**Round 1- Dynamics of Machine Lab**

**Name of Developer:** Prof. Dr. K V Gangadharan

**Institute:** National Institute of Technology Karnataka, Surathkal

### Email id: kvganga@nitk.ac.in

### Department: Mechanical Engineering

### Lab Submission Number: 143

### Discipline: Mechanical Engineering

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

### Name of experiment: Balancing of Multiple Mass in Multiple Plane

### Experiment Number: 7

### FOCUS AREA: Experimental Analysis Methods

**About the Experiment:** The balancing of rotating mass in multiple plane experiment is carried out to calculate the additional mass required for balancing the unbalance moment and also to find out the angular position of the additional masses used for balancing. The purpose of the experiment is to take an unbalanced system with rotating masses and adjust the radii and angles of the two outer masses in order to achieve a balanced system. It was initially observed that the system was unbalanced because of excessive vibration but calculating the correct radii and angles for the outer masses and adjusting them accordingly resulted in a balanced system and very little vibration was present.

**1. Learning Objectives**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr. No** | **Learning Objectives** | **Cognitive level** | **Action verb** |
| 1. Students will be able to: | State the reasons for balancing of rotating mass | Recall | State |
| 2. Students will be able to: | Identify instruments used in the experiment | Recall | Identify |
| 3. Students will be able to: | Describe conditions to be satisfied to achieve balance in rotating bodies | Understand | Describe |
| 4. Students will be able to: | Apply the mathematical equations acting on the rotating body | Apply | Apply |
| 5. Students will be able to: | Examine and compare the calculated values with the simulation | Analyze | Examine |
| 6. Students will be able to: | Evaluate how change in mass and position can improve the balance of the rotating body | Evaluate | Evaluate |

**2. Instructional Strategy**

### 2.1 Method: Expository

### 2.2 Assessment Method: Formative Assessment

2.3 Description: The animation of the masses is shown in front and top view for better visualization. Both the masses and radii can be varied and see the related changes in the animation. For better understating of the experiment one can compare their results by submitting their answers and the change in animation will give better understanding in the vibration.

**3. Task & Assessment Questions**

|  |  |  |  |
| --- | --- | --- | --- |
| **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. | Q9, Q8, Q7 |
| 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. | Q1, Q2 |
| 3 | Explain the step by step procedure to be carried out in the experiment. | Understand the procedure to be followed to conduct the experiment. | Q3, Q5, Q11 |
| 4. | To carryout necessary calculations required for the experiment | To perform the required calculations | Q4, Q6 |
| 5. | To notice the outcome of the experiment | Observe the outcome of the experiment | Q14, Q13, Q12 |
| 6. | Observations to be noted down. | Note down the mass and position of the balancing mass | Q10, Q4 |

### Additional Assessment Questions:

### Which of the following statements are associated with complete dynamic balancing of rotating systems?

1. The system is automatically statically balanced.
2. Resultant couple due to all inertia forces is zero.
3. Centre of masses of the system lies on the axis of rotation.
4. Support reactions due to forces are zero but not due to couples.
5. A, C and D only
6. A, B, C and D
7. B, C and D only
8. A, B and C only

Answer: a

### An important assumption made by this technique is that the system follows linear relationship?

1. vibration amplitude is inversely proportional to the force producing the vibration
2. vibration amplitude is equal to the force producing the vibration
3. vibration amplitude is proportional to the force producing the vibration
4. None of the above

Answer: c

1. Which of the following conditions cause rectification of vibration inputs?
2. Low current
3. Heating
4. Low voltage
5. High voltage

Answer: b

1. What is the output given by an accelerometer if the instrument is accelerated upward with an acceleration of 10g?
2. 11g
3. 10.5g
4. 11.5g
5. 10g

Answer: a

1. What are the necessary conditions in order to have a complete balance of the several revolving masses in different planes? Which of the following statements are correct?
2. The couples about the reference plane must balance
3. The forces in the reference plane must balance
4. The statement B
5. The statement A
6. The statements A & B
7. None of the above

Answer: C

1. Two cylinders of the same size and mass roll down an incline, starting from rest. Cylinder X has most of its mass concentrated at the rim, while cylinder Y has most of its mass concentrated at the center. Which reaches the bottom first?
2. Y
3. X
4. Both reaches at same time

Answer: a

1. Rotation in different planes require the balancing of-
2. Force
3. Moment
4. Both
5. None of these

**Answer:** C

1. Cause of unbalance-
2. Eccentricity
3. Moment of inertia
4. Angular of Velocity
5. Large diameter of rotor

**Answer:** A

1. Gear box is the example of-
2. Balancing in one plane
3. Balancing in different plane
4. Reciprocating balancing
5. None of these

**Answer:** B

1. Balancing of multiple mass in multiple plane the net force and moment should be-
2. Net force > net moment
3. Net moment > net force
4. Net force = 0, net moment ≠ 0
5. Net force = 0, net moment = 0

**Answer:** D

1. Which statement correct for dynamic balancing-
2. The centre of gravity of the system of masses lies on the axis of rotation.
3. Any resultant centrifugal force or couple does not exist.

**Answer:** B

1. Unbalancing is cause of vibration
2. True
3. False

**Answer:** A

1. Which of the following statements is correct about the balancing of a mechanical system?  
   A) If it is under static balance, then there will be dynamic balance also  
   B) If it is under dynamic balance, then there will be static balance also  
   C) Both static as well as dynamic balance have to be achieved separately  
   D) None of the mentioned

**Answer:** C

1. Which of the following statements are associated with complete dynamic balancing of rotating systems?  
   1. Resultant couple due to all inertia forces is zero.  
   2. Support reactions due to forces are zero but not due to couples.  
   3. The system is automatically statically balanced.  
   4. Centre of masses of the system lies on the axis of rotation.  
   A) 1, 2, 3 and 4  
   B) 1, 2, and 3 only  
   C) 2, 3 and 4 only  
   D) 1, 3 and 4 only

**Answer:** D

**4. Simulator Interactions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr. No** | **What students will do?** | **What Simulator will do?** | **Purpose of the task** |
| 1. | Understand initial condition | Display rotating masses with default masses and radii | To provide basic environment to start the experiment. |
| 2. | **Calculate the mass and angle by the analytical method**  **And then enter it to the table provided** | Provide table for input of desired parameters, namely the unbalance masses, the radii of rotation of the masses from the centre shaft, the angle between the masses and the distance between the two planes, | To input desired parameters |
| 3. | **Input the distance of the center of the rotation for the reference plane** | Display table for the user to enter values of radii of rotation at which the balancing masses have to be added and also their relative distances from the reference plane. | To input the distance of radii of rotation from the reference plane |
| 4. | Click on submit | Display submit tab | To change the values as per required and to obtain results |