**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 analysis of slider crank mechanism

**FOCUS AREA:** Experimental Analysis Method

**About the Experiment:**

The slider crank mechanism is one of the most basic forms of closed loop mechanisms. It has a single degree of freedom and is often used to convert rotary motion into linear motion by varying link lengths. From an application perspective it is very important to understand the dynamics of such a system. The kinematics of the system is largely governed by the link length and so is the dynamics of the system. 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 slider crank 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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| --- | --- | --- | --- |
| **S.No** | **Learning Objectives** | **Cognitive level** | **Action verb** |
| 1. Student will be able to: | State the concepts of dynamic analysis of slider crank | Recall | State |
| 2. Student will be able to: | Understand the significance of parameter and select the variable accordingly. | Understand | Select |
| 3. Student will be able to: | Calculate the velocity, acceleration and force acting on each link. | Apply | Calculate |
| 4. Student will be able to: | Examine the calculated values with the simulation results | Analyse | Examine |
| 5. Student will be able to: | Evaluate how change in length, angle and driving force results in change of acceleration, velocity and work done by the mechanism | Evaluate | Evaluate |

**2. Instructional Strategy**

### 2.1 Method: Expository

### 2.2 Assessment Method: Formative Assessment

**2.3 Description:**

The animation of the slider crank mechanism is shown for better understanding on mechanism with the help of animation of velocity and acceleration triangles. The mass, length of each link can be varied to check the change in motion of the mechanism. For better understating of the dynamic analysis of slider crank mechanism the free body diagram of each link is given with the help of offset analysis and acceleration of CG.

### The animation of slider crank mechanism is shown with velocity and acceleration diagram. The rotational speed and length of connecting rod and crank can be varied to change the motion of the mechanism. The animation of acceleration of CG and offset analysis is given. The acceleration values have been represented as a vector situated on the centre of the links which varies dynamically with respect to the variations in the input speed and angle. Offset analysis simplifies the forces acting on the body of the links by representing the torque acting on the body by displacing the inertial forces at a certain distance from the centre parallel to the inertial force. These offset distances are represented through the table. The mass of each link can be varied for understanding effect of forces on each link.

**3. Task & Assessment Questions**

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| --- | --- | --- | --- |
| **S.No.** | **Instruction Given by the Teacher** | **Tasks to be done by the Students** | **Assessment question aligned with the task** |
| 1. | Explain the dynamic forces acting on four bar mechanism | Understand the significance of the experiment and recall its applications. | Q2, Q3 , Q8, Q11 |
| 2. | Explain the step by step procedure to be carried out in the experiment. | Understand the procedure to be followed to conduct the experiment. | Q5, Q12, Q6 |
| 3. | Derive all the governing equation and to carryout required calculations | Apply the derived equations and calculate the values. | Q1, Q9 |
| 4. | Compare analytical value with simulation results | Note down the acceleration at the centre of the link, torque, forces acting on each link and compare it with analytical value | Q12 |
| 5. | Observe the changes in mechanism due to variation in parameter | Evaluate changes in acceleration, velocity and forces due to change in mass and length of link. | Q13 |

**Additional Assessment Questions:**

1. The number of links in a planer mechanism with revolute joints having 10 instantaneous centers is  
   a)2   
   b)4   
   c)3   
   d) 5

Answer: C

1. **The crank and lever mechanism will produce**
2. Oscillating motion
3. Translating motion
4. Zig-zag motion
5. Rotary motion

Answer: A

1. **If crank is fixed in single slider crank chain, we get**
2. Beam engine
3. Oscillating engine
4. Rotary engine
5. Reciprocating engine

Answer: C

1. **The oscillating cylinder engine can be obtained by fixing**
2. Connecting rod
3. Lever
4. Slider
5. Crank

Answer: A

1. Klein's construction is useful to determine
2. crank has non-uniform angular velocity
3. crank has uniform angular velocity and angular acceleration
4. crank has a uniform angular velocity
5. there is no such criterion

Answer: c

1. Klein construction can be used to determine acceleration of various parts when the crank is at
2. right angles to the link of the stroke
3. at450 to the line of the stroke
4. outer dead center
5. inner dead center
6. all the above

Answer: e

1. The number of dead centers in a slider crank mechanism are
2. 2
3. 3
4. 1
5. may be any number depending upon position of mechanism

Answer: a

1. The slider crank mechanism coverts rotary motion to \_\_\_\_\_\_\_\_\_\_
2. Linear motion
3. Rotary Motion
4. Cycloidal Motion
5. Parabolic motion

Answer: Linear motion

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: 9

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

Answer: 2

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

Answer: 1

1. A slider sliding at 10 mm/s on a link is roating at 60 rpm is subjected to corioli’s acceleration of magnitude
2. 395 mm/s^2
3. 126 mm/s^2
4. 100 mm/s^2
5. 200 mm/s^2

Answer: 126 mm/s^2

1. Consider following statements:

Coriolis component of acceleration depends on

1. Velocity of slider
2. Angular velocity of the link
3. Acceleration of the slider
4. Angular acceleration of the link

Of these statements

1. 1 and 2 are correct
2. 1 and 3 are correct
3. 2 and 4 are correct
4. 1 and 4 are correct

Answer: (a) 1 and 2 are correct

4. Simulator Interactions:

|  |  |  |  |
| --- | --- | --- | --- |
| Sr. No. | What students will do? | What Simulator will do? | Purpose of the task |
| 1. | See the labeling of the set-up and click on the button. | Display label image and display “Show initial condition” button | To recall the set up |
| 2. | Vary the mass of the link by using the required knob button | Display length of each links and the angle theta | To provide the information related to position, velocity and acceleration. |
| 3. | Select any one mode to simulate the mechanism (Pause and Run Mode) and provide the theta value | Display the Numerical Values of position, velocity and acceleration of the linkage. | To give the basic information that how theta affects the velocity and acceleration |
| 4 | Navigate to the next page using the arrows displayed and vary the length, | Display the acceleration at the CG | to see the effect of change of length on the slider crank mechanism |
|  | Navigate to the next page using the arrows displayed | Display the offset analysis animation and tabular column containing offset values | To observe the offset analysis |
| 6. | Note down all the values of forces acting on each link and can further navigate the result through the variables section using the arrows in the control section. | Display all the forces acting on the body | Gives the detail about how forces are interconnected with the variables |