Ex/FTBE/ME/T/214/2019

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING EXAMINATION - 2019

(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).

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1. (*a*). In a 4-bar linkage the link lengths are as follows: l_1 (fixed link), l_2 (input link), l_3 (coupler) and l_4 (output link). The input angle is denoted by θ_2, measured in anti-clockwise direction from the horizontal. Derive analytical expressions for the output angle (θ_4) and the coupler angle (θ_3). Also determine expressions for angular velocities of the coupler and the output link. [18]
(*b*). What do you understand by Coriolis component of acceleration? Explain with an example. Derive an expression for the Coriolis component of acceleration. [02+05]

2. (*a*). Define: Straight Line Mechanism. Give an example of an exact straight line mechanism (consisting of revolute pairs only) and draw its schematic representation. Find out the ratio of link lengths for Chebyshev's straight line mechanism. [02+03+06]
(*b*). Write down the expression for mobility (degree of freedom) of a planar mechanism considering compound hinges. Determine the mobility of the mechanism shown in Figure Q2b. [01+03]
(*c*). Define: Kinematic chain. Explain Kinematic inversion. Write down the names of the mechanisms which are inversions of a double slider crank chain and write a short note on any one of them. [01+02+01+03]
(*d*). Prismatic pair is nothing but a limiting case of a revolute pair, where the revolute pair is located at infinity along a direction perpendicular to the direction of sliding – Explain. [03]

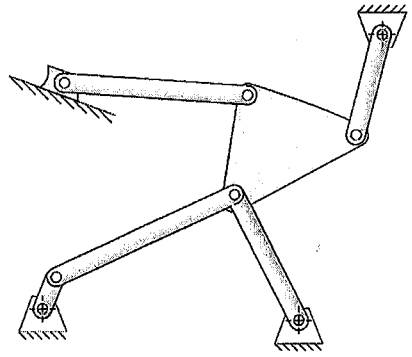

Figure Q2b

3. (*a*). Derive the expressions for actuating force and torque transmission capacity for a cone clutch according to Uniform wear theory. [08]
(*b*). A cone clutch (with cone angle 30^0) is used to transmit power of 10 kW at 800 rpm. The pressure intensity at the contact interface is not to exceed 85 kN/m^2. Width of the conical surface is half of the mean radius. If coefficient of friction is 0.15, then find the dimensions of the contact surfaces. Assume uniform wear theory. Also find the axial actuating force required to operate the clutch. [10]
(*c*). Prove that the torque transmission capacity of centrifugal clutch is given by: $T = \mu z m r_g r_d(\omega_2^2 - \omega_1^2)$. [07]

4. (*a*). Describe the working principle of a short shoe block brake with a schematic diagram. Draw the free body diagram of forces acting on the drum and lever for clockwise rotation of the drum and derive expressions for the following: Hinge pin reactions, actuating force on the lever. Comment on whether such a brake can be self-locking. [03+03+02+02]

(*b*). For a block brake with long shoe, prove that torque transmission capacity: $T = \mu NR\left[\frac{4\sin\theta}{2\theta+\sin 2\theta}\right]$ [15]

5. (*a*). Derive the condition for maximum power transmission by a belt drive considering the effect of centrifugal tension. [08]

(*b*). In an open belt drive that connects two pulleys, the angle of contact of the small pulley is given by θ, while the friction coefficient between belt and pulley is given by μ. The initial tension in the belt is T_i. The velocity (v) of the belt is such that centrifugal tension can be neglected. Prove that the power transmitted can be expressed as follows: $P = 2T_i v\left(\frac{e^{\mu\theta}-1}{e^{\mu\theta}+1}\right)$. [05]

(*c*). Two pulleys are mounted on two parallel shafts that are 2.0 m apart and are connected by a leather belt with cross-section of 80 mm × 12 mm and mass density of 0.001 g/mm^3. The direction of rotation of the two pulleys is opposite to each other. The diameters of the pulleys are 500 mm and 240 mm respectively. Find the angle of contact between the belt and each pulley and the length of the belt. If it is desired to alter the direction of rotation of the driven shaft, what changes are to be made in the drive? Should the length of the belt be changed? If yes, by how much? [12]

6. (*a*). Write down the expression of displacement within the rise part of the cycle, when the follower moves according to parabolic motion. Derive the expressions for velocity, acceleration and jerk from the above expression and indicate the values of maximum velocity and acceleration. Draw schematic representation of displacement, velocity, acceleration and jerk variation against cam rotation angle for one cycle. Point out the disadvantage associated with such kind of follower motion. [02+03+02+04+02]

(*b*). Write short notes on the following: (***any 3***) [3×04]

(*i*). Classification of cam follower mechanism based on follower shape

(*ii*). Friction material for a clutch

(*iii*). Slip in belt-pulley drive

(*iv*). Transmission angle of 4 bar linkage

(*v*). Gear train