

BACHELOR OF FOOD TECHNOLOGY & BIO-CHEMICAL ENGINEERING EXAMINATION

2018

(2nd Year, 1st Semester)

BASICS OF MECHANISMS

Time: 3 hours

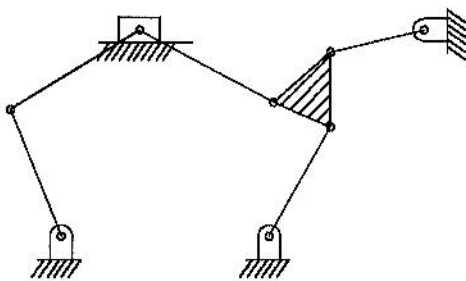
Full Marks: 100

Missing data, if any, are to be reasonably chosen.

Give sketches wherever applicable.

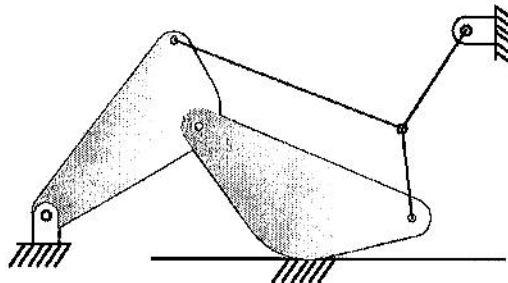
Answer any Four (4).

1. (a) Derive an expression for mobility (degree of freedom) of a planar mechanism considering compound hinges. Determine the mobility of the mechanism shown in Figure Q1a. [04+2×03]
- (b) Explain (with neat sketches) what is meant by Binary, Ternary and Quaternary link. Prove that the minimum number of binary links in a single degree of freedom planar linkage is 4. In a 6-link chain what is the highest possible order of links? Find out following number synthesis, number of different types of links that can make up the above mentioned 6-link chain. [03+04+01+03]
- (c) Write down the Grashof criterion for a planar 4-bar linkage. Write down the characteristics of 4-bar linkage depending on the following conditions: Shortest link is (i) adjacent to fixed link, (ii) opposite the fixed link and (iii) the fixed link. [02+02]



(i)

Figure Q1a



(ii)

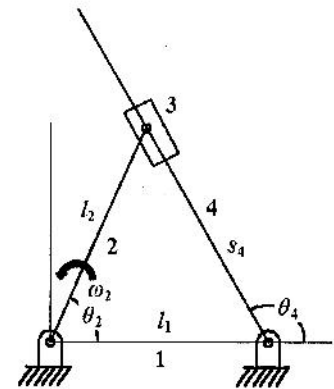


Figure Q2a

2. (a) A 4 bar linkage is shown in Figure Q4. Link 2 is the input link and the input angular velocity is ω_2 (uniform). Link 2 is connected to a slider (Link 3), which is free to slide along Link 4. Link 1 is the fixed link of the mechanism. The link lengths are as shown in the figure. For a given input angle (θ_2) analytically find out the sliding distance (s_4) and angle of link 4 (θ_4) with the horizontal. Also find out expressions for linear velocity of slider and angular velocity of link 4. [15]
- (b) O_2ABO_4 is a four bar linkage with O_2O_4 as the fixed link. The link lengths are given as follows: $O_2A = 200$ mm, $AB = 400$ mm, $O_4B = 450$ mm and $O_2O_4 = 600$ mm. Points A and B lie in the same side of the fixed link with B to the left of A. Find out the angle output link makes with the horizontal when the input link is at an angle of 90° with the horizontal. [10]

- 3 (a) Classify cam-follower mechanism on the basis of follower shape and draw neat sketches for each category. Write down the expression of displacement within the rise part of the cycle, when the follower moves according to Simple Harmonic Motion (SHM). Explain the procedure to graphically draw the displacement curve in the above mentioned case. In case of a cam-follower mechanism define the following terms with neat sketches: Base circle, Prime circle. [04+01+03+04]

(b) Derive the displacement expression for a 3-4-5 polynomial cam. [08]

(c) Prove that for translating roller follower: (Symbols have their usual meaning) [05]

$$F_n = \frac{F_s}{\cos \varphi - \mu \left(1 + 2 \frac{l_1}{l_g} \right) \sin \varphi}$$

4. (a) Prove that in a flat belt, the belt tensions are related by the following expression: $\frac{T_1 - mv^2}{T_2 - mv^2} = e^{\mu \theta}$. [10]

(b) An open belt connects two pulleys, the smaller pulley being 400 mm in diameter. The angle of contact on the smaller pulley is 160° and the coefficient of friction between belt and pulley is 0.25. The velocity of the belt is such that centrifugal tension can be neglected. Determine an expression for power transmitted in terms of initial tension, belt velocity, coefficient of friction and angle of contact. Also determine the increase (in %) in power transmission capacity for the following situations: (i). Initial tension is increased by 10% (all other parameters remaining same). (ii). Angle of contact is increased by 10% (all other parameters remaining same) by using an idler pulley. [12]

(c) Explain what you understand by slip in case of belt-pulley drive. Why the slack side is preferably kept on top in horizontal flat belt drives? [01+02]

5. (a) Derive the expression for torque transmission capacity for a single plate friction clutch according to –
i) Uniform pressure theory and ii) Uniform wear theory

Mention the conditions where these two theories are applicable? Explain why the torque transmission capacity of an old, worn out clutch is less than that of a new clutch. [10+01+02]

(b) Describe the working principles of a centrifugal clutch. [05]

(c) A single plate clutch consists of only one pair of contacting surfaces. It is used for an engine, which develops a torque of 180 N-m. The permissible intensity of pressure is 350 kPa and coefficient of friction is 0.35. Assuming uniform wear theory, calculate the inner and outer diameters of the friction lining. Consider that the inner diameter of the lining is 0.577 times the outer diameter. Also determine the friction radius of the clutch. [07]

6. (a) Explain the difference between simple and differential band brakes. Draw the free body diagram of forces acting on the actuating lever and derive an expression for the actuating force. Explain the condition of self-locking for differential band brakes. Is it possible for simple band brakes to be self-locking? [02+04+02+02]

(b) Write short notes on the following: (any 3) [3×05]

- (i). Elliptic trammel mechanism
- (ii). Paucellier mechanism
- (iii). Coriolis component of acceleration
- (iv). Short and long shoe (block) brake
- (v). Square jaw clutch