Crank mechanism

Name: Monish Kumar (S11065194) The University of the South Pacific MM313 Dynamic Systems Experiment 2- Crank Mechanism Aim: To investigate the relationship between piston displacement and crank angle for different ratios between the connecting rod and the crank. Also to look at the relationship between the turning moment on the crank shaft and crank angle for a given force on the piston. Equipment and Instrument: Introduction: A crank is an arm attached at right angles to a rotating shaft by which reciprocating motion is imparted to or received from the shaft. It is used to convert circular motion into reciprocating motion, or vice-versa.

The arm may be a bent portion of the shaft, or a separate arm attached to it. Attached to the end of the crank by a pivot is a rod, usually called a connecting rod. The end of the rod attached to the crank moves in a circular motion, while the other end is usually constrained to move in a linear sliding motion. Theory: Figure 1. 0: Slider crank mechanism The slider crank mechanism as shown in figure 1. 0 is a kinematic mechanism. The piston displacement from the top dead centre, x, can be determined from the geometry of the mechanism, in terms of the lengths of the connecting rod, L, and crank, R, and the crank angle, ? can be expressed as x= L+R-(Lcos? -Rcos?) Also from the geometry, it can be seen that Rsin? = Lsin? And sin? = sin? n Hence cos? =[1+sin? n2]1/2 Where n is a ratio: n= LR Procedure: Part A: 1) No weights and hangers required, the unit initial starting position 0 in the protractor is setup and 90? and 270? protractor positions to be in line with the level lines in each side. 2) The unit is to be setup in its highest point, Top dead centre point was used to work out the displacement value 3) The mounted disc was turned 30? nd the displacement was noted on the results table, this step was again repeated for different angles and different crank positions. Part B: Results: PART A Table 1: Results of Piston Displacement Crank angle| Displacement| | P1 (mm) experiment| P1 (mm) theory| P2 (mm) experiment| P2 (mm) theory| P3 (mm) experiment| P3 (mm) theory| 0| 0| 0| 0| 0| 0| 0| 30| 3| 3. 180748214| 5| 4. 252344481| 7| 5. 324742758| 45| 7| 6. 86291501| 10| 9. 20565874| 13| 11. 55001055| 60| 12| 11. 51142198| 17| 15. 51081741| 20| 19. 51263112| 90| 22| 22. 02041029| 31| 30. 01960212| 39| 38. 2202662| 120| 31| 31. 51142198| 45| 43. 51081741| 53| 55. 51263112| 135| 35| 35. 14718626| 50| 48. 80363849| 63| 62. 4616988| 150| 38| 37. 82176437| 53| 52. 74976709| 68| 67. 67857183| 180| 39| 40| 56| 56| 71| 72| Table 2: calculation of the angle ? Crank angle| ? | 0| 0| 30| 5. 73917| 45| 8. 130102| 60| 9. 974222| 90| 11. 53696| 120| 9. 974222| 135| 8. 130102| 150| 5. 73917| 180| 1. 40E-15| Graph of Displacement (mm) vs. Crank angle position (?) Sample Calculation: For Displacement P1 at 30? crank angle. To find, ? , n = 5 sin? = sin? n ?= sin-1sin? n= sin-1sin305= 5. 73917?

To calculate the theoretical displacement, x: x= r1-cos? +nr(1-cos?) x= 201-cos30+nr1-cos5. 73917= 3. 180748214 mm Discussion: 1. After plotting the graph of Displacement versus the crank angle position, the graph show that the experimental values and the theoretical displacement can be compared, the experimental plot and the theoretical plot are almost same. 2. From the results graph the graph show that the measured displacement follows the theoretical curve very well. The maximum difference between the experimental and theoretical displacement is 2 mm. 3. For full rotation i. e. 60? the motion of the piston is close to simple harmonic, after 180? the displacement will gradually decrease to 0, it will form a cosine graph. PART B: Piston Balance and Forces Table 3: Piston balance and forces Angle (?)| No added Piston Weight P3 (N)| 4N Added Piston Weight P3 (N)| | LHS| RHS| LHS| RHS| 0| 4. 9| 4. 9| 4. 9| 4. 9| 30| 5. 3| 4. 9| 5. 8| 4. 9| 45| 5. 5| 4. 9| 6. 1| 4. 9| 60| 5. 7| 4. 9| 6. 3| 4. 9| 90| 5. 8| 4. 9| 6. 2| 4. 9| 120| 5. 5| 4. 9| 5. 8| 4. 9| 135| 5. 3| 4. 9| 5. 6| 4. 9| 150| 5. 1| 4. 9| 5. 5| 4. 9| 180| 4. 9| 4. 9| 4. 9| 5. 3| 225| 4. 9| 5. 3| 4. | 6. 5| 270| 4. 9| 5. 4| 4. 9| 6| 315| 4. 9| 5. 5| 4. 9| 5. 7| Graph of Weights vs. Angle (No added Piston Weight P3 (N)) Graph of Weights vs. Angle (4N added Piston Weight P3 (N)) Discussion: 1) Experimental results was not satisfactory, there was some errors made which was due to friction between the mounted disc and the protractor. 2) After looking at the results graph the greatest amount of force approximately at 60? to 90? for no added piston weight. The weight is 5. 8 N at LHS whereas for 4N added piston weight the greatest amount of force is 6. 5 N at 225? RHS. Conclusion:

The kinematic motion of the crank mechanism can be expressed in terms of the lengths of the crank and the conrod, and the displacement of the crankshaft. The experimental measurements of piston displacement agree with the prediction of a theoretical model of the piston motion. Due to friction errors were made in the second part of the experiment but still manage to get the results to find out the greatest amount of force being exerted on crank mechanism. Reference: Experiment 2 - Crank Mechanism. (2013). Suva, Fiji Islands. Kearney, M. (2005, August 15). Kinematics of a Slider- crank mechanism.