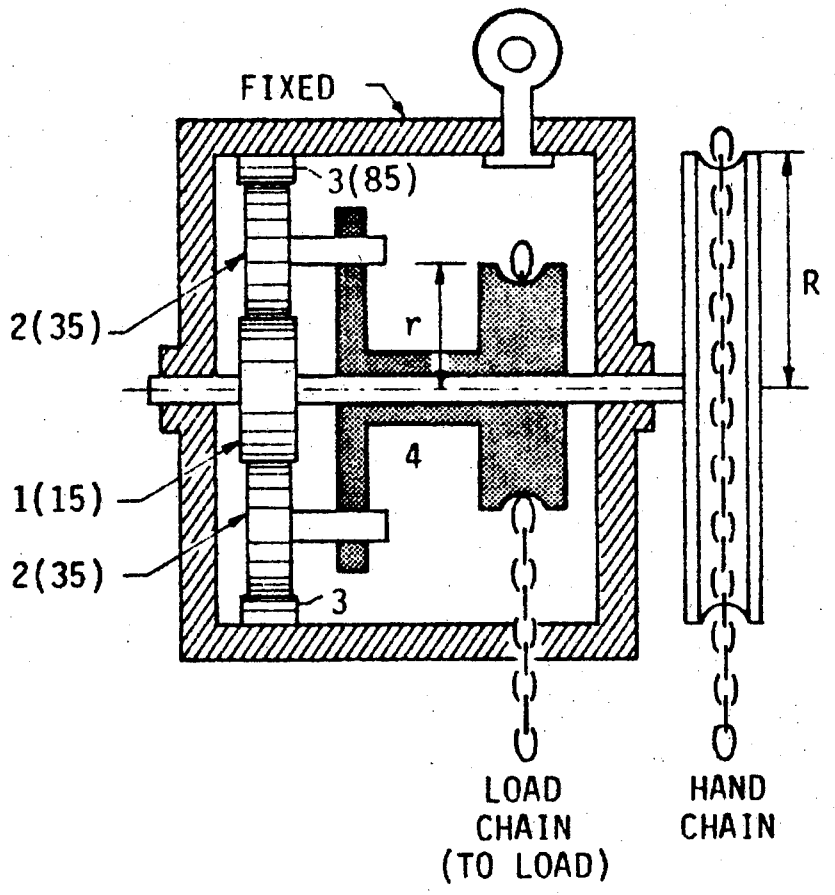

Figure 4