# INSTRUCTIONAL MANUAL FOR STATIC & DYNAMIC BALANCING MACHINE

## OBJECTIVE:-

- To study the Static & Dynamic Balancing system.

## AIM:-

- To balance the masses Statically & Dynamically of a simple rotating mass system.
- To observe the effect of unbalance in a rotating mass system.

## INTRODUCTION:-

A system of rotating masses is said to be in static balance if the combined mass centre of the system lies on the axis of rotation. When several masses rotate in different planes, the centrifugal forces, in addition to being out of balance, also form couples. A system of rotating masses is in dynamic balance when there does not exist any resultant centrifugal force as well as resultant couple.

## THEORY:-

### CONDITIONS FOR STATIC AND DYNAMIC BALANCING:

- If a shaft carries a number of unbalanced masses such that the center of mass of the system lies on the axis of rotation, the system is said to statically balance.
- The resultant couple due to all the inertia forces during rotation must be zero.

These two conditions together will give complete dynamic balancing. It is obvious that a dynamically – balanced system is also statically balanced, but the statically balanced system is not dynamically balanced.

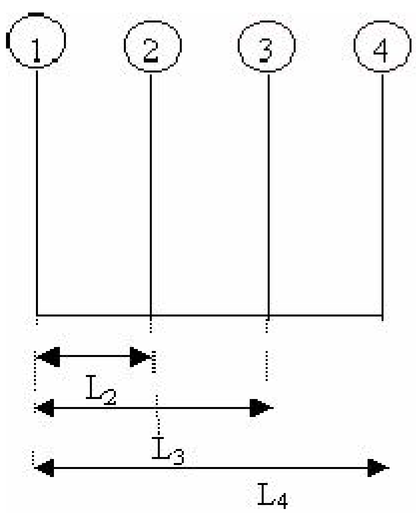
### BALANCING OF SEVERAL MASSES ROTATING IN DIFFERENT PLANES:

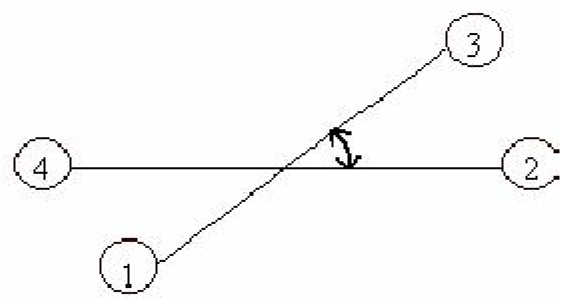
When several masses revolve in different planes, they may be transferred to a reference plane (written as RP), which may be defined as the plane passing through a point on the axis of rotation and perpendicular to it. The effect of transferring a revolving mass (in one plane) to a reference plane is to cause a force of magnitude equal to centrifugal force of the revolving mass to act in the reference plane, together with a couple of magnitude equal to the product of the force and the distance between the plane of rotation and the reference plane. In order to have a complete balance of the several revolving masses indifferent planes, the following conditions must be satisfied:

1. The forces in the reference plane must balance, i.e. the resultant force must be zero.
2. The couple about the reference plane must balance, i.e. the resultant couple must be zero.

Let us now consider four masses m1, m2, m3 and m4 revolving in planes 1, 2, 3 and 4 shown in fig. The relative angular positions of these masses are shown in the end view Fig. The magnitude, angular position and position of the balancing mass m1 in plane 1may be obtained as discussed below:

1. Take one of the planes, say 1as the reference plane (R.P.). The distance of all the other planes to the left of the reference plane may be regarded as negative, and those to the right as positive.
2. Tabulate the data as in table. The planes are tabulated in the same order i.e. 1,2,3.




| Plane | Weight No. | Mass (m) | Radius (r) | Angle (θ) | Mass Moment (mxr) | Distance from Plane 1 (L) | Couple m x r x L |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 1 (R.P.) | 4 | m1 | r1 | θ1 | m1 r1 | 0 | 0 |
| 2 | 1 | m2 | r2 | $\theta2=0^0$ | m2 r2 | L2 | m2 r2 L2 |
| 3 | 2 | m3 | r3 | θ3 | m3 r3 | L3 | m3 r3 L3 |
| 4 | 3 | m4 | r4 | θ4 | m4 r4 | L4 | m4 r4 L4 |

1. The position of plane 4 from plane 2 may be obtained by drawing the couple polygon with the help of data given in column no. 8.
2. The magnitude and angular position of mass m1 may be determined by drawing the force polygon from the given data of column no.5 & column no.6 to some suitable scale. Since the masses are to be completely balanced, therefore the force polygon must be closed figure. The closing side of force polygon is proportional to the m1 r1.

The angular position of mass m1 must be equal to the angle in anticlockwise measured from the R.P. to the line drawn on the fig. parallel to the closing side of force polygon.

**DESCRIPTION:-**

The apparatus consists of a steel shaft mounted in ball bearings in a stiff rectangular mainframe. A set of four blocks of different weights is provided and may be detached from the shaft. A disc carrying a circular protractor scale is fitted to one side of the rectangular frame. A scale is provided with the apparatus to adjust the longitudinal distance of the blocks on the shaft. The circular protractor scale is provided to determine the exact angular position of each adjustable block. The shaft is driven by electric motor mounted under the main frame, through a belt. For static balancing of weights the main frame is suspended to support frame by chains then rotate the shaft manually after fixing the blocks at their proper angles. It should be completely balanced. In this position, the motor driving belt should be removed.

For dynamic balancing of the rotating mass system, the main frame is suspended from the support frame by two short links such that the main frame and the supporting frame are in the same plane. Rotate the statically balanced weights with the help of motor. If they rotate smoothly and without vibrations, they are dynamically balanced.

**UTILITIES REQUIRED**:

- Electricity Supply: Single phase, 220 volts DC, 5-15 amp socket with earth connection.
- Bench Area Required: 0.1 m x 0.5 m

**TECHNICAL SPECIFICATION: -**

- **Drive Motor** : FHP Motor, variable speed, with speed controller
- **Balancing Weight** : 4 Nos. of Stainless Steel with different sized eccentric Mass for varying unbalance
- **Rotating Shaft** : Material Stainless Steel
- The whole Set-up is well designed and arranged in a good quality painted Structure

## EXPERIMENTAL PROCEDURE:

1. Insert all the weights in sequence 1- 2- 3 - 4 from pulley side.
2. Fix the pointer and pulley on shaft.
3. Fix the pointer on 0 o (θ2) on the circular protractor scale.
4. Fix the weight no. 1 in horizontal position.
5. Rotate the shaft after loosening previous position of pointer and fix it on θ3.
6. Fix the weight no. 2 in horizontal position.
7. Loose the pointer and rotate the shaft to fix pointer on θ4.
8. Fix the weight no. 3 in horizontal position.
9. Loose the pointer and rotate the shaft to fix pointer on θ1.
10. Fix the weight no.4 in horizontal position.
11. Now the weights are mounted in correct position.
12. For static balancing, the system will remain steady in any angular position.
13. Now put the belt on the pulleys of shaft and motor.
14. Supply the main power to the motor through dimmerstat.
15. Gradually increase the speed of the motor. If the system runs smoothly and without vibrations, it shows that the system is dynamically balanced.
16. Gradually reduce the speed to minimum and then switch off the main supply to stop the system.

## OBSERVATION & CALCULATION:-

### OBSERVATION TABLE

| Sr. No. | Plane | Mass, m (gms) | Angle from reference line, θ (degree) | Distance, L (mm) |
|---|---|---|---|---|
| 1. | 1 | | | |
| 2. | 2 (R.P) | | | |
| 3. | 3 | | | |
| 4. | 4 | | | |

### CALCULATION TABLE

| Plane | Mass, m (gms) | Mass Moment m x r | Couple m x r x L |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |

**NOMENCLATURE:-**

| | | |
|---|---|---|
| L | = | Distance between particular weight from weight 1, mm |
| W | = | Mass of particular weight, kg |
| θ | = | Angle of particular weight from Reference Point, degree |

**PRECAUTIONS & MAINTENANCE INSTRUCTIONS:-**

1. Never run the apparatus if power supply is less than 180 volts & above than 230volts.
2. Increase the motor speed gradually.
3. Experimental set up should be tight properly before conducting experiment.
4. Before starting the rotary switch, dimmer stat should be at zero position.

**TROUBLESHOOTING:-**

1. If the shaft is not rotate but motor rotate check both the pulleys.
2. If the main light is not ON check the main switch.
3. If the motor is not working check the rotary switch & dimmer stat.

**REFERENCES:-**

1. Thomas Bevan, **"The Theory of Machines"**, 3rd ed., CBS Publishers & Distributors, ND, 1984, Page 521-524.
2. SS Rattan, **"Theory of Machines"**, 11th ed., Tata McGraw Hill, ND, 2000, Page470-472.