**Round 1- Dynamics of Machine Lab**

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### Department: Mechanical Engineering

### Discipline: Mechanical Engineering

### Name of the Lab: Dynamics of Machine Lab

### Name of experiment: Dynamics of Four Bar Mechanism

### Experiment Number: 1

### FOCUS AREA: Experimental Analysis Methods

**About the Experiment**:

A four bar link mechanism or linkage is the most fundamental of the plane kinematics linkages. It is a much-preferred mechanical device for the mechanization and control of motion due to its simplicity and versatility. Basically, it consists of four rigid links which are connected in the form of quadrilateral by four pin joints. A link that makes complete revolutions is the crank, the link opposite to the fixed link is the coupler and the forth link a lever or rocker if oscillates or another crank, if rotate. Through the process of the simulation, one would understand how to calculate the forces on each link for a constant angular velocity as input. The dynamic analysis of the four bar mechanism is covered after understanding the kinematic analysis since the acceleration of the links are required to calculate the forces on the link.

**1. Learning Objectives and Cognitive Level:**

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| **Sr. No** | **Learning Objectives** | **Cognitive level** | **Action Verbs** |
| 1. Students will be able to: | Define the concepts of dynamic analysis of four bar mechanisms | Recall | Define |
| 2. Students will be able to: | Describe the use of four bar mechanism | Understand | Describe |
| 3. Students will be able to: | Calculate the velocity and acceleration on each link. | Apply | Calculate |
| 4. Students will be able to: | Examine the calculated values with the experimental results | Analyse | Examine |
| 5. Students will be able to: | Evaluate how change in length, angle and driving force results in acceleration, velocity and work done by the mechanism changes | Evaluate | Evaluate |

**2. Instructional Strategy:**

### 2.1 Method: Expository

### 2.2 Assessment Method: Formative Assessment

### 2.3 Description:

### The animation of four bar mechanism is shown with the help of velocity and acceleration diagram. The rotational speed and length of each link can be varied to change the motion of the mechanism. For better understanding the animation of acceleration of CG and offset analysis is given. The mass of each link can be varied for understanding the forces and motion due to forces on each link.

### 3. Task & Assessment Questions:

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| **Sr. No.** | **Instructions given by the Teacher** | **Tasks to be done by the Students** | **Assessment question aligned with the task** |
| 1. | Explain the significance of this experiment in real world applications. | Understand the significance of the experiment and recall its applications. | Q.1, Q.4 |
| 2. | Display/show the different Instruments used in the experiment. Explain the significance of each Instrument and its use in the experiment. | Recall the various Instruments used in the experiment and understand its significance. | Q.8 |
| 3. | Explain the step by step procedure to be carried out in the experiment. | Understand the procedure to be followed to conduct the experiment. | Q.11 |
| 4. | Explain how to use the various equipment’s used in the experiment. | Follow the instructions carefully in order to get the required outcome such as acceleration, velocity and force | Q.11, Q.5 |
| 5. | Explain the significance change in length and drive force in achieving optimal results | Understand the significance explained | Q.9, Q.2 |
| 6. | Explain the various forces acting on the bars and its calculations. | Understand the various forces and its calculations. | Q.9, Q.10, Q.13 |
| 7. | To carry out the required calculations | Understand the volume calculation of the slump cone. | Q.3, Q.6, Q.7 |
| 8. | Observations to be noted down. | Note down the acceleration at the centre of the link, torque, forces acting on each link etc. | Q.6, |

### Additional Assessment Questions:

### Which of the following statement is correct as regard to the difference between a machine and a structure?

### A machine transforms the available energy into some useful work, whereas in a structure no energy is transformed into useful work

### The parts of a machine move relative to one another, whereas the members of a structure do not move relative to one another.

### The links of a machine may transmit both power and motion, whereas the members of a structure transmit forces only.

### All the above statement

### Answer: d

### Explanation: None

### A kinematic chain is known as a mechanism when

### Three of the links is fixed

### Two of the links is fixed

### One of the links is fixed

### None of the above

### Answer: c

### .

### The Grubler’s criterion for determining the degrees of freedom (n) of a mechanism having plane motion is

### N= 4(l-1)-3j

### N= 3(l-1)-2j

### N= 2(l-1)-2j

### N= (l-1)- j

### Answer: b

### What is the use of beam engine?

### To convert oscillatory motion into rotary motion

### To convert rotary motion into oscillatory motion

### To convert rotary motion into reciprocating motion

### To convert reciprocating motion into rotary motion

### Answer: c

### How many revolute joints are there in a four bar mechanism

### 1

### 4

### 6

### 8

### Answer: b

### **Which of the following is an inversion of four bar kinematic chain?**

### **Reciprocating engine**

### **Rotary engine**

### **Oscillating Engine**

### **Beam engine**

### **Answer: a**

### “Inversions of Four Bar Chain”.

### Match list 1 with list 2

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| --- | --- |
| List 1 | |
| A | Quick return Mechanism |
| B | Apron mechanism |
| C | Indexing mechanism |
| D | Regulating wheel |

|  |  |
| --- | --- |
| List 2 | |
| 1 | Lathe |
| 2 | Shaper |
| 3 | Milling machine |
| 4 | Centreless grinding |

### A-3, B-2, C-1, D-4

### A-2, B-1, C-3, D-4

### A-4, B-2, C-3, D-1

### A-2, B-3, C-4, D-1

### Answer: b

1. What is the Grashof linkage criterion?
2. s+l>p+q
3. s+l<p+q
4. s+p>l+q
5. s+p<l+q

Answer: B

1. How many equations in total are formed in the process of finding out the forces on each link?
2. 3
3. 6
4. 9
5. 12

Answer: C

1. How many forces are acting on each link due to other links?
2. 2
3. 3
4. 4
5. 5

Answer: A

1. What is the order of analysis of the four bar linkage?
2. Position analysis, Velocity analysis, Dynamic Analysis, Acceleration analysis
3. Dynamic Analysis, Acceleration analysis, Position analysis, Velocity analysis
4. Position analysis, Velocity analysis, Acceleration analysis, Dynamic Analysis
5. Dynamic Analysis, Position analysis, Velocity analysis, Acceleration analysis,

Answer: C

1. How many degrees of freedom does a four bar mechanism have?
2. 0
3. 1
4. 2
5. 3

Answer: B

1. What is the shortest link for the following category of four bar mechanism?
2. Double crank (s + l < p + q)
3. Double rocker (s + l < p + q)
4. Frame and coupler
5. Frame and side
6. Coupler and side
7. Coupler and frame

Answer: a

### 4. Simulator Interactions:

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| Sr. No | What students will do? | What Simulator will do? | Purpose of the task |
| 1. | See the displayed objectives and apparatus used then click on next button | Display objective and apparatus used | Recall the experiment |
| 2. | Change the length and speed as per required | Display length of each links and the angle theta | To change the lengths to the desired values |
| 3. | Click on the arrow mark and proceed for the next section | Display the velocity and acceleration diagram along with the table containing, position, acceleration of each link and display arrow marks to proceed | To get the velocity, acceleration and position of each link |
| 4. | Navigate to the next page using the arrows displayed | Display the acceleration at the CG | To obtain the acceleration at CG’s |
| 5. | Change to the required torque and angle theta and click next button | Display acceleration at CG and also provision to change the torque and angle | To obtain acceleration when torque is changed |
| 6. | Change the masses as required and click on arrow to proceed. | Display provision to change mass of each bars and display table containing the values of forces acting on each links | To change the masses of each bars and to get desired output |

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