BINDURA UNIVERSITY OF SCIENCE EDUCATION
FACULTY OF SCIENCE AND ENGINEERING

AEH210

Department of Engineering and Physics
Bachelor of Science (Honours) Degree in Agricultural Engineering Part 2
Theory of mechanisms and machines

3 HOURS (100 Marks)

MAR 2024.

INSTRUCTIONS

Answer any FOUR questions. Each carries 25 marks

Only calculator is allowed

Question 1

A planar mechanism (drawn with a scale coefficient of K_L = 0.001 m/mm) has a rotation speed of 60 rev/min in the driving element AB, as shown in Figure 1:

a) Write down the lengths of each element. [5]
b) Calculate the linear velocities of points B and C. [5]
c) Determine the linear acceleration of point C. [5]
d) Calculate the angular velocities of elements 1 and 2? [5]
e) Determine the angular accelerations of elements 2 and 3. [5]

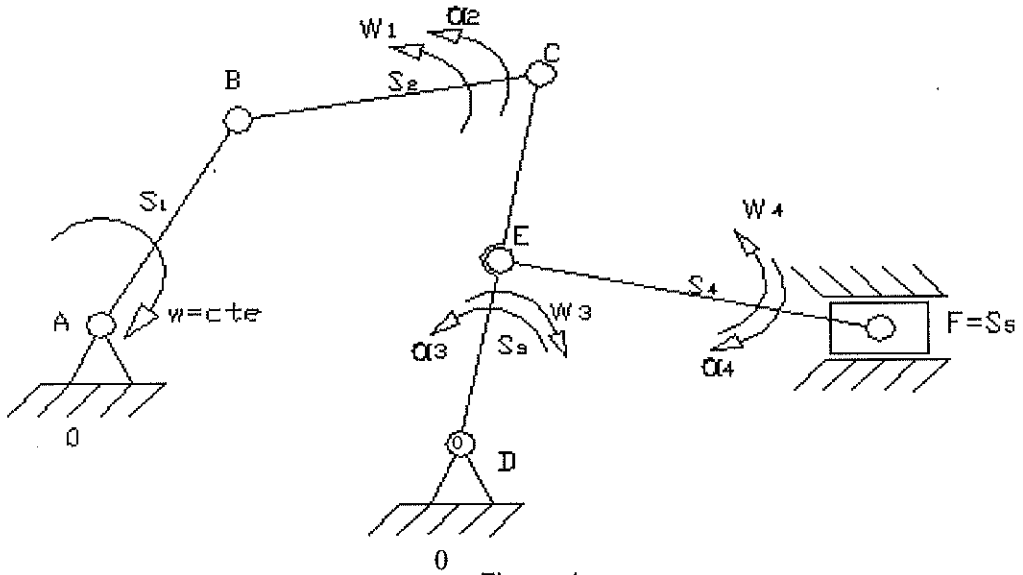

Figure 1

Question 2

A cylindrical toothed gear transmission (figure 2) has a driven wheel of diameter d_{w2} = 363 mm, rotation speed of n_2 = 480 rev/min. The pinion has a number of teeth Z_1 = 24 and the toothing module is m = 5.5 mm.

a) Obtain the gear ratio of the toothed pair. [4]

b) Establish the total number of teeth? [4]

c) Calculate the number of teeth of wheel Z_2. [4]

d) Determine the pitch diameter of the pinion d_{w1} [4]

e) Obtain the height of the teeth (h). [4]

f) Determine the transmission intern centres distance (a_ω). [5]

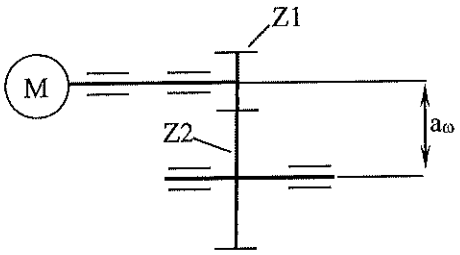

Figure 2

Question 3

In relation to cam mechanisms:

a) Define a cam mechanism [5]

b) Classify it according to the criteria below and give examples:

I. cam geometry. [5]

II. follower geometry. [5]

III. Upper Pair Closure Type. [5]

IV. The movement of the follower. [5]

Question 4

Figure 3 represents the plane mechanism of a pump, which has constant acceleration, develops a rotational speed of n_1 = 180 rev/min:

a) The inertia moment of the center of mass S_2 and S_3 [6]

b) The inertia forces of elements 2 and 3. [7]

c) The weight (G) of elements 1 and 2. [5]

d) The moment of the forces of inertia in element 2. [7]

Required information:

K_L = 0.002 m/mm; m_1= 5 kg; m_2= 27k; m_3= 40Kg

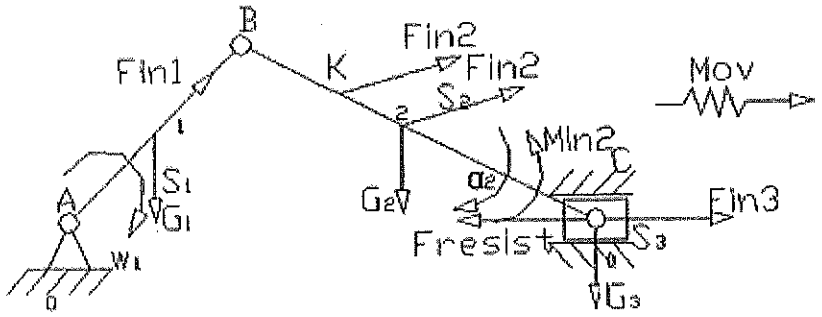

Figure 3

Velocity diagram Acceleration diagram.

Kv = 0.005 m/s·mm Ka = 0.05 m/s$_2$·mm.

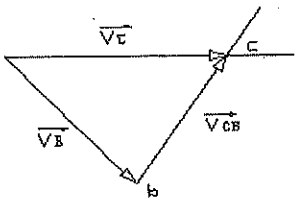

Figure 4

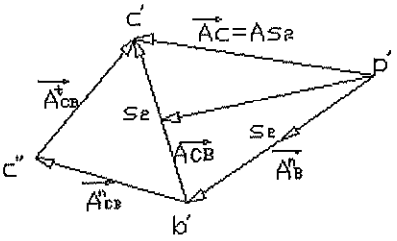

Figure 5

Question 5

Figure 6 represents a mechanical reciprocating press:

a) Draw a graphical representation of its links. [7]
b) Determine the degree of mobility. [10]
c) Classify it according to class and order. [8]

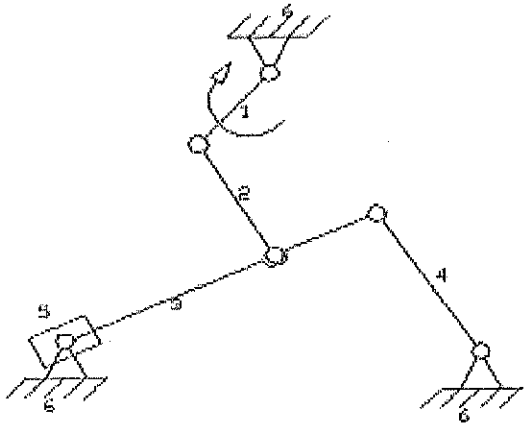

Figure 6

Question 6. Related to Theory of Mechanisms:

a) Conceptualize mechanism. [5]

b) Explain the differences between a machine and a mechanism. [6]

c) Define work machines (give at least two example). [7]

d) Define motor machines (give at least two example). [7]

Apendix

Equation	Equation
$W=3\,(n-1)-2p_1-p_2$	$a_w = 0{,}5\cdot\left(Z_1+Z_2\right)\cdot m$
$Kl=\frac{L_{AB}}{AB}\,;\,Kv=\frac{\upsilon}{pb}\,;\,K_a=\frac{\bar{a}}{pb'}$	$\mathrm{h_a = m_t}$
$\omega=\frac{\Pi\cdot n_1}{30}$	$\mathrm{h = 2{,}25\cdot m_t}$
$Is=\frac{m_1\cdot l^{\,2}}{12}$	$d_{w1}=m_t\cdot Z_1$
$V_B = L_{AB}\cdot w_1$	$d_{w2}=m_t\cdot Z_2$
$V_C = V_B + V_{C/A}$	$\mathrm{d_{a1} = d_{w1} + 2\cdot m_t}$
$A^{t}_{B/A}=l_{BA}\cdot\alpha$	$\mathrm{d_{a2} = d_{w2} + 2\cdot m_t}$
$A_{B/A}=l_{BA}\cdot w^2$	$\mathrm{d_{f1} = d_{w1} - 2\cdot m_t - 2\cdot c}$
$\xi=\frac{a^t}{L}$	$\mathrm{d_{f2} = d_{w2} - 2\cdot m_t - 2\cdot c}$
$\vec{A}_C=\vec{A}_B+\vec{A}^{\,n}_{C/B}+\vec{A}^{\,t}_{C/B}$	
$\mathrm{F_{in} = - m\cdot As}$	$\mathrm{M_{in} = - Is.\alpha}$

End of paper