Parala Maharaja Engineering College

A CONSTITUENT COLLEGE OF B.P.U.T GOVT. OF ODISHA

LABORATORY MANUAL

(MEPC2207) Machines and Mechanisms Lab

SEMISTAR-IV

Department of

Automobile engineering

Parala Maharaja Engineering College, Berhampur

A Government Engineering College affiliated to

Biju Patnaik University of Technology, Odisha, Rourkela, India

ପାରଳା ମହାରାଜା ଯାନ୍ତ୍ରିକ ମହାବିଦ୍ୟାଳୟ, ବ୍ରହ୍ମପୁର

(ସରକାରୀ ଯାନ୍ତ୍ରିକ ମହାବିଦ୍ୟାଳୟ)

LIST OF EXPERIMENTS

Sl. No	Name of the experiments
01	Design of any one working model related to Kinematics & Dynamics of Machines, Module I &II
02	Design of any one working model related to Kinematics & Dynamics of Machines, Module III,IV& V
03	Experiments on Simple/Compound/Reverted Gear trains
04	Study of interference and undercutting for gear drives
05	Determination of Moment of Inertia of a fly wheel
06	Performance characteristics of a spring loaded governor.
07	Experiment/Study on Screw Jack.
08	Experiment/Study on clutches.
09	Experiment on static and dynamic balancing apparatus.

SAFETY IN THE LAB

- You are only allowed in the laboratory when there is a 'responsible person' present such as a demonstrator or the laboratory staff.
- Do not touch any equipment or machines kept in the lab unless you are asked to do so.
- A tidy laboratory is generally safer than an untidy one, so make sure that you do not have a confused tangle of electrical cables. Electrical equipment is legally required to be regularly checked, which means it should be safe and reasonably reliable: do not tamper or attempt to repair any electrical equipment (in particular, do not rewire a mains plug or change a fuse - ask one of the laboratory staff to do it). Never switch off the mains using the master switches mounted on the walls. Please make yourself aware of the fire exits when you first come into the lab. When the alarm sounds please leave whatever you are doing and make your way quickly, calmly and quietly out of the lab. You must always follow instructions from your demonstrators and the laboratory staff.
- You must keep walkways clear at all times and in particular coats and bags must be stowed away safely and must not pose a trip hazard.
- It is important that you make a point of reading the "Risk Assessment" sheet included in the manuscript of each experiment before you start work on the experiment.
- Please take notice of any safety information given in your scripts. If an experiment or project requires you to wear PPE (personal protective equipment) such as gloves and safety glasses, then wear them.
- Always enter the lab wearing your shoes. It is strictly prohibited to enter the lab without shoes.
- There must be NO smoking, eating, drinking, use of mobile phones or using personal headphones in the laboratory. This last point is not because we dislike your choice of music but because you must remain aware of all activity around you and be able to hear people trying to warn you of problems.
- Keep the lab neat and clean.

<u>Experiment-03</u>

Experiments on Simple/Compound/Reverted Gear trains

Aim of the experiment:

To understand the working principles of simple, compound, and reverted gear trains and to calculate speed ratios and torque relationships for each type of gear train.

Apparatus Required

- Gear train models (simple, compound, reverted).
- Tachometer.
- Weights and pulleys for load application.
- Torque measurement device.
- Vernier calliper (for gear dimensions).
- Stopwatch.

Theory

a) Gear Train Types

1. **Simple Gear Train**
    - A system where each gear is mounted on a separate shaft.
    - Used for low-speed applications.
2. **Compound Gear Train**
    - Two or more gears mounted on the same shaft.
    - Used to achieve higher speed ratios.
3. **Reverted Gear Train**
    - Input and output shafts are co-axial.
    - Common in compact designs like watches.

Procedure

Experiment 1: Simple Gear Train

1. Set up the simple gear train with the required gears.
2. Measure the number of teeth for driver and driven gears.
3. Rotate the driver gear and measure the speeds using a tachometer.
4. Calculate speed ratio and compare with theoretical values.

Experiment 2: Compound Gear Train

1. Arrange gears in a compound configuration.
2. Ensure proper meshing between the gears.
3. Measure speeds of input and output shafts.
4. Record observations and compute speed ratios and torque.

Experiment 3: Reverted Gear Train

1. Assemble a reverted gear train where input and output shafts are aligned.
2. Observe speed and torque at different points.
3. Compare results with theoretical expectations.

Observation Table:

Gear Train Type	Driver Teeth	Driven Teeth	Speed of Driver (rpm)	Speed of Driven (rpm)	Speed Ratio (Theoretical)	Speed Ratio (Practical)	Efficiency (%)

Precautions

- Ensure gears are properly lubricated to minimize friction.
- Avoid excessive loading on the shafts to prevent damage.
- Record measurements carefully to avoid errors.

Results

- Speed ratios and torque relationships for different gear trains were observed.
- Efficiency and deviations between theoretical and practical values were analysed.

Experiment-4

Study of interference and undercutting for gear drives

Aim of the experiment:

To understand the concepts of interference and undercutting in gear drives and to study the effect of pressure angle, module, and number of teeth on interference and undercutting.

Apparatus Required

- Gear drive models with various numbers of teeth and pressure angles.
- Vernier calliper (for gear measurements).
- Dial gauge (for interference measurement).
- Protractor or gear template (to measure pressure angles).

Theory

a) Interference in Gears

- **Definition**: Interference occurs when non-conjugate portions of the gear teeth come into contact, disrupting smooth power transmission.
- **Causes**: Typically caused by gears with fewer teeth or small pressure angles.

b) Undercutting in Gears

- **Definition**: Undercutting happens when gear tooth material is removed excessively near the base circle, weakening the teeth.
- **Causes**: Results from attempts to avoid interference, particularly in gears with a low number of teeth.

c) Key Parameters

1. **Pressure Angle (α)**: Affects the position of the line of action. Larger pressure angles reduce interference but may increase stress.

2. **Minimum Number of Teeth (Z_{min})**: Prevents interference for a given pressure angle:

   $$Z_{min} = 2/Sin^2 (\alpha)$$

3. **Module (m)**: Gear size parameter; larger modules reduce interference but increase the gear's physical size.

d) *Graphical Representation*

- Involute profiles demonstrate the extent of interference or undercutting.

Procedure

Experiment 1: Study of Interference

1. **Setup**: Mount the gears with varying pressure angles and number of teeth.
2. Measure the gear dimensions (module, number of teeth, pressure angle).
3. Observe meshing and record any interference during rotation.
4. Repeat with different gear combinations, noting conditions where interference occurs.

Experiment 2: Study of Undercutting

1. **Setup**: Use gears designed to have fewer teeth than Zmin.
2. Measure the tooth profile using a profile projector or CAD software.
3. Identify regions where undercutting occurs near the base circle.
4. Compare practical observations with theoretical tooth profiles.

Experiment 3: Pressure Angle and Module Effects

1. Use gears with different pressure angles (e.g., 14.5°, 20°, 25°).
2. Observe and measure the occurrence of interference and undercutting.
3. Record and analyse variations with changes in module and pressure angle.

Observation table:

Parameter	Gear 1 (Teeth)	Gear 2 (Teeth)	Pressure Angle (°)	Module (mm)	Observed Interference	Observed Undercutting

Calculations

a) Minimum Number of Teeth to Avoid Interference:

$$Z_{min} = 2/Sin^2 (\alpha)$$

Substitute values of α and calculate Zmin.

Precautions

- Ensure gears are aligned properly to prevent misinterpretation of interference.
- Use precise measuring tools to determine tooth dimensions and angles.
- Avoid excessive load during rotation to ensure results reflect true gear behaviour.

Conclusion:

Experiment-5

Determination of Moment of Inertia of a fly wheel

Aim of the experiment: To find the moment of inertia of a fly wheel.

Apparatus required:

The flywheel
weight hanger with slotted weights
stop clock
metre scale etc.

Theory:

A flywheel is an inertial energy-storage device. It absorbs mechanical energy and serves as a reservoir, storing energy during the period when the supply of energy is more than the requirement and releases it during the period when the requirement of energy is more than the supply. The main function of a fly wheel is to smoothen out variations in the speed of a shaft caused by torque fluctuations. Many machines have load patterns that cause the torque to vary over the cycle. Internal combustion engines with one or two cylinders, piston compressors, punch presses, rock crushers etc. are the systems that have flywheel.

A flywheel is a massive wheel fitted with a strong axle projecting on either side of it. The axle is mounted on ball bearings on two fixed supports. There is a small peg inserted loosely in a hole on the axle. One end of a string is looped on the peg and the other end carries a weight hanger. A pointer is arranged close to the rim of the flywheel. To do the experiment, the length of the string is adjusted such that when the descending mass just touches the floor, the peg must detach the axle. Now a line is drawn on the rim with a chalk just below the pointer. The string is then attached to the peg and the wheel is rotated for a known number of times 'n' such that the string is wound over 'n' turns on the axle without overlapping. Now the mass m is at a height 'h' from the floor. The mass is then allowed to descend down. It exerts a torque on the axle of the flywheel. Due to this torque the flywheel rotates with an angular acceleration.

Let ω be the angular velocity of the wheel when the peg just detaches the axle and W be the work done against friction per one rotation, then by law of conservation of energy

$$Mgh = \frac{1}{2} I\omega^2 + \frac{1}{2} mv^2 + NW \quad \text{-----------------------}(1)$$

Let N be the number of rotations made by the wheel before it stops. Since the kinetic energy of rotation of the flywheel is completely dissipated when it comes to rest, we can write,

$$NW = \frac{1}{2} I\omega^2$$

$$W = I\omega^2 / 2N \qquad \text{------------------(2)}$$

Using equation 2 in equation 1, we get

$$Mgh = \frac{1}{2} I\omega^2 (1+n/N) + 1/2\ mr^2\omega^2$$

$$I = Nm/N+n\ (2gh/\omega^2 - r^2) \qquad \text{---------------------(3)}$$

where, ‘r’ is the radius of the axle. To determine ‘ω’ we assume that the angular retardation of the flywheel is uniform after the mass gets detached from the axle. Then

average angular velocity = total angular displacement/time taken

$$\omega+0/2 = 2\pi N/t$$

therefore, $\omega = 4\pi N/t$ --(4)

Procedure:

To start with the experiment one end of the string is looped on the peg and a suitable weight is placed in the weight hanger. The fly wheel is rotated ‘n’ times such that the string is wound over ‘n’ turns on the axle without overlapping.

The flywheel is held stationary at this position. The height ‘h’ from the floor to the bottom of the weight hanger is measured. The flywheel is then released. The mass descends down and the flywheel rotates. Start a stop watch just when the peg detaches the axle. Count the number of rotations ‘N’ made by the wheel during the time interval between the peg gets detached from the axle and when the wheel comes to rest. The time interval ‘t’ also is noted.

The experiment is repeated for same ‘n’ and same mass ‘m’. The average value of ‘N’ and ‘t’ are determined. The moment of inertia ‘I’ is calculated using equations (3) and (4). The entire experiment is repeated for different values of ‘n’ and ‘m’ and the average value of I is calculated.

- Ensure that the length of the string is such that when the mass just touches the floor the peg gets detached from the axle.
- In certain wheels the peg is firmly attached to the axle. In such case, one end of the string is loosely looped around the peg such that when the mass just touches the floor the loop gets slipped off from the peg.
- 'm' is the sum of mass of weight hanger and the additional mass placed on it.

Determination of moment of inertia

Mass suspended at one end of the string 'm' kg	Height from the floor to the bottom of weight hanger 'h' m	Number of windings of string on the axle 'n			No. of rotations of the wheel after the detachment of the peg from the axle 'N'			Time interval in between the detachment of the peg and when the wheel comes to stop, 't' sec.	ω	I
		1	2	Mean N	1	2	Mean T sec.			

Result:

Moment of inertia of the given flywheel I= ------------- $kg.m^2$

Experiment-6

Performance characteristics of a spring loaded governor

Aim of the experiment: To understand the basic idea of the working principle of the gravity governor and its applications and to know function of governor, types of governor and plotting the characteristic curves for different gravity-controlled governor.

Outcome:

After successfully completion of practical the student will be able to know the importance of requirement of the governor and its function as well as applications.

Theory:

The function of a governor is to regulate the mean speed of an engine, when there is variation in the load e.g. when the load on an engine increases, its speed decreases, therefore it becomes necessary to increase the supply of working fluid and when the load on the engine decreases, its speed increases and thus less working fluid is required. The governor automatically controls the supply of working fluid to the engine with the varying load conditions and keeps the mean speed within certain limits.

The governors may, broadly, be classified as:

1. Energy conservation governor and
2. Energy dissipation governor.

The energy conservation type of governor may further be classified as follows:

1. Centrifugal governor and
2. Inertia governor

The centrifugal governors may further be classified as follows:

1. Pendulum type: - Watt governor
2. Loaded type:

i. Dead weight governor (gravity governor): - Porter governor and Proell governor

ii. Spring controlled governors: -Hartnell governor, Hartung governor, WilsonHartnell governor and Pickering governor

Hartnell Governor:

A Hartnell governor is a spring-loaded governor. It consists of two bell crank levers pivoted at the point to the frame. The frame is attached to the governor spindle and therefore rotates with it. Each lever carries a ball at the end of the vertical arm and a roller at the end of the horizontal arm. A helical spring in compression provides equal downward forces on the two rollers through a collar on the sleeve. The spring force be adjusted by screwing at nut up or down on the sleeve.

Observations:

- Mass of the ball (m) = _____________kg.
- Weight of the ball (w) = _____________N.
- Height of the governor (h) = _____________m.
- Maximum equilibrium speed (N1) = _____________ r.p.m.
- Minimum equilibrium speed (N2) = _____________ r.p.m.
- Frictional force (F) = _____________ N.
- Mean equilibrium speed (N) = (N1 + N2)/2 = _____________ r.p.m
- Mass of the central load = _____________ kg.
- Weight of the central load (W) = _____________ N.
- Angle of inclination of the arm to the vertical (α) = _____________
- Angle of inclination of the link to the vertical (β) = _____

Tabulation:

Sl. no	N (rpm)	Lift ‘h’ (m)	Mass (kg)	$F= m\omega^2 r$

Conclusion:

Experiment-7

Experiment/Study on Screw Jack

Aim of the Experiment- To find the Mechanical advantages velocity ratio and the efficiency of simple screw jack.

Apparatus – Screw jack apparatus, pans weight string, Venire scale, meter scale etc.

Theory- the screw jack is simple machine by mean of which heavy load can be rise with the application of small effort .it works on the principle of screw and nut the screw is rotated with help of tommy bar at the end of which effort is applied by doing so. The screw passing through the nut is rise and so is the load placed on its hand.

Procedure:

- Measure the circumference of the flanged table with the help of on inextensible thread or Measure the diameter of the table with an outside caliper.
- Measure the pitch of Thread with the help of Venire Calliper.
- Wrap the string round the circumference of the flanged table and pass it over one pulley. Similarly Warp another string over the circumferences of flanged table and pass it over the second pulley the free end of the both strings be tied to two pans which the weight are to be placed.
- Note down the weight of each pan.
- Place the load W on the top of the table and start adding weight in to the pans so that the load W is just lifted. The effort P is equal to the sum of the Weight Placed so that the load W is just lifted. The effort P is equal to the sum of weights placed on both the pans.
- Calculate the M.A, V.R, and Effiency in each case.
- Repeat the Experiment twice more by varying the load on the top of the table and in the pans.

Tabulation:

Sl.No.	Circumference of the table $=\pi D$	Pitch of scrw P(c.m)	V.R $=\frac{\pi D}{p}$	$weight\ on\ Table$ $w\ (N)$	$Total\ Effort\ P = p_1 + p_2 + wt\ of\ pans$	$M.A = \frac{W}{P}$	%η $= \frac{M.A}{V.R} \times 100$

Calculation: Let the turns through one Revolution

Then The Distance through Load rises in one Revolution = P

Effort moved in one Revolution = πD

- $V.R = \frac{\pi D}{P}$

Weight on the table = w in kg

- $M.A = \frac{W}{P}$
- $\% \eta = \frac{M.A}{V.R} \times 100$.

Calculation – From the above Experiment we find M.A,V.R , and efficacy of screw jack.

Experiment- 8

Experiment/Study on clutches

Aim of the experiment:
 To understand the working principle of various types of clutches.
 To analyse torque transmission, power loss, and frictional characteristics of clutches.

Apparatus Required

- Clutch models (cone clutch, single-plate clutch, multi-plate clutch, centrifugal clutch).
- Torque measurement device.
- Tachometer.
- Vernier caliper (for dimensional measurements).
- Weights (for load application).
- Stopwatch.

Theory

a) Clutches

- **Definition**: Clutches are mechanical devices used to connect or disconnect the engine from the transmission system in vehicles or machinery.
- **Purpose**: Transmit torque and motion from the driving shaft to the driven shaft.

b) Types of Clutches

1. **Single-Plate Clutch**: Used in cars and light vehicles. Simple design, operates on frictional contact.
2. **Multi-Plate Clutch**: Used in heavy-duty vehicles and motorcycles, offers higher torque transmission.
3. **Cone Clutch**: Conical surfaces provide the friction interface.
4. **Centrifugal Clutch**: Engages automatically at higher speeds using centrifugal force.

Parameter:
1. Torque transmission

   $T = \mu W R$

Where, μ = coefficient of friction
W= normal force
R= mean radius of the friction surface.

2. Power

$$P = 2\pi NT$$

Where, N= speed of rotation (in RPM)
T= Torque

Procedure

Part A: Single-Plate Clutch

1. Measure the dimensions of the clutch (radius, friction surface area).
2. Apply a known load using weights to simulate engagement force.
3. Rotate the driving shaft and measure torque transmitted using a torque meter.
4. Vary the speed of rotation and observe its effect on torque transmission.

Part B: Multi-Plate Clutch

1. Repeat the steps from Part A with a multi-plate clutch.
2. Measure torque for different numbers of plates to analyze the effect of increased friction surfaces.

Part C: Cone Clutch

1. Mount the cone clutch setup.
2. Measure the angle of the cone and friction surface dimensions.
3. Apply load and measure torque transmitted during engagement.

Part D: Centrifugal Clutch

1. Observe the engagement process by gradually increasing the rotational speed.
2. Note the speed at which the clutch engages and starts transmitting torque.
3. Record torque and speed during operation.

Tabulation:

Type of Clutch	Force Applied (N)	Radius (m)	Friction Coefficient (μ\muμ)	Torque Transmitted (N·m)	Speed (RPM)	Power Transmitted (W)

Calculation:

1. Torque transmission

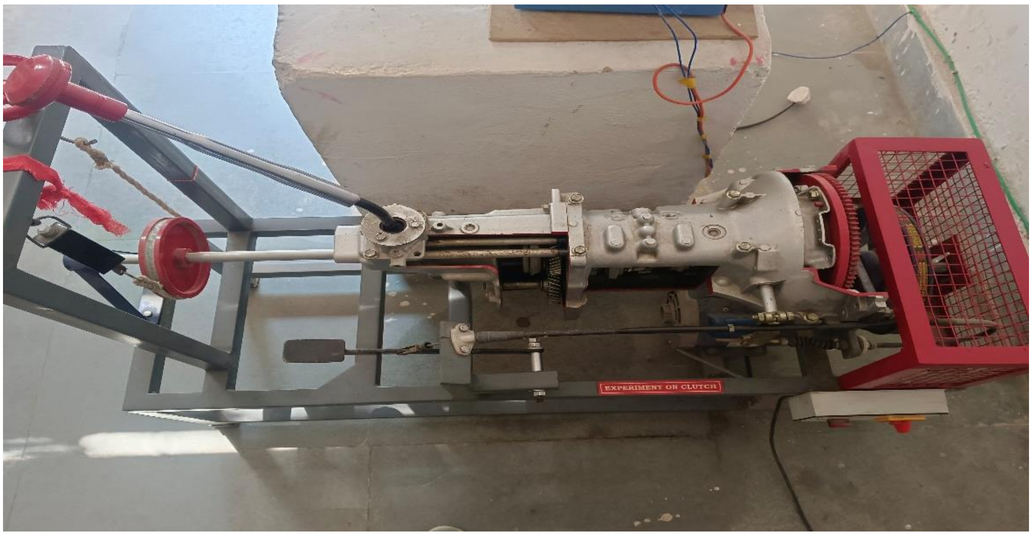
   $T = \mu W R$
2. Power

   $P = 2\pi N T$

3. Analyze differences in torque and power for different clutch types.

Precautions

- Ensure proper alignment of clutch components.
- Avoid excessive speeds that might damage the setup.
- Lubricate components where necessary to prevent wear.
- Measure forces and dimensions accurately for precise calculations.



Results

- Tabulated data showing torque and power transmission for each type of clutch.
- Graphical representation of torque vs. speed for different clutches.

Conclusion:

Experiment-9

STATIC & DYNAMIC BALANCING APPARATUS

Aim of the Experiment: To balance the masses Statically & Dynamically of a simple rotating mass system.
To observe the effect of unbalance in a rotating mass system.
To study the Static & Dynamic Balancing system.

Apparatus Required: Static & Dynamic balancing Apparatus.

Introduction: A system of rotating masses is said to be in static balance if the combined mass center 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 & Dynamic Balancing**

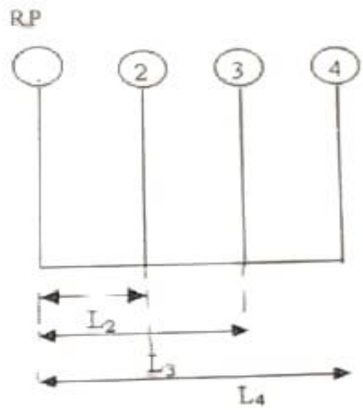
- If a shaft carries a number of unbalanced masses such that the center of mass of the system lies on the axis of rotation, the system is said to statically balance.
- The resultant couple due to all the inertia forces during rotation must be zero. These two conditions together will give complete dynamic balancing. It is obvious that a dynamically balanced system is also statically balanced, but the statically balanced

- **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 in different planes, the following conditions must be satisfied:

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

Let us now consider four masses m_1 m_2, m_3 and m_4 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 min plane 1 may be obtained as discussed below:

- Take one of the planes; say 1 as 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.
- 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 ()	Mass Moment (mr)	Distance From plane (L)	Couple mrL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 (R.P)	4	m_1	r_1	θ_1	$m_1\, r_1$	0	0
2	1	m_2	r_2	θ_2	$m_2\, r_2$	L_2	$m_2\, r_2\, L_2$
3	2	m_3	r_3	θ_3	$m_3 r_3$	L_3	$m_3\, r_3\, L_3$
4	3	m_4	r_4	θ_4	$m_4 r_4$	L_4	$m_4\, r_4\, L_4$

- 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.
- The magnitude and angular position of mass ml may be determined by drawing the force polygon from the given data of column no.5 & column no.6 to 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 ml r1.

The angular position of mass m_1 must be equal to the angle in anticlockwise measured from the RP. 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 main frame. 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.

Utilized Required:

Electricity Supply: Single Phase, 220 VAC. 50OHz, 5-15 amp socket with earth connection.

Bench Area Required: I m x 0.5 m

Experimental Procedure:

- Insert all the weights in sequence 1-2-3 - 4 from pulley side.
- Fix the pointer and pulley on shaft.
- Fix the pointer on 0 on the circular protractor scale.
- Fix the weight no. 1 in horizontal position.
- Rotate the shaft after loosening previous position of pointer and fix it.
- Fix the weight no. 2 in horizontal position.
- Loose the pointer and rotate the shaft to fix pointer
- Fix the weight no.3 in horizontal position
- Loose the pointer and rotate the shaft to fix pointer.

- 10. Fix the weight no. 4 in horizontal position.
- Now the weights are mounted in correct position.
- For static balancing, the system will remain steady in any angular position.
- Now put the belt on the pulleys of shaft and motor.
- Supply the main power to the motor through dimmerstat.
- Gradually increase the speed of the motor. If the system runs smoothly and Without vibrations, it shows that the system is dynamically balanced
- Gradually reduce the speed to minimum and then switch off the main supply to stop the system.

Observation & Calculation:

Observation Table:

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

Calculation Table:

Plane	Mass ,m(gms.)	Mass moment m×r	Couple m×r×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

Precaution & Maintenance Instructions:

- Never run the apparatus if power supply is less then 180volts& above then 230volts.
- Increase the motor speed gradually.
- Experimental setup should be tight properly before conducting experiment.
- Before starting the rotary switch, dimmer stat should be at zero position.