**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**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Learning Objectives** | **Cognitive level** | **Action verb** |
| 1. Student will be able to: | Identify different links of the slider crank linkage | Recall | Identify |
| 2. Student will be able to: | Explain how the CG of each link is at the center of the link | Understand | Explain |
| 3. Student will be able to: | Apply the changes in the parameters under variable section and observe the motion of slider crank mechanism | Apply | Apply |
| 4. Student will be able to: | Calculate the acceleration at the center of gravity of each link by using acceleration component which we got from kinematics analysis | Apply | Calculate |
| 5. Student will be able to: | Examine how acceleration values varies dynamically with respect to the variation in the input speed and angle | Analyze | Examine |

**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.

**3. Task & Assessment Questions**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No.** | **Instruction Given by the Teacher** | **Tasks to be done by the Students** | **Assessment question aligned with the task** |
| 1. | Explain the significance of the experiment with the real world | Recall all the experiments involved in the experiment | Q.8 |
| 2. | Students should go through the analysis properly | Able to derive the governing equation | Q.5, Q.6, Q.11 |
| 3. | Set the initial values or status of the experiment. Change the length and mass of the links. | Ensure that all conditions are addressed or satisfied before starting the experiment. | Q.3, Q.4 |
| 4. | Explain the kinematic analysis on slider crank mechanism. | Follow the instruction and set the value of theta accordingly as per her/his wish | Q.8, Q.9 |
| 5. | Observation to be note down | Figure out the position, velocity and acceleration diagram of the link | Q.1, Q.2, Q.7, Q.10 |
| 6. | Analyze the acceleration at the center of gravity of the link by considering the acceleration vector diagram | Note down the respective values of acceleration of links. |  |

**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

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 |
| 5. | 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 |