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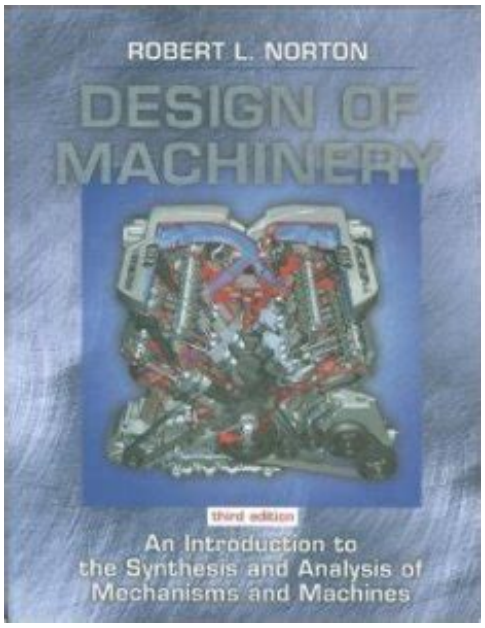

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HATCH Number of links L 4 Number of full joints J1 4 Number of half joints J2 0 2 3 1 M 3 L 1 2 J1 J2 4 M1 1 BODY c. An electric can opener has 2 DOF. d. A folding ironing board. The board 1 itself has one pivot full joint and one pininslot sliding half joint. The two legs 2 and 3 hav a common pivot. One leg connects to the pivot joint on the board and the other to the slider joint. DESIGN OF MACHINERY 5th Ed SOLUTION MANUAL 212 Number of links L 3 Number of full joints J1 2 Number of half joints J2 1 1 3 2 M 3 L 1 2 J1 J2 M1 e. A folding card table has 7 DOF One for each leg, 2 for location in xy space, and one for angular orientation. f. A folding beach chair. The seat 3 and the arms 6 are ternary links. The seat is linked to the front leg2, the back 5 and a coupling link 4. The arms are linked to the front leg 2, the rear leg 1, and the back 5. Links 1, 2, 4, and 5 are binar links. The analysis below is appropriate when the chair is not fully opened. When fully opened, one or more links are prevented from moving by a stop. Subtract 1 DOF when forced against the stop. DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 221 PROBLEM 22 Statement How many DOF do you have in your wrist and hand combined. Solution See Mathcad file P0202. 1. Holding the palm of the hand level and facing toward the floor, the hand can be rotated about an axis through the wrist that is parallel to the floor and perpendicular to the forearm axis and one perpendicular to

the floor 2 DOF. The wrist can rotate about the forearm axis 1 DOF. 2. Each finger and thumb can rotate up and down and sidetoside about the first joint. Additionally, each finger can rotate about each of the two remaining joints for a total of 4 DOF for each finger and thumb. 3. Adding all DOF, the total is Wrist Hand Thumb Fingers 4x4 1 2 4 16 TOTAL 23 DESIGN OF MACHINERY 5th Ed. PROBLEM 23 Statement How many DOF do the following joints have a. Your knee b. Your ankle c. Your shoulder d. Your hip
e.

Your knuckle Solution See Mathcad file P0203. a. Your knee. 1 DOF A rotation about an axis parallel to the ground. b. Your ankle. 3 DOF Three rotations about mutually perpendicular axes. c. Your shoulder. 3 DOF Three rotations about mutually perpendicular axes. d. Your hip. 3 DOF Three rotations about mutually perpendicular axes.SOLUTION MANUAL 231 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 241 PROBLEM 24 Statement How many DOF do the following have in their normal environment a. A submerged submarine b. An earthorbit satellite c. A surface ship d. A motorcycle road bike e. A twobutton mouse f. A computer joy stick. Solution See Mathcad file P0204. a. A submerged submarine. Using a coordinate frame attached to earth, or an inertial coordinate frame, a submarine has 6 DOF 3 linear coordinates and 3 angles. b. An earthorbit satellite. If the satellite was just a particle it would have 3 DOF. But, since it probably needs to be oriented with respect to the earth, sun, etc., it has 6 DOF. c. A surface ship. There is no difference between a submerged submarine and a surface ship, both have 6 DOF. One might argue that, for an earthcentered frame, the depth of the ship with respect to mean sea level is constant, however that is not strictly true. A ships position is generally given by two coordinates longitude and latitude. For a given position, a ship can also have pitch, yaw, and roll angles. Thus, for all practical purposes, a surface ship has 5 DOF. d. A motorcycle. At an intersection, the motorcycles position is given by two coordinates. In addition, it will have some heading angle turning a corner and roll angle if turning. Thus, there are 4 DOF. e. A twobutton mouse. A twobutton mouse has 4 DOF. It can move in the x and y directions and each button has 1 DOF. f. A computer joy stick. The joy stick has 2 DOF x and y and orientation, for a total of 3 DOF. SOLUTION MANUAL 251 PROBLEM 25 Statement Are the joints in Problem 23 force closed or form closed.

Solution See Mathcad file P0205. They are force closed by ligaments that hold them together. None are geometrically closed. Pure translation. d. The keys on a computer keyboard. Pure translation. e. The hand of a clock. Pure rotation. f. A hockey puck on the ice. Pure rotation. DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 281 PROBLEM 28 Statement Identify the items in Figure P21 as mechanisms, structures, or preloaded structures. SOLUTION MANUAL 291 PROBLEM 29 Statement Use linkage transformation on the linkage of Figure P21a to make it a 1DOF mechanism. Choosing the joint between links 2 and 4, we now have mobility Number of links L 6 Number of full joints J1 6 Number of half joints J2 2 6 3 5 M 3 L 1 2 J1 J2 2 4 M1 1 1 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2101 PROBLEM 210 Statement Use linkage transformation on the linkage of Figure P21d to make it a 2DOF mechanism. We now have mobility Number of links L 6 Number of full joints J1 6 Number of half joints J2 1 M 3 L 1 2 J1 J2 1 6 5 1 2 3 M2 4 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2111 PROBLEM 211 Statement Use number synthesis to find all the possible link combinations for 2DOF, up to 9 links, to hexagonal order, using only revolute joints. Note that the number of links must be odd to have an even DOF see Eq. 2.4. The smallest possible 2DOF mechanism is then 5 links since three will give a structure the delta triplet, see Figure 27. SOLUTION MANUAL 2121 PROBLEM 212 Statement Find all of the valid isomers of the eightbar 1DOF link combinations in Table 22 p. 38 having a. Four binary and four ternary links. b. Five binaries, two ternaries, and one quaternary link. c. Six binaries and two quaternary links. d. Six binaries, one ternary, and one pentagonal link. Solution See Mathcad file P0212. 1. 2. a. Table 23 lists 16 possible isomers for an eightbar chain. However, Table 22 shows that there are five possible link sets, four of which are listed above.

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Therefore, we expect that the 16 valid isomers are distributed among the five link sets and that there will be fewer than 16 isomers among the four link sets listed above. One method that is helpful in finding isomers is to represent the linkage in terms of molecules as defined in Frankes Condensed Notations for Structural Synthesis. The number of straight lines emanating from a circle must be equal to its valence number. 4 Numbers 0, 1, 2, etc. are placed on the straight lines to correspond to the number of binary links used in connecting the higher order links. 5 There is onetoone correspondence between the molecule and the kinematic chain that it represents. Four binary and four ternary links. Draw 4 circles with valence numbers of 3 in each. Then find all unique combinations of straight lines that can be drawn that connect the circles such that there are exactly three lines emanating from each circle and the total of the numbers written on the lines is exactly equal to 4. In this case, there are three valid isomers as depicted by Frankes molecules and kinematic chains below. 8 1 3 3 5 1 0 0 1 3 6 3 3 1 4 2 1 7 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2122 8 0 3 3 2 0 5 0 1 3 7 6 3 1 3 4 1 2 8 5 0 3 3 4 2 0 6 0 2 3 3 3 0 7 1 2 The mechanism shown in Figure P25b is the same eightbar isomer as that depicted schematically above. b. Five binaries, two ternaries, and one quaternary link. Draw 2 circles with valence numbers of 3 in each and one with a valence number of 4. Then find all unique combinations of straight lines that can be drawn that connect the circles such that there are exactly three lines emanating from each circle with valence of three and four lines from the circle with valence of four; and the total of the numbers written on the lines is exactly equal to 5. In this case, there are five valid isomers as depicted by Frankes molecules and kinematic chains below. 0 3 2 4 7 0 1 5 3 3 2 6 4 8 1 2 DESIGN OF MACHINERY 5th Ed.

https://fjdeboer.com/images/Ct151-Husqvarna-Manual.pdf

SOLUTION MANUAL 2123 5 1 3 0 3 0 2 6 4 7 3 2 4 8 1 2 5 0 3 1 3 3 7 1 2 4 6 1 2 8 4 1 5 1 3 1 6 3 4 0 1 3 2 7 8 4 1 2 5 1 3 1 6 3 3 1 1 1 8 4 7 2 4 1 c. Six binaries and two quaternary links. Draw 2 circles with valence numbers of 4 in each. Then find all unique combinations of straight lines that can be drawn that connect the circles such that there are exactly four lines emanating from each circle and the total of the numbers written on the lines is exactly equal to 6. In this case, there are two valid isomers as depicted by Frankes molecules and kinematic chains below. SOLUTION MANUAL 2124 0 2 7 4 4 4 5 3 6 2 8 2 1 2 1 4 1 7 4 4 d. 3 6 2 2 5 8 2 1 Six binaries, one ternary, and one pentagonal link. There are no valid implementations of 6 binary links with 1 pentagonal link. Note that the sliders are attached to links 3 and 5 in such a way that they can not rotate relative to the links. The number of links and 1DOF joints remains the same. There are no 2DOF joints in either mechanism. A 4 3 5 2 1 6 B DESIGN OF MACHINERY 5th Ed. Note that the slider is attached to link 3 in such a way that it can not rotate relative to the link. SOLUTION MANUAL 2151 PROBLEM 215 Statement Calculate the Grashof condition of the fourbar mechanisms defined below. Build cardboard models of the linkages and describe the motions of each inversion. Link lengths are in inches or double given numbers for centimeters. Part 1. a. b. c. 2 2 2 4.5 3.5 4.0 7 7 6 9 9 8 Part 2. d. e. f. 2 2 2 4.5 4.0 3.5 7 7 7 9 9 9 Solution 1. See Mathcad file P0215 Use inequality 2.8 to determine the Grashof condition. SOLUTION MANUAL 2161 PROBLEM 216 Statement Which types of electric motor would you specify a. b. c. Solution To drive a load with large inertia. To minimize variation of speed with load variation. To maintain accurate constant speed regardless of load variations. See Mathcad file P0216. a. Motors with high starting torque are suited to drive large inertia loads.

http://idc504.com/images/Ct12-Manual.pdf

Those with this characteristic include serieswound, compoundwound, and shuntwound DC motors, and capacitorstart AC motors. b. Motors with flat torquespeed curves in the operating range will minimize variation of speed with load variation. Those with this characteristic include shuntwound

DC motors, and synchronous and capacitorstart AC motors. b. Speedcontrolled DC motors will maintain accurate constant speed regardless of load variations. SOLUTION MANUAL 2171 PROBLEM 217 Statement Describe the difference between a camfollower half joint and a pin joint. Solution See Mathcad file P0217. 1. A pin joint has one rotational DOF. A camfollower joint has 2 DOF, rotation and translation. The pin joint also captures its lubricant in the annulus between pin and bushing while the camfollower joint squeezes its lubricant out of the joint. SOLUTION MANUAL 2181 PROBLEM 218 Statement Examine an automobile hood hinge mechanism of the type described in Section 2.14. Sketch it carefully. Calculate its DOF and Grashof condition. Make a cardboard model. Analyze it with a freebody diagram. Describe how it keeps the hood up. Solution Solution of this problem will depend upon the specific mechanism modeled by the student. SOLUTION MANUAL 2191 PROBLEM 219 Statement Find an adjustable arm desk lamp of the type shown in Figure P22. Sketch it carefully. Measure it and sketch it to scale. Describe how it keeps itself stable. Are there any positions in which it loses stability. Why Solution Solution of this problem will depend upon the specific mechanism modeled by the student. Determine a The rated torque in ozin ounceinches, the industry standard for fractional hp motors b The noload speed c Plot the powertorque curve and determine the maximum power that the motor can deliver. Given Rated speed, N NR 2500 rpm R HR Rated power, H R 1 8. From the graph the equation for the torquespeed curve is 3000.DESIGN OF MACHINERY 5th Ed.

SOLUTION MANUAL 2211 PROBLEM 221 Statement Find the mobility of the mechanisms in Figure P24. Solution See Figure P24 and Mathcad file P0221. 1. Use equation 2.1c Kutzbachs modification to calculate the mobility. a. This is a basic fourbar linkage. The input is link 2 and the output is link 4. The crosshatched pivot pins at O2 and O4 are attached to the ground link 1. Number of links L 4 Number of full joints J1 4 Number of half joints J2 0 M 3 L 1 2 J1 J2 A 2 3 O2 M1 b. 4 C O4 This is a fourbar linkage. The input is link 2, which in this case is the wheel 2 with a pin at A, and the output is link 4. The crosshatched pivot pins at O2 and O4 are attached to the ground link 1. Number of links L 4 Number of full joints J1 4 Number of half joints J2 0 A 2 O2 3 M 3 L 1 2 J1 J2 4 B M1 c. O4 This is a 3cylinder, rotary, internal combustion engine. The pistons sliders 6, 7, and 8 drive the output crank 2 through piston rods couplers 3, 4, and 5. There are 3 full joints at the crank where rods 3, 4and 5 are pinned to crank 2. The crosshatched crankshaft at O2 is supported by the ground link 1 through bearings. Number of links L 8 Number of full joints J1 10 Number of half joints J2 0 M 3 L 1 2 J1 J2 6 3 2 4 M1 7 5 8 DESIGN OF MACHINERY 5th Ed. d. SOLUTION MANUAL 2212 This is a fourbar linkage. The input is link 2, which in this case is a wheel with a pin at A, and the output is the vertical member on the coupler, link 3. Since the lengths of links 2 and 4 O2A and O4B are the same, the coupler link 3 has curvilinear motion and AB remains parallel to O2O4 throughout the cycle. The crosshatched pivot pins at O2 and O4 are attached to the ground link 1. Number of links L 4 Number of full joints J1 4 Number of half joints J2 0 M 3 L 1 2 J1 J2 B O4 O2 M1 e. 3 A 2 4 This is a fourbar linkage with an output dyad. The input rocker is link 2 and the output rocker is link 8. Links 5 and 6 are redundant, i.e.

the mechanism will have the same motion if they are removed. The input fourbar consists of links 1, 2, 3, and 4. The output dyad consists of links 7 and 8. The crosshatched pivot pins at O2, O4 and O8 are attached to the ground link 1. In the calculation below, the redundant links and their joints are not counted subtract 2 links and 4 joints from the totals. A Number of links L 6 Number of full joints J1 7 Number of half joints J2 0 O2 4 O4 G E 3 2 D 5 C 6 7 M 3 L 1 2 J1 J2 O8 M1 F H 8 f. This is a fourbar offset slidercrank linkage. The input is link 2 crank and the output is link 4 slider block. The crosshatched pivot pin at O2 is attached to the ground link 1. Number of links L 4 Number of full joints J1 4 Number of half joints J2 0 4 B 3 M 3 L 1 2 J1 J2 A M1 2 O2 DESIGN OF MACHINERY 5th Ed. g. SOLUTION MANUAL 2213 This is a fourbar linkage with an alternate output dyad. The input rocker is link 2 and the outputs rockers are links 4 and 6. The input fourbar consists of links 1, 2, 3, and 4. The alternate output dyad consists of links 5 and 6. The crosshatched pivot pins at O2, O4 and

O6 are attached to the ground link 1. Number of links L 6 Number of full joints J1 7 Number of half joints J2 0 O6 3 B A 2 M 3 L 1 2 J1 J2 4 C 6 O2 M1 5 D O4 h. This is a ninebar mechanism with three redundant links, which reduces it to a sixbar. Since this mechanism is symmetrical about a vertical centerline, we can split it into two mirrored mechanisms to analyze it. Either links 2, 3 and 5 or links 7, 8 and 9 are redundant. To analyze it, consider 7, 8 and 9 as the redundant links. Analyzing the ninebar, there are two full joints at the pins A, B and C for a total of 12 joints. Number of links L 9 Number of full joints J1 12 Number of half joints J2 0 6 O2 2 8 7 5 C B M 3 L 1 2 J1 J2 O8 A 9 3 M0 4 D E The result is that this mechanism seems to be a structure.

By splitting it into mirror halves about the vertical centerline the mobility is found to be 1. Subtract the 3 redundant links and their 5 6 minus the joint at A associated joints to determine the mobility of the mechanism. Number of links L 9 3 Number of full joints J1 12 5 Number of half joints J2 0 6 O2 2 5 B M 3 L 1 2 J1 J2 3 M1 D 4 A DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2221 PROBLEM 222 Statement Solution 1. Find the Grashof condition and Barker classifications of the mechanisms in Figure P24a, b, and d. See Figure P24 and Mathcad file P0222. Use inequality 2.8 to determine the Grashof condition and Table 24 to determine the Barker classification. L1 174 L2 116 L3 108 L4 110 A 2 3 Condition. The input is link 2, which in this case is the wheel with a pin at A, and the output is link 4. The crosshatched pivot pins at O2 and O4 are attached to the ground link 1. L1 162 L2 40 L3 96 L4 122 B A 2 3 O2 4 Condition. O4 A 3 2 O2 B O4 4 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2231 PROBLEM 223 Statement Find the rotability of each loop of the mechanisms in Figure P24e, f, and g. Solution See Figure P24 and Mathcad file P0223. 1. Use inequality 2.15 to determine the rotability of each loop in the given mechanisms. e. This is a fourbar linkage with an output dyad. B A O2 4 O4 G E 3 2 D 5 C 6 7 O8 There are two loops in this mechanism. The first loop consists of links 1, 2, 3 or 5, and 4. The second consists of links 1, 4, 7 or 6, and 8. By inspection, we see that the sum of the shortest and longest in each loop is equal to the sum of the other two. Thus, both loops are Class III. f. 8 This is a fourbar offset slidercrank linkage. The crosshatched pivot pin at O2 is attached to the ground link 1. 4 A 2 O2 O6 This is a fourbar linkage with an alternate output dyad. The input rocker is link 2 and the outputs rockers are links 4 and 6. The input fourbar consists of links 1, 2, 3, and 4. The alternate output dyad consists of links 5 and 6.

The crosshatched pivot pins at O2, O4 and O6 are attached to the ground link 1.Then links 1 and 4 for are both infinitely long. Since these two links are equal in length and, if we say they are finite in length but very long, the rotability of the mechanism will be determined by the relative lengths of 2 and 3. Thus, this is a Class I linkage since link 2 is shorter than link 3. g. H F 3 B 2 4 C A 6 O2 5 D Using the notation of inequality 2.15, N 4 LN r4 L1 r2 L2 r1 LN L1 202 O4 L3 r3 L2 L3 187 Since LN L1 L2 L3, this is a a class II mechanism. SOLUTION MANUAL 2241 PROBLEM 224 Statement Find the mobility of the mechanisms in Figure P25. Solution See Figure P25 and Mathcad file P0224. 1. Use equation 2.1c Kutzbachs modification to calculate the mobility. In the kinematic representations of the linkages below, binary links are depicted as single lines with nodes at their end points whereas higher order links are depicted as 2D bars. a. This is a sixbar linkage with 4 binary 1, 2, 5, and 6 and 2 ternary 3 and 4 links. The inverted Ushaped link at the top of Figure P25b is represented here as the binary link 8. Number of links L 8 Number of full joints J1 10 Number of half joints J2 0 M 3 L 1 2 J1 J2 M1 5 6 2 3 7 8 2 O2 4 O4 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2251 PROBLEM 225 Statement Find the mobility of the ice tongs in Figure P26. a. When operating them to grab the ice block. b. When clamped to the ice block but before it is picked up ice grounded. c. When the person is carrying the ice block with the tongs. Solution See Figure P26 and Mathcad file P0225. 1. Use equation 2.1c Kutzbachs modification to calculate the mobility. a. In this case there are two links and one full joint and 1 DOF. Number of links L 2 Number of full joints J1 1 Number of half joints J2 0 M 3 L 1 2 J1 J2 b.

When the block is clamped in the tongs another link and two more full joints are added reducing the DOF to zero the tongs and ice block form a structure. Number of links L 2 1 Number of full joints J1 1 2 Number of half joints J2 0 M 3 L 1 2 J1 J2 c. M1 M0 When the block is being carried the system has at least 4 DOF x, y, and z position and orientation about a vertical axis. SOLUTION MANUAL 2261 PROBLEM 226 Statement Find the mobility of the automotive throttle mechanism shown in Figure P27. Solution See Figure P27 and Mathcad file P0226. 1. This is an eightbar linkage with 8 binary links. It is assumed that the joint between the gas pedal 2 and the roller 3 that pivots on link 4 is a full joint, i.e. the roller rolls without slipping. The pivot pins at O2, O4, O6, and O8 are attached to the ground link 1. Use equation 2.1c Kutzbachs modification to calculate the mobility. Number of links L 8 Number of full joints J1 10 Number of half joints J2 0 M 3 L 1 2 J1 J2 M1 7 6 O6 8 FULL JOINT 5 4 O4 3 2 O2 O8 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2271 PROBLEM 227 Statement Sketch a kinematic diagram of the scissors jack shown in Figure P28 and determine its mobility. Describe how it works. Solution See Figure P28 and Mathcad file P0227. 1. The scissors jack depicted is a seven link mechanism with eight full and two half joints see kinematic diagram below. Link 7 is a variable length link. Its length is changed by rotating the screw with the jack handle not shown. The two blocks at either end of link 7 are an integral part of the link. The block on the left is threaded and acts like a nut. The block on the right is not threaded and acts as a bearing. Both blocks have pins that engage the holes in links 2, 3, 5, and 6. Joints A and B have 2 full joints apiece. When the screw is turned to give the jack a different height the jack has 1 DOF.

4 3 5 7 A B 2 6 1 Number of links L 7 Number of full joints J1 8 Number of half joints J2 2 M 3 L 1 2 J1 J2 M0 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2281 PROBLEM 228 Statement Find the mobility of the corkscrew in Figure P29. Solution See Figure P29 and Mathcad file P0228. 1. The corkscrew is made from 4 pieces the body 1, the screw 2, and two arms with teeth 3, one of which is redundant. The second arm is present to balance the forces on the assembly but is not necessary from a kinematic standpoint. Using equation 2.1c, the DOF mobility is Number of links L 3 Number of full joints J1 2 Number of half joints J2 1 M 3 L 1 2 J1 J2 M1 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2291 PROBLEM 229 Statement Figure P210 shows Watts sun and planet drive that he used in his steam engine. The beam 2 is driven in oscillation by the piston of the engine. The planet gear is fixed rigidly to link 3 and its center is guided in the fixed track 1. The output rotation is taken from the sun gear 4. Sketch a kinematic diagram of this mechanism and determine its DOF. Can it be classified by the Barker scheme. If so, what Barker class and subclass is it. Solution See Figure P210 and Mathcad file P0229. 1. Sketch a kinematic diagram of the mechanism. The mechanism is shown on the left and a kinematic model of it is sketched on the right. It is a fourbar linkage with 1 DOF see below. A 2 2 1 3 3 1 4 B 4 1 2. C Use equation 2.1c to determine the DOF mobility. There are 4 links, 3 full pin joints, 1 half pininslot joint at B, and 1 half joint at the interface C between the two gears, shown above by their pitch circles. Links 1 and 3 are ternary. Kutzbachs mobility equation 2.1c Number of links L 4 Number of full joints J1 3 Number of half joints J2 2 M 3 L 1 2 J1 J2 3. M1 The Barker classification scheme requires that we have 4 link lengths.

The motion of link 3 can be modeled by a basic fourbar if the half joint at B is replaced with a full pin joint and a link is added to connect B and the fixed pivot that is coincident with the center of curvature of the slot that guides pin B. L1 2.15 L2 1.25 L3 1.80 L4 0.54 This is a Grashof linkage and the Barker classification is I4 type 4 because the shortest link is the output. SOLUTION MANUAL 2301 PROBLEM 230 Statement Figure P211 shows a bicycle hand brake lever assembly. Sketch a kinematic diagram of this device and draw its equivalent linkage. Determine its mobility. Hint Consider the flexible cable to be a link. Solution See Figure P211 and Mathcad file P0230. 1. The motion of the flexible cable is along a straight line as it leaves the guide provided by the handle bar so it can be modeled as a translating full slider that is supported by the handlebar link 1. The brake lever is a binary link that pivots on the ground link. Its other node is attached through a full pin joint

to a third link, which drives the slider link 4. Number of links L 4 Number of full joints J1 4 Number of half joints J2 0 M 3 L 1 2 J1 J2 M1 CABLE BRAKE LEVER 3 2 4 1 1 DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2311 PROBLEM 231 Statement Figure P212 shows a bicycle brake caliper assembly. Determine its mobility under two conditions. a. b. Brake pads not contacting the wheel rim. Brake pads contacting the wheel rim. Hint Consider the flexible cable to be replaced by forces in this case. Solution 1. See Figure P212 and Mathcad file P0231. The rigging of the cable requires that there be two brake arms. However, kinematically they operate independently and can be analyzed that way. Therefore, we only need to look at one brake arm. When the brake pads are not contacting the wheel rim there is a single lever link 2 that is pivoted on a full pin joint that is attached to the ground link 1. Thus, there are two links frame and brake arm and one full pin joint.

Number of links L 2 Number of full joints J1 1 Number of half joints J2 0 BRAKE ARM FRAME 2 M 3 L 1 2 J1 J2 M1 2. 1 When the brake pad contacts the wheel rim we could consider the joint between the pad, which is rigidly attached to the brake arm and is, therefore, a part of link 2, to be a half joint. The brake arm with pad, wheel which is constrained from moving laterally by the frame, and the frame constitute a structure. Number of links L 2 Number of full joints J1 1 Number of half joints J2 1 BRAKE ARM FRAME 2 M 3 L 1 2 J1 J2 M0 1 1 HALF JOINT DESIGN OF MACHINERY 5th Ed. SOLUTION MANUAL 2321 PROBLEM 232 Statement Find the mobility, the Grashof condition, and the Barker classifications of the mechanism in Figure P213. Solution See Figure P213 and Mathcad file P0232. 1. Use equation 2.1c Kutzbachs modification to calculate the mobility. When there is no cable in the jaw or before the cable is crimped this is a basic fourbar mechanism with with 4 full pin joints Number of links L 4 Number of full joints J1 4 Number of half joints J2 0 M 3 L 1 2 J1 J2 M1 When there is a cable in the jaw this is a threebar mechanism with with 3 full pin joints. While the cable is clamped the jaws are stationary with respect to each other so that link 4 is grounded along with link 1, leaving only three operational links. 2. Number of links L 3 Number of full joints J1 3 Number of half joints J2 0 M 3 L 1 2 J1 J2 M0 Use inequality 2.8 to determine the Grashof condition and Table 24 to determine the Barker classification. The rated speed for this fractional horsepower motor is 10000 rpm at a rated voltage of 130V. Determine a The rated torque in ozin ounceinches, the industry standard for fractional hp motors b The noload speed c The operating speed range d Plot the powertorque curve in the operating range and determine the maximum power that the motor can deliver in the that range.