MAHA BARATHI ENGINEERING COLLEGE

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
2(f) & 12(B) status of UGC, New Delhi

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DEPARTMENT OF MECHANICAL ENGINEERING

ME3581– METROLOGY AND DYNAMICS LABORATORY

III Year/V Semester B.E MECH

Regulation 2021
(As Per Anna University, Chennai syllabus)

ME3581	METROLOGY AND DYNAMICS LABORATORY	L	T	P	C
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OBJECTIVES:

The main learning objective of this course is to prepare the students able to:

- Apply the principles of kinematics involved in various mechanisms.
- Apply the principles of dynamics involved in various experiments
- Demonstrate the calibration of simple linear measuring instruments used in manufacturing industries.
- Demonstrate the important linear and angular measurements carried out in manufacturing industries.
- Demonstrate the measurement of prismatic components using contact and non-contact methods and surface metrology.

Part-I: DYNAMICS LABORATORY (30)

LIST OF EXPERIMENTS:

1. Study of gear parameter.
2. Kinematic models to study various mechanisms.
3. Determination of moment of inertia of flywheel and axle system.
4. Determination of Mass Moment of Inertia of axis symmetric bodies using Turn Table apparatus
5. Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
6. Transverse vibration of Free-Free beam – with and without concentrated masses.
7. Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies.
8. Dynamic analysis of cam mechanism.
9. Experiment of Watt Governor.
10. Experiment of Porter Governor.
11. Experiment of motorized gyroscope.
12. Determination of critical speed of shaft.

Part-II: **METROLOGY LABORATORY** **(30)**

LIST OF EXPERIMENTS:

1. Calibration of vernier caliper using gauge blocks and measurement of given samples.
2. Calibration of micrometer using gauge blocks and measurement of given samples using micrometer.
3. Calibration of dial gauge using given gauge blocks.
4. Calibration of vernier height gauge using gauge blocks and measurement of given sample using vernier height gauge.
5. Calibration of vernier depth gauge using gauge blocks and measurement of given sample using vernier depth gauge.
6. Measurement of bore diameter of given samples using Bore gauge.
7. Measurement of bore diameter of given samples using telescopic gauge
8. Measurement of linear dimensions of given sample using Comparator.
9. Measurement of angles using sine bar.
10. Measurement of gear parameters using gear tooth vernier.
11. Non-contact (Optical) measurement using Profile projector.
12. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.

COURSE OUTCOMES:

Upon the completion of this course the students will be able to:

- Determine the measurement of various kinematic parameters.
- Found the vibration parameters in various experiments.
- Select a suitable measuring instrument for measurement of linear and angular dimensions and use the same for carrying out measurements.
- Calibrate simple linear measuring instruments like Vernier caliper, micrometer, Vernier height gauge, etc. using gauge blocks.
- Use advanced measuring equipment, surface finish measuring equipment to carry out measurements.

Course period: 60 Hours

INDEX
DYNAMICS LABORATORY

Ex.No.	Date	Name of the Experiment	Page No.	Marks	Sign
1.		Study of gear parameter.			
2.		Kinematic models to study various mechanisms			
3.		Determination of radius of gyration and moment of inertia of Connecting rod by oscillation method			
4.		Determination of mass moment of inertia of compound pendulum			
5.		To study the displacement motion curve of cam			
6.		Experimental verification of gyroscopic couple			
7.		Determination of mass moment of inertia using turn table apparatus			
8.		Determination of radius of gyration using Bifilar suspension			
9. a		Determine natural frequency of torsional vibration in single rotor system			
9. b		Determine natural frequency of torsional vibration in two rotor system			
10.		To determine the whirling speed of shafts with various diameters experimentally and compare it with theoretical values.			
11.		Transverse vibration of free beam setup			
12. a		Determination Of Range Sensitivity, Effort Etc., for Watts Governor			
12. b		Determination Of Range Sensitivity, Effort Etc., for porter Governor			

INDEX
METROLOGY LABORATORY

Ex.No.	Date	Name of the Experiment	Page No.	Marks	Sign
1.a		Calibration of Vernier caliper			
1.b		Calibration of Micrometer			
1.c		Calibration of Dial gauge			
2.a		Determine the height of the given specimen by using Vernier Height gauge			
2.b		Determine the height of the given specimen by using Vernier Depth gauge			
3		Measurement of gear parameters using gear tooth vernier.			
4.a		Measurement of angles using sine bar.			
4.b		Non-contact (Optical) measurement using Profile projector.			
5.a		Measurement of linear dimensions of given sample using Comparator.			
5.b		Measurement of bore diameter of given samples using Telescopic gauge.			
6.a		Measurement of bore diameter of given samples using Bore gauge.			
6.b		Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.			

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(AFFILIATED TO ANNA UNIVERSITY)

CHINNASALEM, 606201

DEPARTMENTOF MECHANICAL ENGINEERING

DYNAMICS LABORATORY

SL. NO.	NAME OF EQUIPMENTS	QUANTITY
1	Cam follower setup.	1No.
2	Motorized gyroscope.	1No.
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1No.
4	Whirling of shaft apparatus.	1No.
5	Two rotor vibration setup.	1No.
6	Spring mass vibration system.	1No.
7	Torsional Vibration of single rotor system setup	1No.
8	Gear Models	1No.
9	Turntable apparatus	1No.

METROLOGY AND MEASUREMENTS LABORATORY

SL. NO.	NAMEOFEQUIPMENTS	QUANTITY
1	Micrometer	5Nos.
2	Vernier Caliper	5Nos.
3	Vernier Height Gauge	2Nos.
4	Vernier depth Gauge	2Nos.
5	Slip Gauge Set	1No.
6	Gear Tooth Vernier	1No.
7	Sine Bar	1No.
8	Profile Projector	1No.
9	Mechanical Comparator	1No.
10	Dial Gauge	2Nos.
11	Bore Gauge	1No.
12	Telescopic Gauge	1No.

1. To study various types of Kinematic links, pairs, chains and Mechanisms

AIM: - To study various types of kinematics links, pairs, chains & Mechanisms.

APPARATUS USED: - Kinematics links, pairs, chains & Mechanisms.

THEORY: - 1. Definitions of kinematics links, pairs, chains & Mechanisms.

2. Classifications of kinematics links, pairs, chains & Mechanisms.

3. Diagrams of kinematics links, pairs, chains & Mechanisms

4 Advantages & Disadvantages of kinematics links, Pairs, chains & Mechanisms.

5. Applications of kinematics link, Pairs, chains & Mechanism

6. Examples of kinematics link, Pairs, chains & Mechanisms.

KINEMATIC LINK: - A mechanism is made of a number of resistant bodies out of which some may have motions relative to the others. A resistant body or a group of resistant bodies with rigid connections preventing their relative movement is known as a link. A link also known as kinematic link or element.

Examples :- A slider-crank mechanism consists of four links: frame and guides, crank connecting rod and slider, the crank link may have crankshaft and flywheel also, forming one link having no relative motion of these.

CLASSIFICATIONS OF LINKS:-

1. Binary link

2. Ternary link

3. Quarternary link

KINEMATIC PAIR: - A kinematic pair or simply a pair is a joint of two links having relative motion between them.

CLASSIFICATIONS OF PAIRS:

1- Kinematics pairs according to nature of contact:-

(i) Lower pair (links having surface or area contact)

Examples- Nut turning on a screw, shaft rotating in a bearing, universal joint etc.

(ii) Higher pair (Point or line contact between the links)

Examples:- when rolling on a surface, cam and follower pair, tooth gears, ball and roller bearings etc.

2- Kinematics pairs according to nature of Mechanical Constraint:-

(a) Closed pair (when the elements of a pair are held together mechanically)

Examples :- all the lower pairs and some of the higher pair

(b) Unclosed pair (when two links of a pair are in contact either due to force of gravity or some spring action),

Example :- cam and follower pair.

3- Kinematics pairs according to nature of relative motion:-

(i) Sliding pair

(ii) Turning pair

(iii) Rolling Pair

(iv) Screw pair (Helical pair)

(v) Spherical pair

KINEMATIC CHAIN :- A kinematic chain is an assembly of links in which the relative motions of the links is possible and the motion of each relative to the others is definite. If indefinite motions of other links , it is a non-kinematic chain.

Types of kinematics chains :-

(i) Four bar chain or quadric cycle chain

(ii) Single slider crank chain

(iii) Double slider crank chain

MECHANISM :- A linkage is obtained if one of the links of a kinematics chain is fixed to the ground. If motion of each link results in definite motions of the others, the linkage is known as a mechanism. If one of the links of a redundant chain is fixed, it is known as a structure. The degree of freedom of a structure is zero or less. A structure with negative degree of freedom is known as a superstructure.

OBSERVATION & CONCLUSION:-

1. Comparison between kinematics links,Pairs, chains & Mechanisms.
2. Type of Motion to be named.

VIVA-QUESTIONS:-

a) Define machine & structure.

b) Concept of kinematics links, pairs, chains & mechanism.

c) Classification & examples of all the kinematics links, pairs, chains & mechanism.

d) Grasshof's criterion.

e) Types & examples of constrained motion.

2.**To study various types of gear trains- simple, compound, reverted, epicyclic and differential**.

AIM: -To study various types of gear trains- simple, compound, reverted, epicyclic and differential.

APPARATUS USED: -. Arrangement of Gear train system.

THEORY: -

1. Definition of. Geart rain
2. Classification of Geartrain
3. Diagrams of different types of Gear train.
4. Working & Construction of different types of Gear train.
5. Advantages & Disadvantages of Gear train
6. Applications of Gear train .
7. Examples of Gear train

GEAR TRAIN :- A gear train is a combination of gears used to transmit motion from one shaft to another. It becomes necessary when it is required to obtain large speed reduction within a small space. The following are the main types of gear trains:

(i) Simple gear train

(ii) Compound gear train

(iii) Reverted gear train

(iv) Planetary gear train

SIMPLE GEAR TRAIN :- A series of gears, capable of receiving and transmitting motion from one gear to another is called a simple gear train. In it, all the gear axes remain fixed relative to the frame and each gear is on a separate shaft.

Train Value = Number of teeth on driving gear / Number of teeth on driven gear

COMPOUND GEAR TRAIN :- When a series of gears are connected in such a way that two or more gears rotate about an axis with the same angular velocity, it is known as compound gear train. In this type, some of the intermediate shafts.

Train Value = Product of Number of teeth on driving gear / Product of Number of teeth on driven gear

REVERTED GEAR TRAIN :- If the axes of the first and last wheels of a compound gear coincide; it is called a reverted gear train. Such an arrangement is used in clocks and in simple lathes where 'back gear' is used to give a slow speed to the chuck.

Train Value = Product of Number of teeth on driving gear / Product of Number of teeth on driven gear

PLANETARY OR EPICYCLIC GEAR TRAIN :- When there exists a relative motion of axis in gear train, it is called a planetary or an epicyclic gear train (or simply epicyclic gear or train). Thus in an epicyclic train, the axis of at least one of the gears also moves relative to the frame.

Consider two gear wheels S and P, the axis of which are connected by an arm a. if the arm 'a' is fixed, the wheels S and P constitute a simple train. However, if the wheel s is fixed so that the arm can rotate about the axis of S, the wheel P would also move around S. therefore, it is an epicyclic train.

DIFFERENTIAL GEAR :- When a vehicle takes a turn, the outer wheels must travel farther than the inner wheels. In automobiles, the front wheels can rotate freely on their axis and thus can adapt themselves to the conditions. Both rear wheels are driven by the engine through gearing. Therefore, some sirt of automatic device is necessary so that the two rear wheels are driven at slightly different speeds. This is accomplished by fitting a differential gear on the rear axle.

OBSERVATION & CONCLUSION: -

1. Comparison between simple, compound reverted, epicyclic and differential. Gear train.
2. To calculate the train value.
3. To calculate the speed of any gear.

APPLICATIONS :-

(i) Gear trains are used in automobiles.

(ii) Reverted gear train are used in clock and simple lathe

(iii) Epicyclic gear are used in transmission, computing devices.

(iv) Gears are used in different machinery.

VIVA-QUESTIONS :-

a. Define about gear trains with classification, advantages & disadvantages and applications.

b. Define train value.

c. Define differential gear train with applications.

3. DETERMINATION OF RADIUS OF GYRATION AND MOMENT OF INERTIA OF CONNECTING ROD BY OSCILLATION METHOD

Date:

Exp No:

AIM:

To determine the radius of gyration & moment of inertia of connecting rod using oscillation method.

APPARATUS REQUIRED:

1. Connecting rod
2. Verniercalliper
3. Stop watch

FORMULA:

Time period t_p= time taken / No of oscillation in (sec)

Moment of Inertia $I=mk^2$ (kgm^2)

K-radius of gyration(m) $K^2=h(l-h)$

Natural frequency $F_n=1/2\pi\sqrt{g/L}$ (Hz)

L_1=Equivalent length of the connecting rod when the system is from the small end.

$L_{1=g(TP1/2\Pi/)}{}^2$

h_1=Distance of small end from centre of gravity .

Natural frequency $F_{n2}=1/2\pi\sqrt{g/L_2}$ (Hz)

L_2= Equivalent length of the connecting rod when the system is from the big end.

$L_{2=g(TP2/2\Pi/)}{}^2$

L=L1+L2/2

h_2= Distance of big end from centre of gravity .

$h_1+h_2=l+d_1/2+d_2/2$

l- Length of connecting rod

PROCEDURE:

1.The experimental setup is taken and stand is fixed for oscillation of connecting rod.

2.The connecting with its small end is hanged on the stand.

3.Connecting rod is passed to a point and then it is released and allowed to oscillate.

4.Time is noted for 5 oscillation of rod.

5.Now some procedure is followed by hanging rod &readings are taken to find radius of gyration & MOI of connecting rod by using the formula.

$I=mk^2$ (kgm^2)

S.No	Type of End	Time for 5 oscillation (t)(s)	Mean time(s)	Time period $T_p(s)=t/n$	Natural Frequency $(Hz)(1/t_p)$	Radius of Gyration (k)(m)	Moment of Inertia $I(kgm^2)$

RESULT:

Thus the radius of gyration & moment of inertia of given connecting rod is found out using oscillation method.

Radius of gyration =

Moment of Inertia =

Questions

1. Define crank effort and crank pin effort .
   Crank effort is the net effort applied at the crank pin perpendicular tothecrank , which gives the required turning moment on the crankshaft.
   The component of force acting along connecting rod perpendicular tothe crank is known as crank-pin effort.

2. Define Piston effort
   Net force acting on the piston is termed as piston effort.

3. What is meant by turning moment diagram or crank effort diagram?It is the graphical representation of the turning moment or crank effort for variosposition of the crank.It turning moment diagram, the turning moment is taken as the ordinate and crankangle as abscissa.

4. Explain the term maximum fluctuation of energy in flywheels. The difference between the maximum and the minimum energies is known as maximum fluctuation of energy. Maximum fluctuation=maximum energy-minimum energy .

5. Define coefficient of fluctuation of energy.It is the ratio of maximum fluctuation of energy to the work done per cycle .Ce=maximum fluctuation of energy/work done per cycle .

6. Define coefficient of fluctuation of speed. It is the ratio of maximum fluctuation of speed to the mean speed is called the coefficient of fluctuation of speed.
   Cs= (N1-N2)/NWhere,N1=maximum speedN2=minimum speed N=mean speed=(N1+N2)/2.

7. Define coefficient of steadiness.
   The reciprocal of the fluctuation of speed is known as coefficient of steadiness'=1/Cs =N/ (N1-N2).
8. Why flywheels are needed in forging and pressing operations
   In both the machines flywheels are required to control the variations in speed during each cycle of an engine.
9. Define static force analysis. If components of a accelerate, inertia is produced due to their masses. However, the magnitude of these forces is small compared to the externally applied loads. Hence inertia effects due to masses are neglected. Such an analysis is known as static force analysis.

10. Differentiate between static & dynamic equilibrium.
    Necessary and sufficient conditions for static and dynamic equilibrium are:1.vector sum of all the forces acting on a body is zero.2. The vector sum of all the moments of all the forces acting about any arbitrary pointer axis is zero. First conditions are sufficient conditions for static equilibrium together with second condition is necessary for dynamic equilibrium

4. DETERMINATION OF MASS MOMENT OF INTERIA OF COMPOUND PENDULUM

Ex**. No.;**
Date:

Aim

To find out the moment of inertia of the given body

Apparatus required:

1. Compound pendulum
2. Scale
3. Stop watch

Experimental Setup:

A compound pendulum represents a represents a rigid body supported at 'O'. So that it can swing in vertical plane about some axis passing through it.

Formula used:

1. Time period $Tp= 2\pi / \sqrt{Kexp^2+OH^2/g}$ xOG
   OG-distance between centre of gravity and suspension point
2. Experimental radius of gyration= $\sqrt{(4 \pi^2 /T}$ xgxOG)-Oh^2
   Time period observed =time taken/ no. oscillation
3. Experimental Frequency =1/T
4. Theoritical frequency =1/T $\sqrt{}$ GxOh/g^2 +oh^2

L-Length of compound pendulum
Moment of Inertia I= mk^2
m- mass of the compound pendulum

Procedure:

1. Measure the distance of suspension point O from the center of gravity G of given compound pendulum
2. Compound pendulum is suspended from the suspension point and is oscillated.
3. Time taken for 10 oscillations is found out using stop watch and three trials are made for the same suspension point.
4. By varying the distance of suspension point above procedure is repeated.
5. Average time taken for each suspension point is calculated.
6. Using formula Natural frequency, radius of gyration and Moment of inertia are calculated.

OBSERVATION:

Length of compound pendulum L= 1000mm
Mass of the compound pendulum=800mm
Distance of Centre of Gravity=L/2
Mass=760kg

Tabulation

Sl. No.	Height	Time taken for 10 oscillation				Mean time' t' sec	Time period T=t/n sec	Natural frequency		Radius of gyration of k		Moment of inertia Kg-m^2
								Exp fn	Ther fn	Exp	Kthe	

Result :

Thus Radius of gyration of given compound pendulum and moment of inertia are found out Experimental radius of gyration Kexp=
Theoretical radius of gyration Kth=
Moment of inertia I=

Questions

1. What is free body diagram? A free body diagram is a sketch of the isolated or free body which shows all the pertinent weight force, the externally applied loads, and the reaction from its supports connections acting upon it by the removed elements.

2. Differentiate between static & dynamic equilibrium. Necessary and sufficient conditions for static and dynamic equilibrium are:1.vector sum of all the forces acting on a body is zero.2. The vector sum of all the moments of all the forces acting about any arbitrary pointer axis is zero. First conditions are sufficient conditions for static equilibrium together with second condition is necessary for dynamic equilibrium.

3. Define applied and constraint force. The external force acting on a system of body from outside the system is called applied force. The constraint forces are the forces existing internally within the body.

4. Differentiate between static force analysis and dynamic force analysis. If components of a machine accelerate, inertia forces are produced due to their masses. If the magnitude of these forces are small compared to the externally applied loads, they can be neglected while analysis the mechanism. Such analysis is known as static force analysis.

5. Define inertia force.
   The inertia force is an imaginary force, which when acts upon a rigid body, brings it in an equilibrium position. Inertia force = -Accelerating force = -m.a

7. StateD"Alembert"sprinciple.
   D'Alembert's principle states that the inertia forces and torques, and the and torques acting on a body together result in static equilibrium.

8. State principle of superposition.
   The principle of superposition states that for linear systems the individualresponses to several disturbances or driving functions can be superposed oneach other to obtain the total response of the system.

9. What is meant by turning moment diagram or crank effort diagram?
   It is the graphical representation of the turning moment or crank effort for variousposition of the crank.It turning moment diagram, the turning moment is taken as the ordinate and crankangle as abscissa.

10. Explain the term maximum fluctuation of energy in flywheels.
    The difference between the maximum and the minimum energies is known asmaximum fluctuation of energy.Maximum fluctuation=maximum energy-minimum energy .

5. TO STUDY THE DISPLACEMENT MOTION CURVE OF CAM

Exp No:
Date:

Aim :

To study the profile of given can using cam analysis system and to draw the displacement diagram for the follower and the cam profile .Also to study the Jump speed characteristics of the cam follower mechanism .

Apparatus required :

Cam analysis system and dial gauge .

Description :

A cam is a machine element such as cylinder or any other solid with a surface of contact so designed as to give the follower . A cam is a rotating body imparting oscillating motor to the follower . All the cam mechanisms are composed atleast of 3 links .

- Cam
- Follower
- Frame which guides the follower

Procedure :

1. Cam analysis system consists of cam roller follower . Pull the rod and guides of pull rod .
2. Set the cam through 10 degree and note the projected length of the pull rod above the guide .
3. Calculate the life by subtracting each reading with initial reading .

Jumpspeed :

1. The cam is run at gradually increasing speed at which the follower jumps off .
2. The jump speed is observed for the different loads of follower .

Tabulation

Angular Displacement of cams in degree	Linear displacement of the Follower in mm
	Linear displacement of the follower in mm **Circular Arc Cam**
0	
20	
40	
60	
80	
100	
120	
140	
160	
180	
200	
220	
240	
260	
280	
300	
320	
340	
360	

Graph: TodrawangulardisplacementsofthecamVsthelineardisplacementsofthe FollowerbygraphicalandPolarchart.

Result: Thus by measuring the follower lift cam profile was drawn and jumping speed was observed for the different loads of follower.

Questions

1. Define unbalance.:
A disc cam produces unbalance because its mass is not symmetricalwith the axis of rotation

2. Define windup.
Twisting effect produced in the camshaft during the raise of heavy loadfollower is called as windup.

3. What are the effect and causes of windup?
The effect of windup will produce follower jump or float or impact.
Causes of windup are:
When heavy loads are moved by the follower,
When the follower moves at a high speed, and
When the shaft is flexible.

4. Flywheels are needed in forging and pressing operation?
In both forging and pressing operation, flywheels are required to control the variations in speed during each cycle of an engine.

5. What is cam dynamics?
Cam dynamics is the study of cam follower system with considering the dynamicforces and torques developed in it

6. How jump of the follower is reduced in cam follower system
In cam follower system the jump is reduced by using retaining spring

7. What is the remedy for camshaft windup?
Camshaft windup can be prevented to a large extend by mounting theflywheel as close as possible to the cam.

8. What is Spring surge
Spring surge means vibration of the retaining spring.

9. What are the types followers used in cam mechanism
Flat, Mushroom, roller

6. EXPERIMENTAL VERIFICATION OF GYROSCOPIC COUPLE

Date:
Exp No:

Aim:

To determine the active and the reactive gyroscopic couples and compare them.

Apparatus required:

Gyroscopic, tachometer, variable voltage transformer, rotating disc with a light reflecting sticker to scraboscope speed measurement.

Procedure:

1.The disc is made to rotate at a constant speed at a specific time using variable voltage transformer.

2.the speed of the disc(N) is measured using a scraboscope or tachometer.

3. a weight/mass is added on the extending platform attached to the disc .

4.this causes an active gyroscopic couple and the whole assembly (rotating disc, rotor and weight platform with weight) is standing to move in a perpendicular plane to that of plane rotating disc. This is called gyroscopic motion.

5.the time taken(t) to the transverse a specific angular displacement(Ø) is noted.

Formula used:

1. Mass moment of inertia of the disc(I)

   $I = md^2/8$

   M-mass of disc

   d-diameter of disc

2. Angular velocity of disc(ω)

   $\omega = 2\prod N/60$ rad/sec

   N- speed of disc

3. Angular velocity of precession

   $\omega_p = (Ø/t)*(\prod/180)$ rad/sec

4. Reactive gyroscopic couple

   $C_r = I\omega\omega_p Nm$

5. Active gyroscopic couple

   C_a=wL

   w- weight added mg in N

   L- Distance between centre of weight to the centre plane of disc.

   Graph: between active and reactive and gyroscopic couples are obtained.

   Active couple vs reactive couple

   Weight added vs reactive couple

TABULATION:

S no	Speed	Weight added		Angular displacement (θ)	Time for angle turned (t)	Angular revolution of precession (r/s)	Angular velocity of disc (r/s)	Active couple (N/m)	Reactive couple (N/m)
		M Kg	W (N)						

Result :

Thus the above characteristics curves are drawn in graph and the comparison between active and reactive and gyroscopic couples are obtained.

Questions

1. What is the effect of gyroscopic couple on rolling of ship? Why?
   We know that, for the effect of gyroscopic couple to occur, the axis of precession should always be perpendicular to the axis of spin. In case of rolling of a ship, the axis of precession is always parallel to the axis of spin for all positions. Hence there is no effect of the gyroscopic couple acting on the body of the ship[during rolling.

2. What is the principle of inertia governors? In inertia governors, the balls are so arranged that the inertia forces caused by an angular acceleration or retardation of the shaft tend to alter their positions.

3. Define power of a governor? The power of a governor is the work done at the sleeve for a given percentage change of speed. It is the product of the mean value of the effort and the distance through which the sleeve moves. Power=Mean Effort Lift of sleeve

4. What is meant by isochronous condition in governors? A governor with zero range of speed is known as an isochronous governor. Actually theisochronisms is the stake of Infinite sensitivity.

5. Give the applications of gyroscopic principle. It is used:(i) In instrument or toy known as gyroscope.(ii) In ships in order to minimize the rolling and pitching effects of waves, and(iii) In aero planes, Monorail cars, gyrocompasses, etc.

6. What so you mean by governor effort? The mean force acting on the sleeve for a given percentage change of speed for lift of the sleeve is known as the governor effect.

7. What is controlling force diagram? When the graph is drawn between the controlling force as ordinate and radius of rotation of the balls as abscissa, the graph so obtained is called controlling force diagram.

8. What is a gyroscope
   Gyroscope is a spinning body rotating about its own axis and is able to move on other directions

9. What is meant by axis of precession
   The spinning axis of a body will precess about an axis perpendicular axis when a moment is applied on spinning body, this perpendicular axis is known as axis of precession.

7. DETERMINATION OF MASS MOMENT OF INTERIA USING TURN TABLE APPARATUS

Exp No: **Date:**

AIM:

To determine angular velocity ,angular acceleration moment of inertia ,centrifugal force of turn table.Experimental setup:

*rotary disc: 390mm dial×12 thick with central bush ,weight hanger

*motor: variable spur 0-800rpm,0-30VDC,compact 2.5amps mount vertically top plate and shaft is extended on top

*control panel: it is combined panel and section at hours DC motor, inside meter /control comprises following

*variac: 0-2A, 0-230v,heavy duty

*RPM meter: digital 0-9999rpm, led display

*fuse: 2A and main switch

*rectifier: bridge rectifier

*sliding weight: it is mount on 2set,2 brackets one side

*weights: 3numbers for each side

*dial weights: 1NO

OBSERVATION:

(DISC) axial load W: 0.1kg

FORMULA:

Initial velocity $v_1 = \pi D_1 N/60$

$D_1 = 2r_1$

Final velocity $v_2 = \pi D_2 N/60$

$D_2 = 2r_2$

Angular acceleration = $(r_2v_2 - r_1v_1)/t$ m./sq.sec

Centrifugal force $f = [\ m(v_2)^2]/v_2$

Moment of inertia I= $m\times(v_2)^2$ kgm^2

V2= final velocity v1= initial velocity M=mass of disc with weight added

PROCEDURE:

1. Weight were added on each side of table.
2. Switched on the motor to turn the table.
3. The voltage 24 volts was set on the voltage regulation
4. Time taken for the sliding of weight is measured by stopwatch.
5. Speed of disc is measured by tachometer.
6. Step 3,4,5, were repeated for adding move masses on each side.

TABULATION:

Weight added on each side(m) In kg	Weight Of a disc (m+2m)	Speed of the disc(rpm)	Time taken In changing position(t) sec	R1	V1 m/s	R2	V2 m/s	Moment of inertia (kgm^2)	Angular Accerlation R2v2-r1v1/t (Rad/s)	C.F=$MV2^2/V2$ (N)

RESULT:

Thus the angular velocity ,angular acceleration mass moment of inertia centrifugal force of theturn table are observed and calculated.

Questions

1. Define linear momentum
   Linear momentum= mv
   m- mass of the body
   v- velocity of the body
2. Define angular momentum
   Angular momentum= Iw
   I- Moment of Inertia
   w- Angular velocity of the body
3. What is mass moment of Inertia
   Second moment about an axis due to mass is termed as Mass moment of Inertia
4. Significant of mass moment of inertia
   Mass moment of inertia of a body will resist rotational effects
5. What is area moment of inertia
   Second moment about an axis due to area is termed as area moment of inertia
6. Significant of area moment of inertia
   Area moment of inertia of a plane will resist bending effects
7. What is general plane motion
   The motion which has both the effect of translation as well as rotation
8. What are the types of motion
   Rectilinear motion, curve linear motion, pure rotation, General plane motion
9. Give examples for general plane motion
   The motion of connecting rod in a reciprocation mechanism, The motion of rope over a cylindrical pulley
10. Define Inertia force
    It's a property of matter by virtue of which a body resist any change in velocity.

8. DETERMINATION OF RADIUS OF GYRATION USING BIFILAR SUSPENSION

Date:
Exp No:
AIM:

To determine the radius of gyration and the moment of inertia of a given rectangular plate.

APPARATUS USED:

1. Main frame
2. Bifilar plane
3. Weight
4. Stop watch

FORMULA:

Time period T=t/n

Natural Frequency $f_n = 1/T$

Radius of gyration K=T/2π$\sqrt{g/l}$ in mm

a- distance of string from Centre of Gravity

T-Time period

L-Length of spring

N-No of oscillation

t- time taken for N oscillations

F_{exp}=1/T (HZ)

F_{th}= 1/2π($\sqrt{2ga/l}K^2_{th}$

K_{th}=L/2$\sqrt{3}$

a=13.5cm a=13.5*10^{-2}m

PROCEDURE:

1. Select the bifilar plane.
2. With the help of chuck tighter the spring at the top.
3. Adjust the length of spring to desired valve.
4. Give a small horizontal displacement about vertical axis.
5. Start the stop watch and note down the time required for N-oscillation.
6. Repeat the experiment by adding weight and also by changing the length of the spring.
7. Do the model calculation.

S.NO	Length of spring (m)	Time taken for 10 oscillation (s)	Mean time(t) (sec)	Time period (T=t/n)	F_{exp}= 1/T	Experimental K_{exp}(COG) (m)	Theoritical radius of gyration K_{th}(m)	F_{th} (Hz)

RESULT:

Thus radius of gyration and moment of inertia are calculated by using Bifilar suspension.

Questions

1. Define logarithmic decrement. Logarithmic decrement is defined as the natural logarithm of the amplitude reduction factor. The amplitude reduction factor is the ratio of any two successive amplitudes on the same side of the mean position.

2. Specify the importance of vibration isolation? When an unbalanced machine is installed on the foundation, it produces vibration in the foundation. So, in order to prevent these vibrations or to minimize the transmission of forces tothe foundation, vibration isolation is important.

3. What are the functions of Governor? The function of a governor is to maintain the speed of an engine within specified limits whenever there is a variation of load. Governors control the throttle valve and hence the fuel supply to carter the load variation on engines.

4.How governors are classified?1. Centrifugal governors.(a) Pendulum type: Example: Watt governor(b) Gravity controlled type: Example: Porter and proell governors) Spring controlled type: Example:Harnell and Hartung governors

5.Differentiate between governor and flywheel?
governor is provided on prime movers such as engines and turbines It is provided on engine and fabricating machines rolling mills, punching machines, shear machines, presses etc.flywheel works intermittently, i.e., only when there is change in load. It works continuously from cycle to cycle.

6. What is meant by sensitiveness of governors?
The sensitiveness is defined as the ratio of the mean speed to the difference between the maximum and minimum speeds. A governor is said to be sensitive, when it really toa small change of speed.

7.What is gyroscopic torque?
Whenever a rotating body changes its axis of rotation, a torque is applied on the rotating body.
State different method of finding natural frequency of a system.1. Equilibrium method,2. Energy method,3. Rayleigh method.

8 What is meant by free vibration and forced vibration? Free (or) natural vibration: When no external force acts on the body, after giving it an initial displacement, then the body is to said to be Free (or) natural vibration Forced Vibration: When the body vibrates under the influences of external forces, then the body is said to be under Forced vibration.

9.Define resonance.
When the frequency of external forces is equal frequency of a vibrating body, the amplitude of vibration becomes excessively large. This phenomenon is known

10. What is meant by degrees of freedom in a vibrating system?
The number of independent coordinate required to completely define the motion of a system is known as degree of freedom of the system

9. TRANSVERSE VIBRATION OF FREE BEAM SETUP

Date:
Exp No

AIM:

To study transverse vibration of a beam subjected to uniform load and concentrated load. The setup is as follows.

Main Frame;

Turnion: 2 brackets of turnion bearing with slots to insert at approx 1metre apart

Weighs; 100 gms * 5nos

Specification:

Length of beam = 1300mm

Width of beam =25mm

Weight of beam =1.6 kg

Procedure:

1. fit beam into both the slots of turnion bearing and tighten them rigidly

2. add weights, either concentrated at center or uniformly

3. Give a swing to beam

$. Note down the time required for 5 oscillation.

5. repeat experiments for different weights

6. Change the position of weights

7. repeat the experiments

8.Find out the deflection for different weights

FORMULA:

1. Theoritical frequency Fth= $0.4985/\sqrt{(d1 + (ds/1.27))}$

$d1$ – deflectio due to weight added

W-Weight applied

$$d_1 = \frac{wl^3}{48EI}$$

L= length of beam

E= 200x10^9N/m^2

I= bh^3/12

b- breadth of beam

H- thickness of beam

d_s – deflection due to self weight of beam

$$d_s = \frac{d_1 wl^4}{384EI}$$

w- weight of beam = bhl x p x g = 1.6kg

c-density of beam material = 8000kg/m^3

b,h- breadth & thickness beam g= 9.81 m/s^2

Time period T = Time taken/no.of. oscillation

Experimental frequency Fexp =1/T

OBSERVATION

length of beam = 109cm

breadth of beam =2.5cm

thickness of beam =0.5cm

TABULATION :

sl.no.	weight added gm	Time taken for n=5 oscillation	mean time (t)	Time period T=t/n	Experimental frequency Fexp =1/T	Deflection d_1 Measured actual	Theoritical frequency Fth= $0.4985/\sqrt{(d_1 + (d_s/1.27))}$

Result

Thus the transverse vibration of the beam subjected to uniform and concentrated load is studied

Questions

1. What are the causes and effect of vibration?The causes of vibration are unbalanced forces, elastic nature of the system, selfexcitation, wind and earthquakes.The existence of vibration elements in any mechanical system produces unwantednoise, high stress, poor reliability and premature failure of one or more of the parts.

2. Define frequency, cycle, period.Frequency: It is the number of cycles described in one secondCycle: It is defined as the motion completed during one time periodPeriod: It is the time interval after which the motion the motion is repeat itself.

2. Define free vibration.

Free vibrations: if the periodic motion continues after the causes of original disturbance is removed, then the body is said to be under free vibrations.

3. What are the different types of vibrations?

1. Free vibrations,2. Forced vibrations,
3. Damped vibrations.

4. State different method of finding natural frequency of a system.1. Equilibrium method,2. Energy method,3. Rayleigh method.

5. What is meant by free vibration and forced vibration? Free (or) natural vibration: When no external force acts on the body, after giving it an initial displacement, then the body is to said to be Free (or) natural vibration Forced Vibration: When the body vibrates under the influences of external forces, then the body is said to be under Forced vibration.

6. Define resonance.

When the frequency of external forces is equal frequency of a vibrating body, the amplitude of vibration becomes excessively large. This phenomenon is known as resonance.

7. What is meant by degrees of freedom in a vibrating system? The number of independent coordinate required to completely define the motion of a system is known as degree of freedom of the system.

8. What is the natural frequency of simple spring mass system?

Natural Frequency, fn=1/2π
√ □□□

S=Stiffness of the spring M= Mass of the body suspended from the spring,
δ = Static deflection of the spring due to the weight.

9. Give examples for the desirable effects of vibration

Alarms, toys

10. What type of dampers are provided in two wheelers?

Viscous damping

10. DETERMINE NATURAL FREQUENCY OF TORSIONAL VIBRATION IN TWO ROTOR SYSTEM

Date:
Exp No

AIM:
To determine period and frequency of turned vibration of two rotor system and compare it with theoretical value.

APPRATUS REQUIRED:

Shaft, measuring tape, stopwatch, chuck key, weight

FORMULA:

Time period T= t/n (sec)

n- no of oscillation

Natural frequency fn: 1/T (HZ)

Theoretical frequency :Fth= $1/2\pi\sqrt{GJ/IaLa}$

G- modulus of rigidity (24×10^9 n/m^2)

J- polar moment of inertia $\pi d^4/32$ mm^4

Ia- ma $d^2/8$

Ib- mb $d^2/8$

L= la+lb

L= Ia/Ib× La+Lb

PROCEDURE:

1. Fix the disc A and B to the shaft and fix it shaft in bearing.
2. Deflect the disc A+B in opposite direction
3. Notedown the time acquired for N=5 osscilation
4. Fit the cross to the disc
5. Repeat the procedure

TABULATION:

Weight of disc (kg)	Time for oscillation (sec)	Time period T=t/n	Experimental natural frequency Fn(HZ)	Moment of inertia Disc A (Ia)	Moment of inertia of disc B (Ib)	Distance of node disc A La(m)	Distance of node of disc(ᾳ) La(m)	Theoretical frequency

RESULT:

Thus the period and frequency of torsional vibration of two rotor system is determined

Questions

1. What is node in a multi rotor system
   Node is section at which the shaft will not undergo any twist
2. Define torsional equivalent shaft
   A shaft having variable diameter for different lengths can be replaced by an equivalent uniform dia such that they have same total angle of twist when equal opposing torques are applied.
3. What are the conditions to be satisfied for an equivalent system that of geared system in torsional vibrations
   1.the kinetic energy of the equivalent system must be equal to the kinetic energy of the original system.
   2.the strain energy of the equivalent system must be equal to the strain energy of the original system.

4. What is the relation between damped and undamped vibration
   Undamped frequency=$(1-E^2)$damped frequency
   E- Damping factor
5. Define free vibration.
   Free vibrations: if the periodic motion continues after the causes of original disturbance is removed, then the body is said to be under free vibrations.

6.What is meant by free vibration and forced vibration? Free (or) natural vibration: When no external force acts on the body, after giving it an initial displacement, then the body is to said to be Free (or) natural vibration Forced Vibration: When the body vibrates under the influences of external forces, then the body is said to be under Forced vibration.

7. Define resonance.
When the frequency of external forces is equal frequency of a vibrating body, the amplitude of vibration becomes excessively large. This phenomenon is known as resonance.

8. What type of motion is exhibited by a vibrating system when it is critically damped? A periodic motion is exhibited

9.What is the limit beyond which damping is detrimental and why?
When the damping factor £=1.the aperiodic motion is resulted .That is ,aperiodicmotion means the system cannot vibrate due to over damping. Once the system isdisturbed, it will take infinite time to come back to equilibrium.

10. Differentiate between transverse and torsional vibrations.
In transverse vibration, the particles of the shaft approximately perpendicular tothe the axis of the shaft.Due to transverse vibration, tensile and compressive stresses are induced
Due to torsional vibration, torsional shear stresses are induced in the shaft.

11. DETERMINATION OF WHIRILING OF SHAFT

Date:

Exp No:
AIM:

To study the winding of shaft and to determine the critical speed of the shaft

APPARATUS REQUIRED:

Meter scale

Whirling of the shaft set ups

DESCRIPTION:

The speed at which the shaft runs so that the additional deflection of shaft from the axis of rotation becomes infinite is known as critical speed. Normally the shaft will always displacement from axis of rotation although the amount of displacement may be very small as a radius of shaft rotates.

FORMULA USED:

Critical speed of the shaft (radian)

where,

g = 9.81 m/s² (acceleration due to gravity)

δ = 5wl^4/384EI (deflection)
Young‟s modulus, E (for stainless steel) = 1.8 x 10_{11} N/ m2
E = 200*10^9 N/m^2(Steel)(young's modulus)

I = π/64 (D^4)-----→Intertia ,ρ = 8000 kg /m^3

Mass=ρ*area*L, Area=π/4 *D^2*L

W=Mass*9.81/length

Fn= √5×g/384δ

V = π/4×d²l

Theoretical whirling speed, Nctheo = {0.4985 / [sqrt (δs / 1.27)]} x60
NC=60×Fn

OBSERVATION:

Young‟s modulus, E (for stainless steel) = 1.8 x 1011 N/ m2
Length of the shaft, L = 1 m
Shaft 1 (stainless steel) Shaft 2 (stainless steel)
m1 = 0.075 kg, m2 = 0.085 kg, m3 = 0.150 kg
d1 = 0.003 m
d2 = 0.004 m
d3 = 0.008 m

GRAPH:

Deflection vs critical speed

PROCEDURE:

1. Take the given rod specimen rod and fix it in the chuck.
2. Using various speed measure the deflection of the rod in mm.
3. Tabulate the reading for different speed and note down the deflection.
4. Calculate the critical speed by using given formula.

TABULATION:

Diameter of the shaft (cm)	Distance between chuck & free end (cm)	Deflection δ	Speed observed	Critical speed	Theoretical Critical speed

RESULT:

Thus the critical speed of the shaft has been obtained.

Questions

1 .What is the limit beyond which damping is detrimental and why?
When the damping factor £=1.the aperiodic motion is resulted, a periodic motion means the system cannot vibrate due to over damping. Once the system is disturbed, it will take infinite time to come back to equilibrium.

2.What is meant by critical damping? The system is said to be critically damped when the damping factor £=1.If then system is critically damped, the mass moves back very quickly to its equilibrium position within no time.

3. What type of motion is exhibited by a vibrating system when it is critically damped? A periodic motion is exhibited

4. Define critical or whirling speed. The speed at which resonance occurs is called critical speed of the shaft. In other words ,the speed at which the shaft runs so that the additional deflection of the shaft from the axis of the rotation becomes infinite ,is known as critical speed.

5. What are the factors that affect the critical speed of a shaft? The critical speed essential depends on;The eccentricity of the C.G.of the rotating masses from the axis of rotation of the shaft.
Diameter of the disc
Span (Length) of the shaft,
Type of supports connections at its ends.

6. What are the causes of critical speed? The Critical Speed occurs due to the one or more following reasons:1. Eccentricity mounting like gear, flywheel, pulleys, etc2. Bending of the shaft due to own weight3. Non-uniform distribution of the rotor material,etc

7. Differentiate between transverse and torsional vibrations.
In transverse vibration, the particles of the shaft approximately perpendicular to the the axis of the shaft.Due to transverse vibration, tensile and compressive stresses are induced
Due to torsional vibration, torsional shear stresses are induced in the shaft.

8. What are the causes and effect of vibration? The causes of vibration are unbalanced forces, elastic nature of the system, self excitation, wind and earthquakes. The existence of vibration elements in any mechanical system produces unwanted noise, high stress, poor reliability and premature failure of one or more of the parts.

9. Define frequency, cycle, period. Frequency: It is the number of cycles described in one second
Cycle: It is defined as the motion completed during one time period
Period: It is the time interval after which the motion the motion is repeat itself.

10. Define free vibration.
Free vibrations: if the periodic motion continues after the causes of original disturbance is removed, then the body is said to be under free vibrations.

12. FREE VIBRATION OF SPRING MASS SYSTEM

Ex. No.:
Date:

AIM:

To determine the natural frequency of spring mass system.

Appratus required:

1. Spring mass setup
2. Masses
3. Stop watch
4. Scale

Experimental setup:

Spring mass system is a setup used to determine the experimental frequency. The body whose frequency is to be determined is suspended by two springs. When the body is moved through a small distance along a vertical axis through the centre of gravity, it will acclelerate in a vertical plane, then by taking the following readings with the single mass system we can determine the frequency of a body.

Formula

1. Time period Tp=n/t
   n- no of oscillations
   t- time taken
2. Natural frequency Fn= 1/ Tp
3. Theoritical frequency $Fn=1/2\pi\sqrt{k/m}$
   k-Stiffness of spring= load /deflection N/m
   m- mass suspended

Procedure

1. Take the reading for free vibration by manual jerk
2. Note down the time period
3. Now switch on the motor
4. Regulate the required speed
5. Take the reading for forced vibration.

Tabulation

Sl no	Mass added M (kg)	Length of the Spring L (mm)		Deflection (mm)		Stiffness k (N/m)	Timefor10 oscillation T(sec)	Time periodfor one tp (sec)	Experimental natural frequency, $f_{n(exp)}$, Hz	Theoretical natural frequency $f_{n(the)}$, Hz
		Initial	Final	Initial	Final					

Graph:

Load vs Deflection

Load vs Theoretical natural frequency

Load vs Experimental natural frequency

Result:

Thus the Natural frequency of the spring mass system is found out.

Questions

1. Determine the natural frequency of mass of 10kgsuspended at the bottom of two springs (of stiffness: 5N/mm and 8N/mm) in parallel.

Natural Frequency ,$fn=1/2\pi\sqrt{}$ k/m

$fn=1/2\pi\sqrt{}$ 13/10 =.74 Hz

2. What is the effect of inertia on the shaft in longitudinal and transverse vibrations? In longitudinal vibrations, he inertia effect of the shaft is equal to the that of a mass one third of the mass of the shaft concentrated at its free end.11. State the expression for the frequency of simple pendulum. Natural Frequency, fn =$1/2\pi\sqrt{}$ k/m

Where L = Length of the string.

3.Give the expression for natural frequency of water, which oscillates in a „U" tube manometer?
Natural Frequency, fn =$1/2\pi\sqrt{}$ g/L
Where L = Column length of the liquid.

4. What are the different types of damping?
Viscous damping,
Coulomb or dry friction damping
Solid or structural damping
Slip or interfacial damping

5. What is meant by Dynamic magnifier

It is the ratio of maximum displacement of forced vibration to the deflection due to the static force.

1. What is the equivalent stiffness when two springs are in series and are in parallel

In series Seq= $1/s_1+1/s_2$
In parallel Seq= $s_1+ s_2$

7. How the mass moment of inertia is related with natural frequency of the system

fn=$1/2\pi\sqrt{}$ s/m
$I= mk^2$

m- Mass of the body
s- stiffness of spring
k- radius of gyration

8. What is amplitude of vibration
Maximum displacement of vibrating body from the mean position.
9. Define Natural frequency
Frequency of free vibration of the system
10. What is longitudinal vibrations
When the particles of the shaft or disc moves parallel to the axis of the shaft then the vibrations are known as longitudinal vibrations.

13. DETERMINE NATURAL FREQUENCY OF TORSIONAL VIBRATION IN SINGLE ROTOR SYSTEM

Date:

Aim

to determine the natural frequency of torsional vibration in single rotor system .

Appratus required

1. Single rotor set up
2. Steel rule
3. Stop watch
4. Chuck key.

Procedure:

1. Length of the shaft is adjusted by loosening the chuck using chuck key and the length of the shat is measured.
2. The rotor is deflected in angular direction
3. The time taken for 5 oscillations are noted
4. Three trials are made and the reading are noted.
5. For different lengths of shaft by adjusting length of shaft, the readings are noted
6. The above procedure is repeated for various shaft material.

Formula:

1. Natural frequency of the shaft $Fn=1/2\pi\sqrt{GJ/Il}$

   G-Modulus of rigidity= $2x10^9$

   Polar moment of inertia $J=\pi d4/32$

   Torsional stiffness =GJ/2

   T theo $=2\pi\sqrt{I/K_t}$

Sr. No.	Length Of Shaft	No. of oscillation	Time	K	Tth	Texp	Fnth	Fnexp
Steel	10mm							
	20mm							
	30mm							
Copper	10mm							
	20mm							
	30mm							

Result:

The natural frequency of the torsional vibration in single rotorsystemis---------- Hz

14.UNIVERSAL GOVERNOR APPARATUS

EX.NO:17 DATE:
AIM:

To determine the radius of rotation, Centrifugal force, Sensitivity, effort, power and draw the characteristics Curves of Watt, Porter, Proell and Hartnell governor.

APPARATUS REQUIRED:

Proell,Porter and Hartnell Governor
Digital Electronic Control Unit
Tachometer

FORMULA:

Where,

Governor Height (h) = ho – X/2 (mm)
Radius of Rotation (r) = √l 2-h (mm)
Centrifugal Force (f)= mω2r (N)
Sensitivity (s) = 2(N2-N1)/(N2+N1)
Percentage Increase in Speed (c) = (N2-N1)/ N1×100
Governor Effort (e) = [c(m+M)g] (N)
Governor Power (p) = ex (N-mm)

N2, N1 are maximum and minimum speed respectively
x= Sleeve displacement, m=mass of the ball in kg, r=radius of rotation

DESCRIPTION:

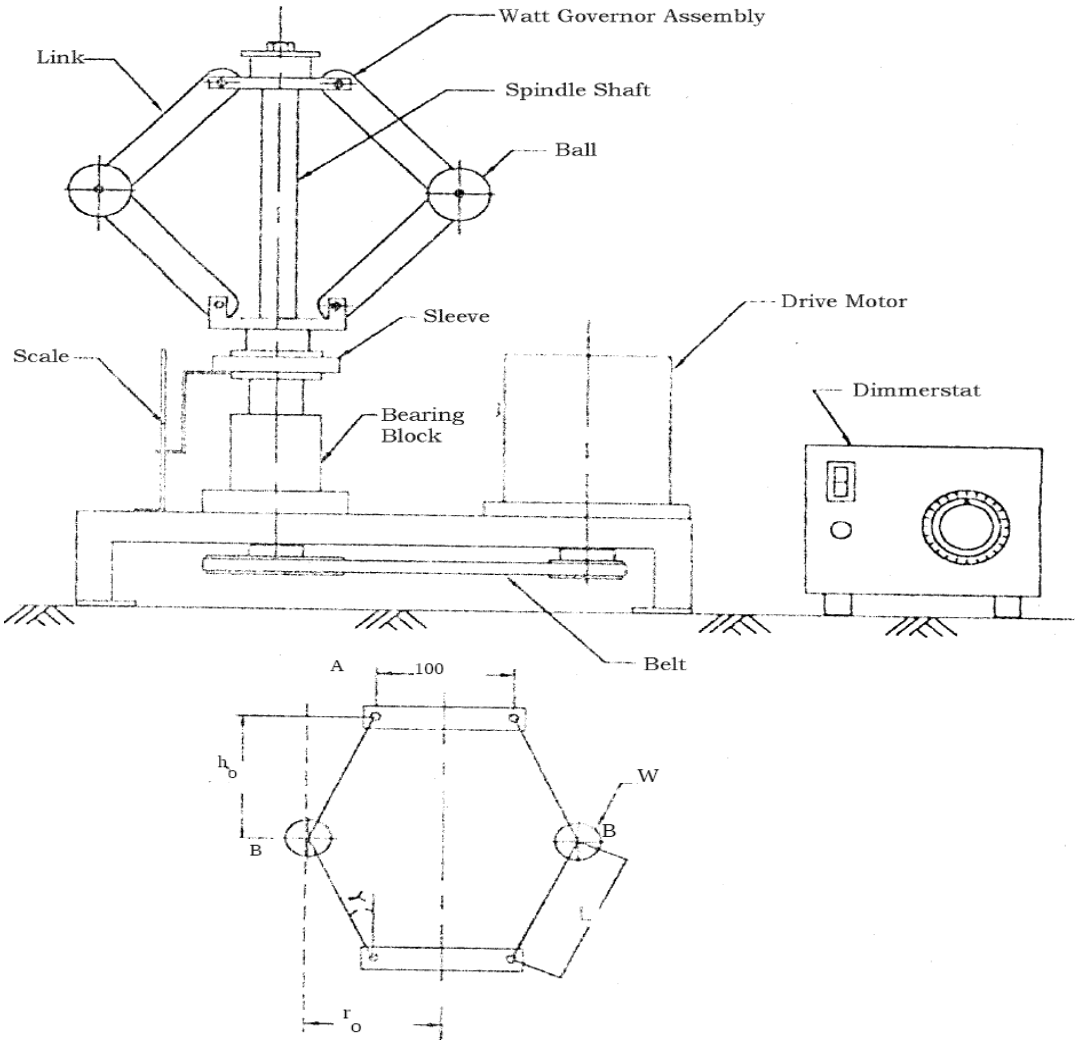
The drive unit consists of a DC electronic motor connected through belt and pulley arrangement. Motor and test set up mounted on a M.S fabricated fram.The governor spindle is driven by motor through V-belt and is supported in a ball bearing.

The optional governor mechanism can be mounted on spindle. Digital speed is controlled by the electronic control unit. A rpm indicate with sensor is to determine the speed. A graduated scale is fixed to the sleeved and guided in vertical direction.

The centre sleeve of the porter, proell and Hartnell governors incorporates a weight sleeve to which weights may be added.

EX.NO:14A Determination Of Range Sensitivity, Effort Etc., for Watts Governor

DATEDIAGRAMATICAL REPRESENTATION OF WATT GOVERNOR:



TABULATION:

S.No	Sleeve Displacement (X) 'mm'	Height of the Governor (h) 'mm'	Speed (N) 'rpm'	Radius of rotation (r) 'mm'	Centrifugal force 'F'	Sensitivity (s)	Effort (e) 'N'	Power (P) 'Nmm'

1. WATT GOVERNOR :-

Arrange the set-up as shown in Fig.5 by using the proper linkages provided. Tighten the bolts and nuts properly. The assembly is ready for conducting the experiment. Now follow experimental procedure as mentioned above.

Go on increasing the speed gradually and take the readings of speed

of rotation `N` and corresponding sleeve displacement `X`.

DIMENSIONS :-

a) Length of each link - L = 0.125 m.

b) Initial height of Governor – ho = 0.105 m.

c) Initial radius of rotation – ro = 0.120 m.

d) Weight of each ball - W = 0.6 kgs.

Radius of rotation `r` at any position could be found as follows

a) Find height h = ho – X/2 mtr.

b) Find " α " by using $\alpha = \cos^{-1}(h/L)$ in Degrees

c) Then r = 0.05 + L Sin α mtr.

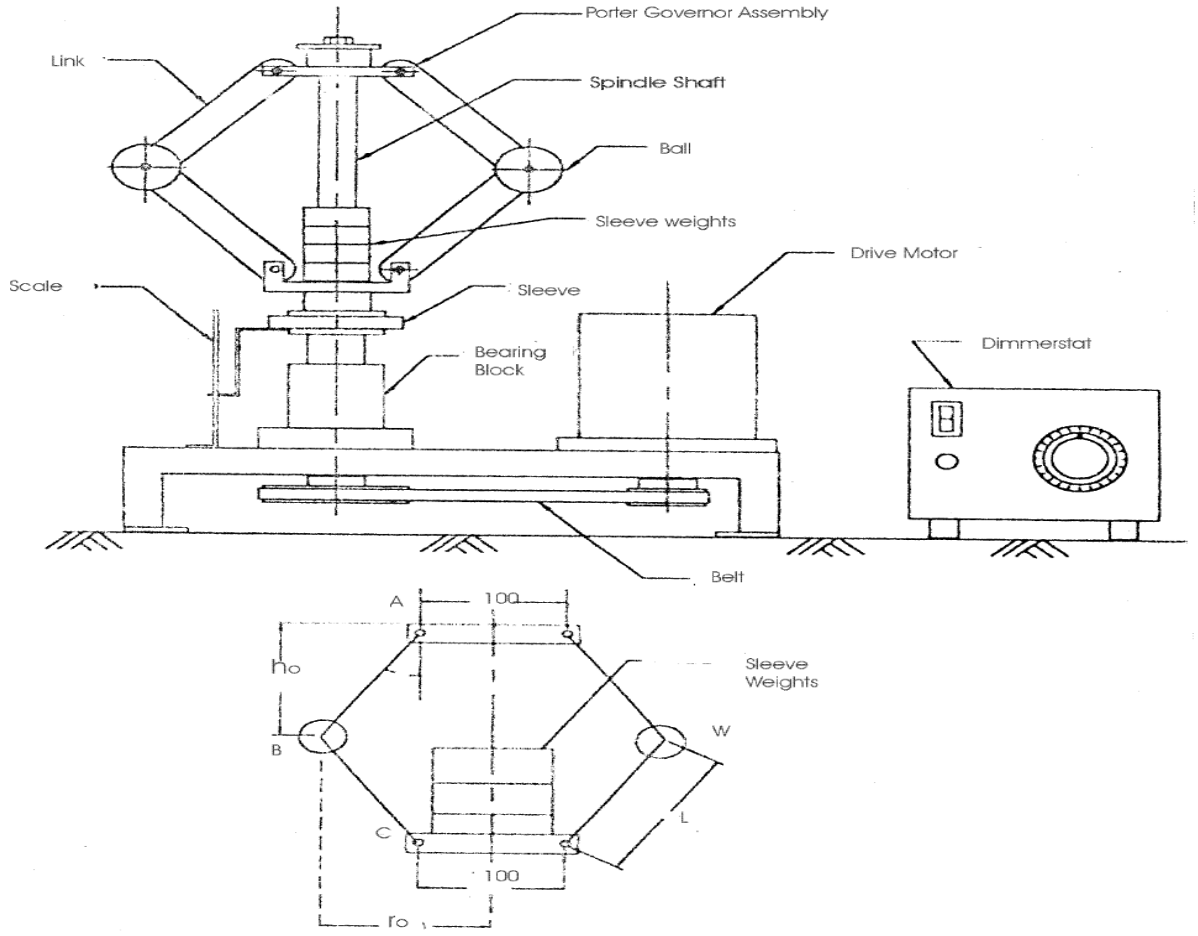
d) Angular Velocity 'ω' = 2π N/60 rad/sec

Graph:

Speed Vs Sleeve Displacement
Centrifugal Force Vs Radius of Rotation

EX.NO:14B Determination Of Range Sensitivity, Effort Etc., for porter Governor

DIAGRAMATICAL REPRESENTATION OF PORTER GOVERNOR



Schematic Layout of Governor Apparatus

S.No	Sleeve Displacement (X) 'mm'	Height of the Governor (h) 'mm'	Speed (N) 'rpm'	Radius (r) 'mm'	Centrifugal force 'N'	Sensitivity (s)	Effort (e) 'N'	Power (P) 'Nmm'

2) PORTER GOVERNOR

Arrange the set-up as shown in Fig. 5 by using the proper linkages & weights provided. Tighten the bolts and nuts properly. The assembly is ready for conducting the experiment. Now follow experimental procedure as mentioned above.

Go on increasing the speed gradually and take the readings of speed of rotation `N` and corresponding sleeve displacement `X`.

Dimensions

a) Length of each link - L = 0.125 m.
b) Initial height of Governor – ho = 0.105 m.
c) Initial radius of rotation – ro = 0.120 m.
d) Weight of each ball - W = 0.6 kgs.
e) Weight of Sleeve weight = 0.5 kgs.

Radius of rotation `r` at any position could be found as follows

a) Find height h = ho – X/2 mtr. ho = 0.10 m
b) Find " α " by using $\alpha = \cos^{-1}(h/L)$ in Degrees
c) Then $r = 0.05 + L \sin \alpha$ mtr.
d) Angular Velocity 'ω ' = 2π N/60 rad/sec

Graph:

Speed Vs Sleeve Displacement

Centrifugal Force Vs Radius of Rotation

Questions

1. What are the functions of Governor?
   The function of a governor is to maintain the speed of an engine within specified limits whenever there is a variation of load. Governors control the throttle valve and hence the fuel supply to carter the load variation on engines.

2. How governors are classified?
   1. Centrifugal governors.(a) Pendulum type: Example: Watt governor(b) Gravity controlled type: Example: Porter and proell governors) Spring controlled type: Example: Harnell and Hartung governors

3. Differentiate between governor and flywheel?
   governor is provided on prime movers such as engines and turbines It is provided on engine and fabricating machines rolling mills, punching machines, shear machines, presses etc. flywheel works intermittently, i.e., only when there is change in load. It works continuously from cycle to cycle.

4. What is meant by sensitiveness of governors?
   The sensitiveness is defined as the ratio of the mean speed to the difference between the maximum and minimum speeds. A governor is said to be sensitive, when it really to a small change of speed.

5. What is gyroscopic torque?
   Whenever a rotating body changes its axis of rotation, a torque is applied on the rotating body.
6. What is the effect of friction on the governor
   The effect of friction on the governor is to increase the range of speed, governor effort and power of governor

7. What is stability of governor? Governor is stable if there is only one radius of rotation for all equilibrium speeds of balls within the working range

8. What is controlling force in a governor?
   Centripetal
   force acting on the flyballs is known as controlling force of a governors

9. What is meant by hunting of governor.
   The phenomenon of continuous fluctuation of engine speed above and below the mean speed is termed as hunting.

10. What is meant by isochrnous governors
    A governor with zero range of speed is known as isochronous governor. It is the stage of infinite sensitivity.

Ex. No: 1.a ***Date:***

CALIBRATION OF

(Vernier Caliper / Micrometer / Dial Gauge)

AIM

To study and calibrate the Vernier caliper, Micrometer, and Dial gauge.

APPARATUS REQUIRED

Surface plate

Vernier caliper

Micrometer

Dial gauge

Slip gauges

SPECIFICATION

Vernier caliper	Range: 0-300 'mm'	L. C:0.02 'mm'
Micrometer	Range: 0-25 'mm'	L. C:0.01 'mm'
Dial gauge	Range: 0-10 'mm'	L. C:0.01 'mm'

STUDY

1. Vernier Caliper

The Vernier caliper has one 'L' shaped frame with a fixed jaw on which Vernier scale is attached. The principle of Vernier is that when two scale divisions slightly different in sizes can be used to measure the length very accurately.

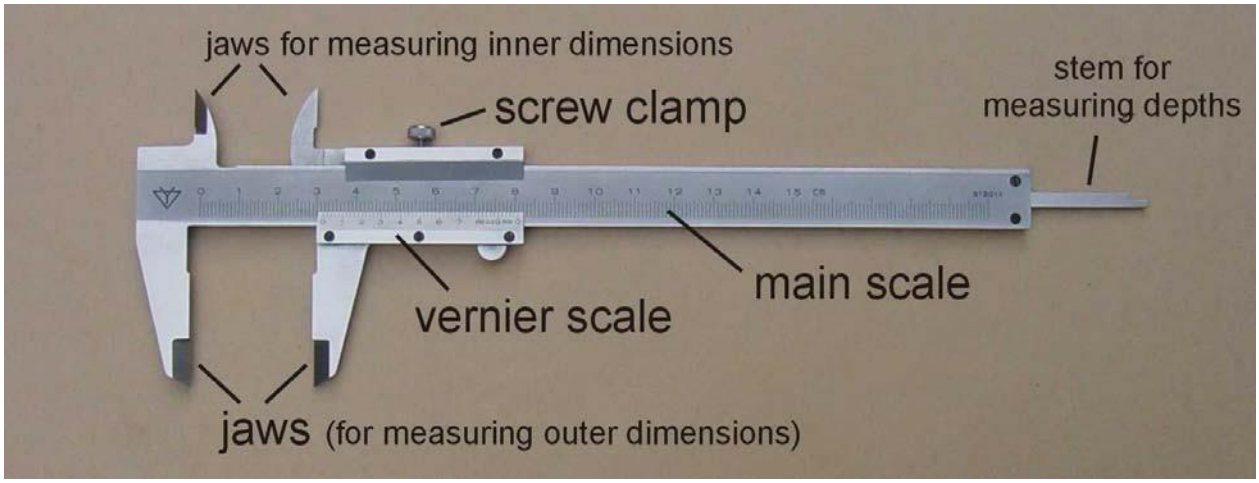


Fig: VERNIER CALIPER

Least Count is the smallest length that can be measured accurately and is equal to the difference between a main scale division and a Vernier scale division.

LEAST COUNT = 1 Main scale division – 1 Vernier scale division

Uses:

- It is used to measure the external diameter, the internal diameter and the length of the given specimen.

2. Micrometer

The micrometer has an accurate screw having about 10 to 20 threads/cm and revolves in a fixed nut. The end of the screw is one tip and the other is constructed by a stationary anvil.

LEAST COUNT = Pitch scale division / Number of threads

Pitch scale division = Distance moved / number of rotation

Uses:

- Outside micrometer is used to measure the diameter of solid cylinder.
- Inside micrometer is used to measure the internal diameters of hollow cylinders and spheres.

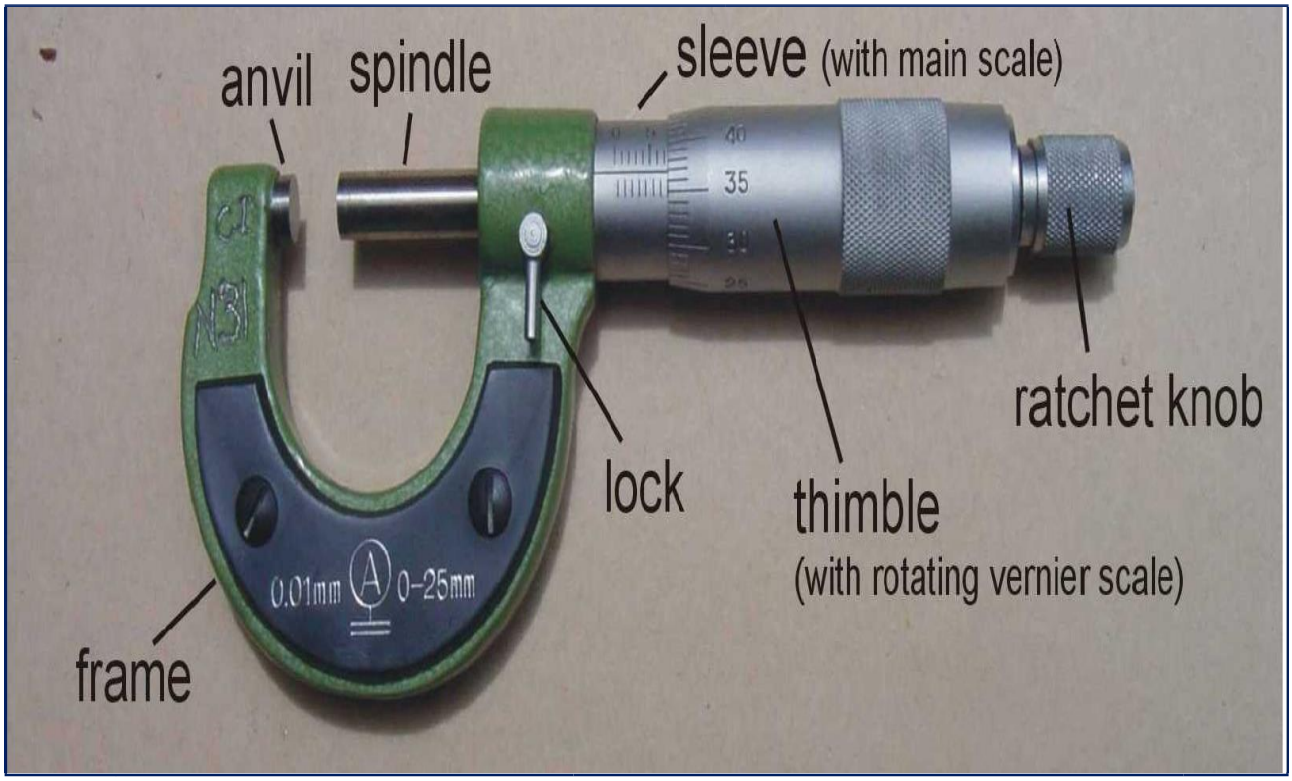


Fig: MICROMETER

3. **Dial gauge**

The dial gauge has got 2 hands. The short hand reads in mm. One complete revolution of long hand reads one mm. The plunger of the dial gauge has to be placed on the surface whose dimension has to be read.

Least Count = One division of the circular scale with long hand.

Uses:

It is used as a mechanical comparator.

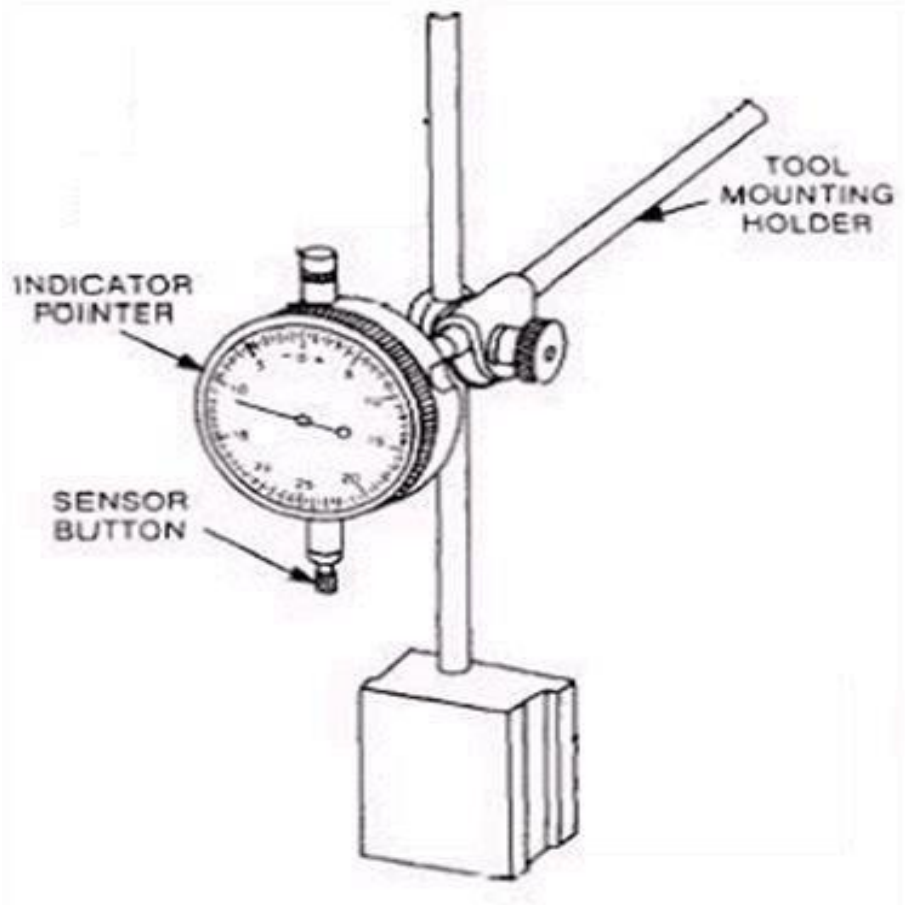


Fig: DIAL GAUGE

4. **Slip gauges**

They are rectangular blocks hardened and carefully stabilized. The surfaces are highly polished to enhance wringing. It is used as a reference standard for transferring the dimensions of unit of length from primary standard. It is generally made up of high carbon, high chromium hardened steel.

Uses:

- These are accurate and used as comparator.

5. **Surface plate**

The foundation of all geometric accuracy and indeed of all dimensional measurement in workshop is surface plate. It is a flat smooth surface sometimes with leveling screws at the bottom.

Uses:

- It is used as a base in all measurements

Procedure for Calibration:

1. The range of the instruments is noted down.
2. Within that range, slip gauges are selected.
3. The measuring instrument is placed on the surface plate and set for zero and the slip gauges are placed one by one between the measuring points (jaws of the instruments.)
4. The slip gauge (actual) readings and the corresponding (observed) readings in the measuring instruments are noted down and tabulated.

FORMULA USED:

1) MD = [MSR + (VSC X LC)]

MD-Measured Dimension
MSR-Main Scale Reading

VSC-Vernier Scale
Coincide LC-Least Count

2) ERROR= Slip gauge reading - Measured Dimension

TABULATION(Vernier Caliper Using Slip Gauge)

S.NO	Least Count of vernier = 0.02mm					
	Slip gauge reading 'mm'	Vernier Caliper Reading 'mm'				Error
		MSR	VSC	VSR = VSC X LC	MD = MSR + VSR	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

TABULATION(Micrometer using Slip gauge)

Least Count of micrometer = 0.01mm						
Sl. No	Slip gauge reading 'mm'	Main scale Reading (MSR) in 'mm'	Thimble scale division (TSD) 'mm'	Thimble scale reading(TSR) =TSD X Least count in 'mm'	Measure dimension (MD) in 'mm'	Error
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

TABULATION(Dial Gauge using Slip gauge)

Least Count of dial gauge= 0.01mm				
Sl.no	Slip gauge reading (mm)	Dial gauge reading (mm)		Error
		Initial valve in (mm)	Final valve in (mm)	
1				
2				
3				
4				
5				

CACULATION:

GRAPHS

Slip gauges reading Vs Measured Dimension
Slip gauge reading Vs Error

Result:

The precision measuring instruments are studied and calibrated.

Viva Questions

1. What is Relative error?

Relative error is defined as the results of the absolute error and the, value of comparison used for calculation of that absolute error. The comparison may be true value or conventional true value or arithmetic mean for series of measurement.

2. Classify the errors.

The errors can be classified into1. Static errors - Reading errors- Characteristic errors,- Environmental errors2. Loading errors3. Dynamic error.

3. What is the basic Principle of measurement?

It is the physical phenomenon utilized in the measurement. If energy kind of quantity measured, there must be a unit to measure it. So this will give the quantity to be measured in number of that unit.

4. What are the applications of Legal metrology?

1. Industrial Measurements.2. Commercial transactions.3. Public health and human safety ensuring.

5. What is the need of inspection?

To determine the fitness of new made materials, products or component part and to compare the materials, products to the established standard.

6. What are the important elements of measurements?

The important elements of a measurement is

1. Measurand.
2. Reference.
3. Comparator.

7. What is LEGAL METROLOGY?

Legal metrology is part of Metrology and it is directed by a National Organization which iscalled "Notional service of Legal Metrology". The main objective is to, maintain uniformity ofmeasurement in a particular country.

8. What are the considerations while manufacturing the slip gauges?

The following additional operations are carried out to obtain the necessary qualities in slipgauges during manufacture.1. First the approximate size of slip gauges is done by preliminary operations.2. The blocks are hardened and wear resistant by a special heat treatment process.3. To stabilize the whole life of blocks, seasoning process is done.4. The approximate required dimension is done by a final grinding process.

9. How do you calibrate the slip gauges?

Comparators are used to calibrate the slip gauges.

10. List the various linear measurements?

i) Length.(ii) Heights and(iii) Thickness.

Ex. No: 2a ***Date:***

VERNIER HEIGHT GAUGE

AIM

To determine the height of the given specimen by using Vernier Height gauge.

APPARATUS REQUIRED

Vernier Height gauge,
Work piece,
Surface plate.

PROCEDURE

1. Clean the main scale, Vernier scale and measuring jaws of the Vernier Height gauge
2. The vernier height gauge is checked for zero error
3. Place the job in Surface plate.
4. Place the measuring jaw such that it touches the surface to be measured from the Smooth surface
5. Measure the main scale reading and Vernier scale coincidence of the Vernier Height gauge

FORMULA

MD = [MSR + (VSC X LC)]

- MD-Measured Dimension
- MSR-Main Scale Reading
- VSC-Vernier Scale Coincide
- LC-Least Count

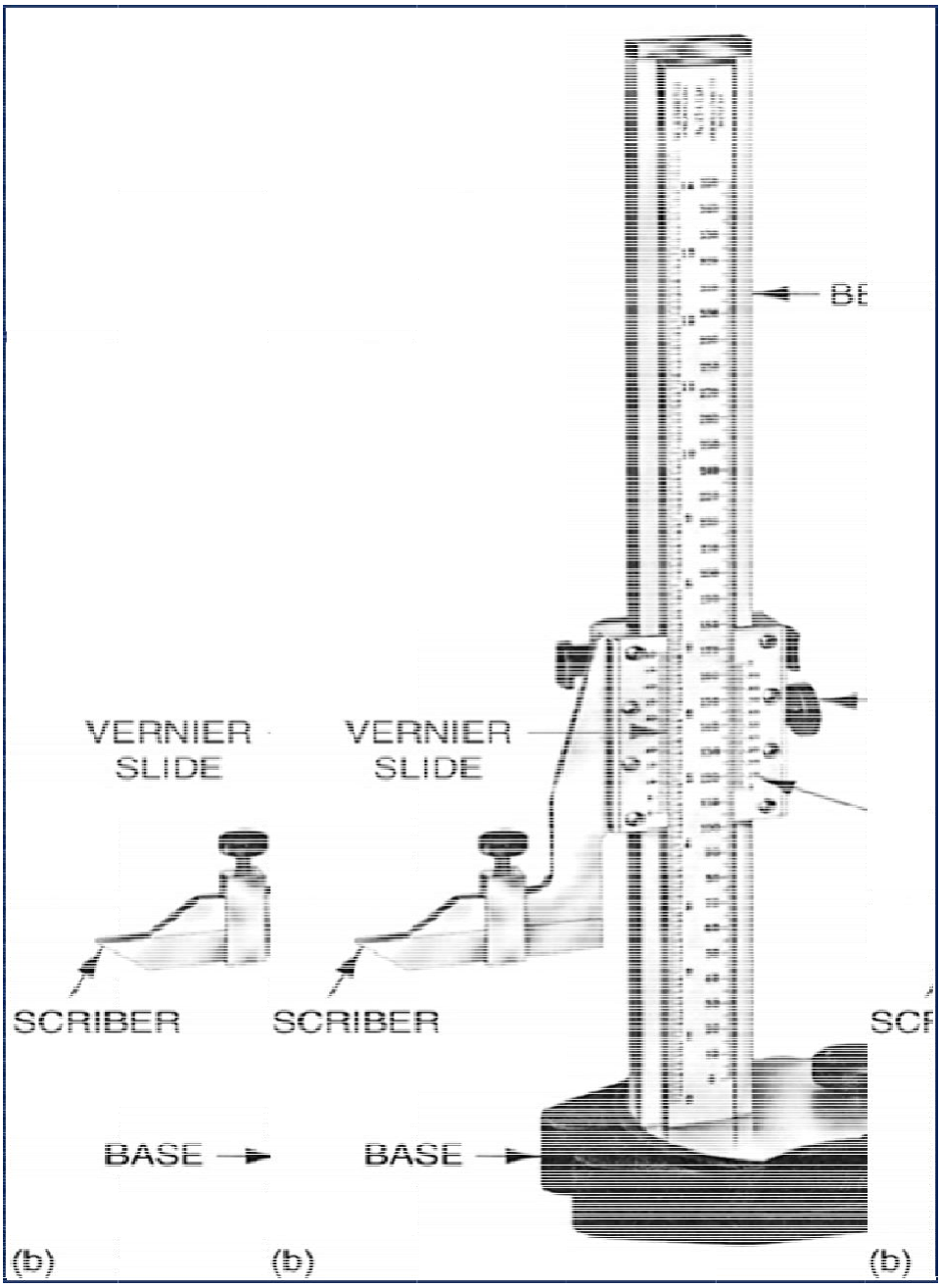


Fig: VERNIER HEIGHT GAUGE

TABULATION (Vernier Height Gauge)

Least count = 0.02mm					
S.NO	Specimen Details	Main scale reading (MSR) (mm)	Vernier Scale coincidence (VSC) (mm)	Vernier scale reading (VSR) = VSC X LC (mm)	Measured Dimension= (MD) in (mm)
1					
2					
3					
4					
5					

CALCULATION

Graph

Main scale reading Vs Measured Dimension

RESULT

Thus the height of the given Specimen is determined using vernier height gauge

Ex. No:2b ***Date:***

VERNIER DEPTH GAUGE

AIM

To determine the Depth of the given specimen to accuracy using Vernier Depth gauge

APPARATUS REQUIRED

Vernier depth gauge

Surface plate

Work piece

PROCEDURE

1. The depth gauge is checked for Zero error
2. It is placed on the surface Plate
3. Thus the given specimen is placed on the surface plate
4. The work piece is placed inside the measuring jaw of the instrument
5. The main scale reading and vernier scale reading are noted
6. The readings are tabulated.

FORMULA USED

MD = [MSR + (VSC X LC)]

MD-Measured Dimension
MSR-Main Scale Reading

VSC-Vernier Scale
Coincide LC-Least Count

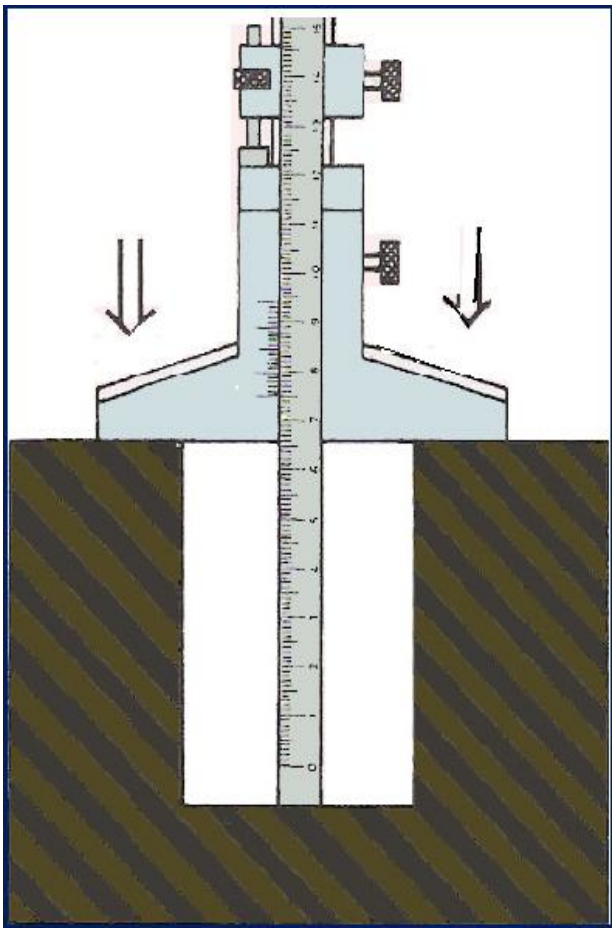


Fig: Vernier Depth Gauge

TABULATION (Vernier Depth Gauge)

S. No	Specimen Details	Main scale reading(MSR) (mm)	Vernier Scale coincidence (VSC) (mm)	Vernier scale reading(VSR) VSC X LC (mm)	Measured Dimension = MSR + VSR (mm)
1					
2					
3					
4					
5					

CALCULATION

Graph

Main scale reading Vs Measured Dimension

RESULT

Thus the Depth of the given Specimen is determined using vernier depth gauge.

Viva Questions

1. What is Range of measurement?:

The physical variables that are measured between two values. One is the higher calibration value H , and the other is Lower value L, The difference between H, and L, is called range.

2. What is Resolution:

The minimum value of the input signal is required to cause an appreciable change in the output known as resolution.

3. Differentiate between sensitivity and range with suitable example.

Example: A Instrument have a scale reading of 0.01mm to 100mm. Here, the sensitivity of the instrument is 0.0lmm i.e. the minimum value in the scale by which the instrument can read. The range is 0.01 to 100mm i.e. the minimum to maximum value by which the instrument can read.

4. Deflne system error and correction.

Error: The deviation between the results of measured value to the actual value. Correction: The numerical value which should be added to the measured value to get the correct result.

5. Define: Measurand.

Measurand is the physical quantity or property like length, diameter, and angle to be measured.

6. Define: Deterministic Metrology.

The metrology in which part measurement is replaced by process measurement. The new techniques such as 3D error compensation by CNC systems are applied.

7.Define over damped and under damped system

Over damped - The final indication of measurement ii approached exponentially from one side.

Under damped - The pointer approach the position corresponding to final reading and makes a number of oscillations around it.

8.Give any four methods of measurement

- Direct method.
- Indirect method.
- Comparison method.
- Coincidence method.

9. Give classification of measuring instruments.

- Angle measuring Instruments.
- Length measuring Instruments.
- Instruments for surface finish.
- Instruments for deviations.

10 .Define True size:

True size is Theoretical size of a dimension

Ex. No: 3 ***Date:***

MEASUREMENT OF GEAR PARAMETERS USING GEAR TOOTH VERNIER

AIM

To measure gear parameter by gear tooth Vernier.

APPARATUS REQUIRED

Gear tooth Vernier, Gear specimen,(SPUR GEAR),Vernier Caliper.

SPECIFICATION

Gear tooth Vernier Range =	Horizontal	= 0-40 mm
	Vertical	= 0-20 mm
	L.C	= 0.02 mm

FORMULA

1.	W	=	NM sin (90/N)
2.	d	=	$\frac{NM}{2}\left(1+\frac{2}{N}-\cos\left(\frac{90}{N}\right)\right)$
3.	m	=	$\frac{D}{(N+2)}$
4.	% ERROR	=	(Ws – W) / (Ws)

Where ,

W = Chordal width of tooth in mm

D = Chordal addendum of gear in mm

M= Module of gear in mm

N= No. of teeth

D = outside Dia in gear in mm

W = chordal thickness mm

PROCEDURE

1. The N, D of the given gear block are measured.
2. The module m' it then calculated.
3. Theoretical values of 'W' and'd' are computed.
4. Theoretical values of 'W' is set in horizontal Vernier scale of gear tooth Vernier and corresponding actual' value scale.
5. Theoretical values of 'c' is set and 'W' is measured along
6. Horizontal scale.
7. This procedure is repeated for 5 teeth and value tabulated.

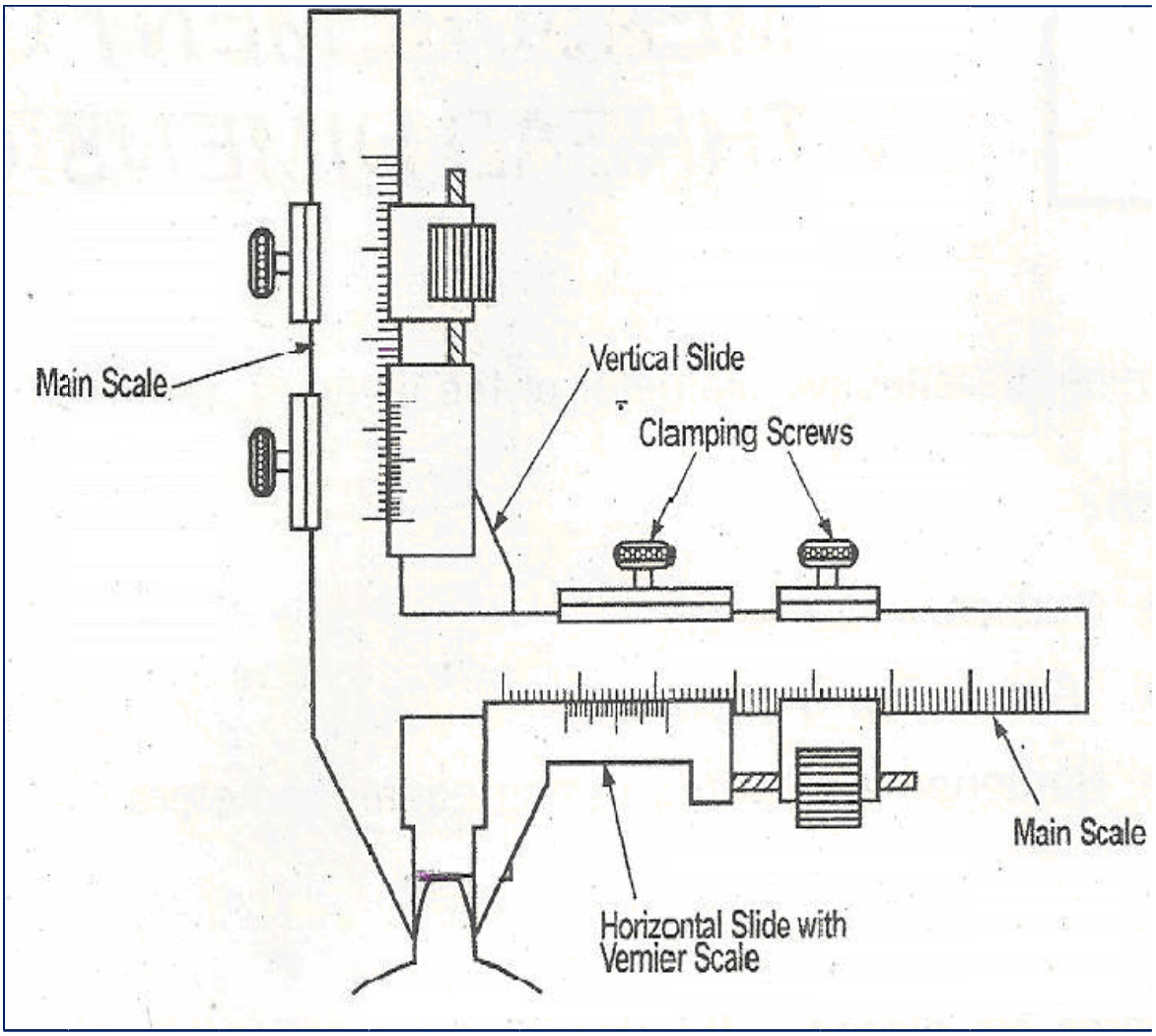


Fig: GEAR TOOTH VERNIER

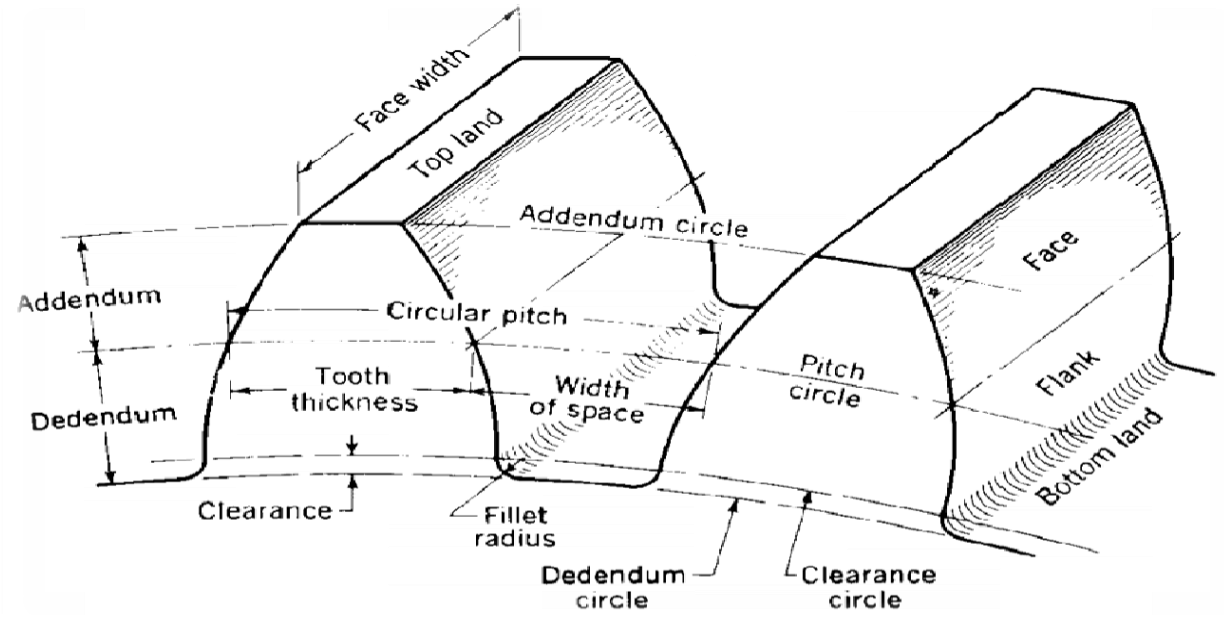


Fig: NOMENCLATURE OF GEAR

OUTSIDE DIAMETER OF G EAR

TRIAL	OUT SIDE DIAMETER 'D' mm	
	GEAR 1	GE AR 2
1		
2		
3		
4		
5		
AVERAGE		

TABULATION

SL. NO	SPECIMEN	NO. OF TEETH (N)	OUTER DIAMETER (OD) "mm"	CHORDAL Depth d "mm"	CHORDAL THICKNESS (W) "mm"				STANDARD CHORDAL THICKNESS Ws "mm"	ERROR(%) Ws – W = ---------- Ws
					T1	T2	T3	AVG		
1	GEAR 1									
2	GEAR 2									

CALCULATION

RESULT

Thus the chordal thickness and addendum of gear is measured using gear tooth Vernier.

Viva Questions

1. Define: Module.

Module= pitch circle diameter/ number of teeth.

2 **Define: Lead angle.**

It is the angle between the tangent to the helix and plane perpendicular to the axis of cylinder.

3. What are the various methods used for measuring the gear tooth thickness?

(i) Gear tooth Vernier.(ii) Constant chord method.(iii) Base tangent method.(iv) Measurement over pins.

4. Name four gear errors.

(i) Pitch error.(ii) Alignment error.(iii) Composite error.(iv) Thickness error.

5. Name the method used for checking the pitch of the gear.

(i) Step by step method.(ii) Direct angular measurement.

6. What are the direct angular measurements methods?

1. Profile checking:a) Optical projection method.b) Involutes measuring method.2. Thickness measurement:a) Chordal thickness method.b) Constance chord method.

6. Define: constant chord.

Constant chord is the chord joining those points, or opposite Aces of the tooth.

7. Give the formula for measuring radius of circle.

R = (I - d)28d

Where, R=Radius of the job I = Distance between the balls d = Diameter of pins.

8. What are the two methods used in measuring radius of concave surface?

a) Edges are well defined .b) Edges are rounded up.

9. What is interferometer?

Interferometer is optical instruments used for measuring flatness and determining the length of slip gauges by direct reference to the wavelength of light.

10. Name the different types of interferometer?

1) NPL flatness interferometer.2) Michelson interferometer.3) Laser interferometer.4) Zesis gauge block interferometer.

Ex. No: 4a ***Date:***

ANGULAR MEASUREMENT USING SINE BAR

AIM

To measure the taper angle of the given specimen using sine bar method.

APPARATUS REQUIRED:

Sine bar

Work Piece

Surface plate

Dial gauge with stand

FORMULA:

$Sin\ \vartheta =$ –

Where,

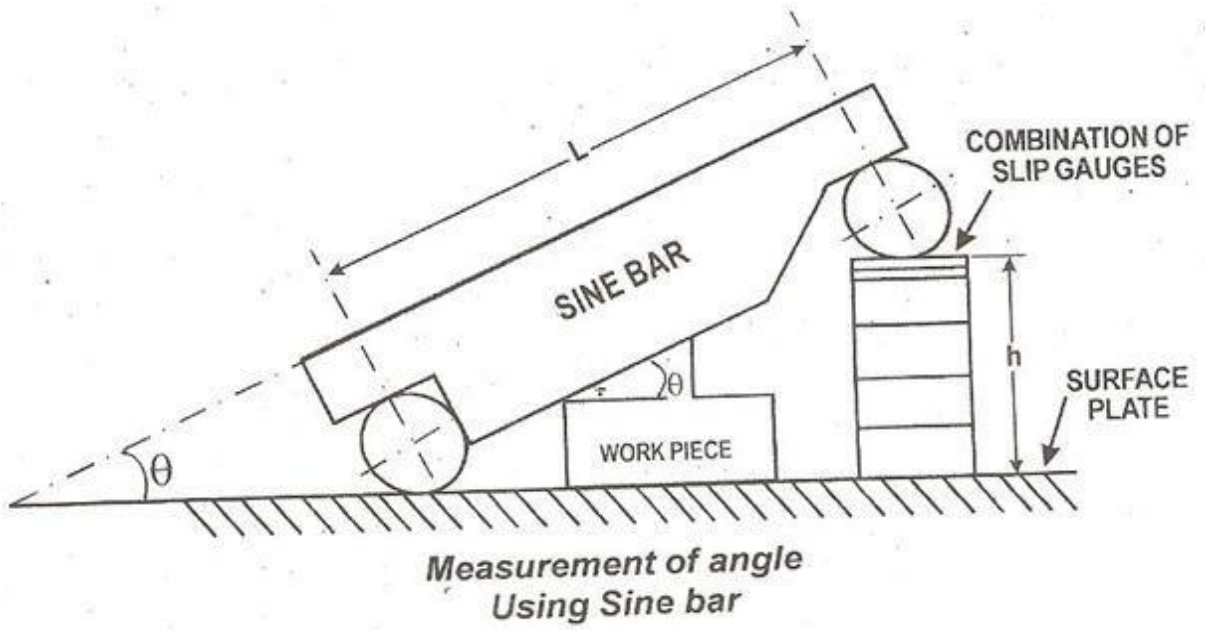
H - Height of the slip gauge

L - Distance between the centers

ϑ - Inclined angle of the specimen

PROCEDURE

1. The given component is placed on the surface plate.
2. One roller of sine bar is placed on surface plate and bottom surface of sine bar is seated on the taper surface of the component.
3. The combination of slip gauges is inserted between the second roller of sine bar and the surface plate.
4. The angle of the component is then calculated by the formula given above.



Measurement of angle Using Sine bar

TABULATION(Sine Bar)

S. No	Length of the sine bar (L) "mm"	Height of the combination of slip gauge (H) "mm"	Taper Angle (ϑ) in 'degree'
1			
2			

CALCULATION

RESULT

Thus the angle in the work pieces were Determined using Sine bar

Angle measured in work piece ,1 = ---------- 'degree'

Angle measured in work piece ,2 = ---------- 'degree'

Viva Questions

1. List out any four angular measuring instrument used in metrology

(i) Angle gauges (ii) Divided scales (iii) Sine bar with slip gauges (iv) Autocollimator (v) Angle dekkor

2. List out any four angular measuring instrument used in metrology

(i) Angle gauges (ii) Divided scales (iii) Sine bar with slip gauges (iv) Autocollimator (v) Angle dekkor

3. Differentiate between sensitivity and range with suitable example.

Example: An Instrument has a scale reading of 0.01mm to 100mm. Here, the sensitivity ofthe instrument is 0.0lmm i.e. the minimum value in the scale by which the instrument can read. The range is 0.01 to 100mm i.e. the minimum to maximum value by which the instrument can read.

4. Define system error and correction.

Error: The deviation between the results of measured value to the actual value. Correction: The numerical value which should be added to the measured value to get the correct result.

5. Define: Measurand.

Measurand is the physical quantity or property like length, diameter, and angle to be measured.

6. Define: Deterministic Metrology.

The metrology in which part measurement is replaced by process measurement. The new techniques such as 3D error compensation by CNC systems are applied.

7. Define over damped and under damped system.

Over damped - The final indication of measurement ii approached exponentially from one side. Under damped The pointer approach the position corresponding to final reading and makesa number of oscillations around it.

8. Give any four methods of measurement

1. Direct method.2. Indirect method.3. Comparison method.4. Coincidence method.

9. Give classification of measuring instruments.

1. Angle measuring Instruments.2. Length measuring Instruments.3. Instruments for surface finish.4. Instruments for deviations.

10. Define True size.

True size is Theoretical size of a dimension.

Ex. No: 4b ***Date:***

MEASUREMENT OF THREAD PARAMETERS USING PROFILE PROJECTOR

AIM

To measure the thread parameter of given screw thread using Profile projector

APPARATUS REQUIRED

Profile projector

Specimen

PARAMETER TO BE MEASURED

Major and Minor diameter

Depth and Pitch of thread

Addendum and dedendum.

THEORY

Minor diameter

It is the diameter of an Imaginary co-axial cylinder which would touch the root of external or internal thread.

Major Diameter

It is the diameter of an imaginary co-axial cylinder which would touch the crest of external or internal thread.

Depth

The distance between the crest and root of the thread is called Depth of Thread

Pitch of Thread

The distance measured parallel to the axis from a point on a thread to the Corresponding next point

Addendum

For external thread it is the radial distance between major and pitch cylinders.

Dedendum

For external thread it is the radial distance between the Pitch and Minor cylinders

For internal thread it is the radial distance between major and Pitch cylinders

Helix angle

The helix angle is made by the thread at the pitch line with axis

PROCEDURE

1. Clean the instrument and its accessories by fine cotton cloth
2. Clamp the specimen in between the jaws present in the profile Projector
3. Switch on the power and adjust the degree of magnification in profile projector
4. The magnification depends upon the distance between the Local plane of the lens and the screen
5. Bring the specimen image to the screens axis by adjusting the micrometer and rotation of screen
6. Now the parameters of threads are measured and tabulate the read.

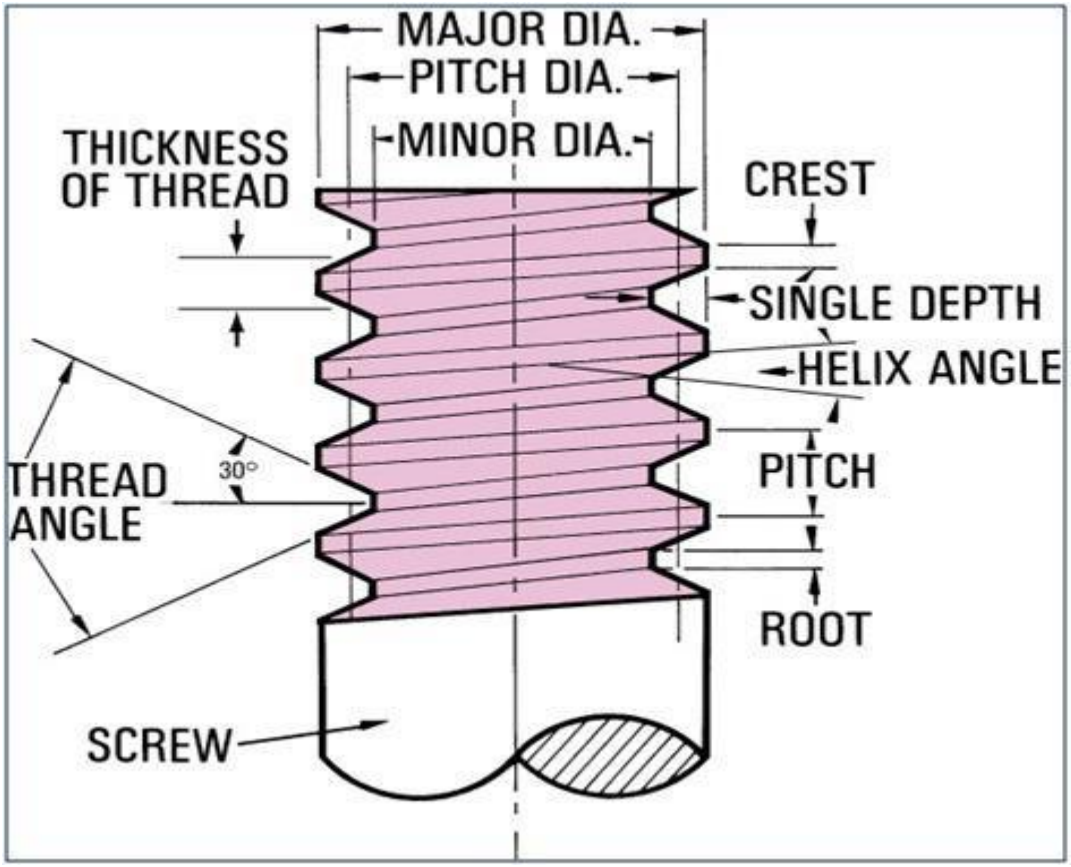


Fig: Nomenclature Of Thread

TABULATION (Taper Angle)

S.No	Initial angle degree	Final angle degree	difference degree	Average degree
1				
2				

TABULATION (Thread Parameters)

Sl.no	Dimension to be measured	Initial point (B) mm	Final point (C) mm	Difference (D) mm
1	PITCH			
2	DEPTH			
3	MAJOR DIAMETER			
4	MINOR DIAMTER			

RESULT

Thus the thread parameters of given screw thread was found using profile projector

Major diameter of the screw =---------- 'mm'

Minor diameter of the screw =---------- 'mm'

Pitch of screw =---------- 'mm'

Depth of screw =---------- 'mm'

Angle of thread =----------'degree'

Viva Questions

1. What is wavelength?

The distance between two crust or two rough is called the wavelength

2. What the different are types of geometrical tests conducted on machine tools?

1. Straightness, 2. Flatness, 3. Parallelism , equi-distance and coincidence.

3. What is Response Time?

The time at which the instrument begins its response for a change measured quantity.

4. Define Repeatability.

The ability of the measuring instrument to repeat the same results g the act measurementsfor the same quantity is known as repeatability.

5. Explain the term magnification.

It means the magnitude of output signal of measuring instrument time's increases to make it more readable.

6. Classify the Absolute error.

The absolute error is classified into1. True absolute error.2. Apparent absolute error.

7. What is Response Time?

The time at which the instrument begins its response for a change measured quantity.

8.What are the two methods used in measuring radius of concave surface?

a) Edges are well defined .b) Edges are rounded up.

9. Name the various types of pitch errors found in screw?

(i) Progressive error.(ii) Drunken error.(iii) Periodic error.(iv) Irregular errors.

10. Define: constant chord.

Constant chord is the chord joining those points, or opposite Aces of the tooth.

Ex. No:5a ***Date:***

SETTING UP OF COMPARATORS FOR INSPECTION (MECHANICAL COMPARATOR)

AIM:

To check the height of the machined component with standard dimensioned component using Mechanical comparator.

TOOLS REQUIRED:

Slip gauge set

Mechanical comparator

Surface plate

Work Piece

PROCEDURE:

1. The slip gauges are built up to the given weight of the component.
2. Dial gauge with stand is placed on the surface plate.
3. The built up gauge is placed under the plunger.
4. The indicator is set to zero.
5. The built up gauge is removed.
6. The given machined component is placed under the plunger.
7. The variation in the height of the component is noted from the reading of the dial.

Dial gauge :

Dial gauges divided in two categories, type1 &type2for general engineering purpose depending upon the movement of the plunger. These are manufactured in two grades, grade a and grade b, with total plunger movement or lift of 3,5 and 10mm. Type1 dial gauge has the plunger movement parallel tip the plane of dial and type 2 has the plunger movement perpendicular to the plane of dial.

TABULATION:(Least count of Mechanical comparator= 0.01 mm)

Sl.no	Specimen	Actual size slip gauge (mm)	Mechanical comparator reading (mm)		Actual size Work piece (mm)	Error	Result
			SCR	LCR			
1	I						
2	II						
3	III						
4	IV						

RESULT:

Thus the height of the machined component with standard dimensioned component using Mechanical comparator.

Viva Questions

1. List out any four angular measuring instrument used in metrology.

(i) Angle gauges.(ii) Divided scales.(iii) Sine bar with slip gauges.(iv) Autocollimator.(v) Angle dekkor.

2. Classify the comparator according to the principles used for obtaining magnification.

The common types are

(i) Mechanical comparators.
(ii)Electrical comparators.
(iii) Optical comparators.
(iv) Pneumatic comparators.

3. What are comparators?

Comparators are one form of linear measurement device which is quick and more convenient for checking large number of identical dimensions.

4. How the mechanical comparator works?

The methods of magnifying small movement of the indicator in all mechanical comparators are effected by means of levers, gear trains or a combination of these elements.

5. State the best example of a mechanical comparator.

A dial indicator or dial gauge is used as a mechanical comparator.

6. Define least count and mention the least count of a mechanical comparator.

Least count. - The least value that can be measured by using any measuring instrument known as least count. Least count of a mechanical comparator is 0.0 1 mm.

7. How the mechanical comparator is used?

State with any one example. Let us assume that the required height of the component I s 32.5mm. Initially, this height is built up with slip gauges. The slip gauge blocks are placed under the stem of the dial gauge. The pointer in the dial gauge is adjusted to zero. The slip gauges are removed- Now, the component to be checked is introduced under the stem of the dial gauge. If there is any deviation in the height of the component, it will be indicated by the pointer.

8. State any four advantages of reed type mechanical comparator.

(i) It is usually robust, compact and easy to handle.(ii) There is no external supply such as electricity, air required.(iii) It has very simple mechanism and is cheaper when compared to other types.(iv) It is suitable for ordinary workshop and also easily portable.

9. Mention any two disadvantages of reed type mechanical comparator.

(i) Accuracy of the comparator mainly depends on the accuracy of the rack and pinion arrangement. Any slackness will reduce accuracy.(ii) It has more moving parts and hence friction is more and accuracy is less.

10. What are the major types of on electrical comparator?

An electrical comparator consists of the following three major parts such as (i) Transducer.(ii) Display device as meter.(iii) Amplifier.

Ex.No: 5b ***Date:***

BORE DIAMETER MEASUREMENT USING TELESCOPIC GAUGE

AIM

To measure the bore diameter using given telescopic gauge.

APPARATUS REQUIRED

Telescopic gauge
Work piece
Vernier caliper

PROCEDURE

2. Clean the given work piece to be measure
3. Select the telescopic gauge and insert into the cylinder bore.
4. Selected the telescopic gauge from the telescopic gauge set.
5. Unlock the telescopic gauge and inserted into the cylinder bore.
6. Measure the distance of telescopic gauge by using vernier caliper.
7. Tabulate the given readings.

TABULATIONBore Diameter Measurement Using Telescopic Gauge

S.No	Telescopic Gauge range (mm)	Vernier Scale Reading			Bore Diameter (mm)
		MSR	VSC	VSR	

RESULT

Thus the given bore diameter is to be measure by using of telescopic gauge.

Viva Questions

1. Define Actual Size.

Actual size = Size obtained through measurement with permissible error.

2. What is Hysteresis?

All the energy put into the stressed component when loaded is not recovered upon unloading. So, the output of measurement partially depends on input called hysteresis.

3. Differentiate accuracy and Uncertainty with example.

Accuracy - Closeness to the true value. Example: Measuring accuracy is ± 0.02mm for diameter 25mm.Here the measurement true values lie between 24.98 to25.02 mm Uncertainty about the true value = ± 0.02mm

4. Define Span.

The algebraic difference between higher calibration values to lower calibration value. Example: In a measurement of temperature higher value is 200*C and lower value is 1500 C means span = 200 - 150

5. Differentiate between precision and accuracy.

Accuracy - The maximum amount by which the result differ from true value. Precision - Degree of repetitiveness. If an instrument is not precise it will give different results for the same dimension for the repeated readings.

6. What is Scale interval?

It is the difference between two successive scale marks in units.

7. What is Response Time?

The time at which the instrument begins its response for a change measured quantity.

8. Define Repeatability.

The ability of the measuring instrument to repeat the same results g the act measurements for the same quantity is known as repeatability.

9. Explain the term magnification.

It means the magnitude of output signal of measuring instrument time's increases to make it more readable.

10. Classify the Absolute error.

The absolute error is classified into1. True absolute error.2. Apparent absolute error.

Ex.No: 6a ***Date:***

BORE GAUGE

AIM

To measure the cylinder bore using bore gauge.

APPARATUS REQUIRED

1. Cylinder block
2. Bore gauge
3. Vernier caliper

PROCEDURE

1. Measure the bore using vernier caliper to get the gross reading of the bore.
2. Select and install the suitable anvil and washers
3. Make a zero adjustment of the bore gauge using inside measuring jaw of the vernier caliper.
4. After the zero adjustment is done insert the bore gauge into the bore and observe the measurement and record the data.

TABULATION (Bore Gauge)

S. No	Bore Gauge		Dial Gauge			Cylinder Size
	Anvil	Washer's	SCR	VSR	TR= SCR+VSR	

RESULT

Thus the bore measurement by using of bore gauge.

Viva Questions

1. Write the advantages of machine vision system.

(i) Reduction of tooling and fixture cash.(ii) Elimination of need for precise part location.(iii) Integrated automation of dimensional verification(iv) Defect detection.

2. Define machine vision.

Machine vision can be defined as a means of simulating the image recognition and analysiscapabilities of the human system with electronic and electromechanical techniques.

3. Define grayscale analysis.

In these techniques, discrete areas or windows are formed around only the portions of theimage to be inspected. For determining if brackets are present, high intensity lighting ispositioned. This type of discrete area analysis is a powerful tool and can be used forinspection of absence, correct part assembly, orientation, part, integrity, etc.

4 Mention the advantages of CMM.

(i) The inspection rate is increased.(ii) Accuracy is reduced.(iii) Operator's error can be minimized. Skill of the operator is reduced.(iv) Reduction in calculating, recording and set up time.(v) No need of GO/NOGO gauges. (vi) Reduction of scrap and good part rejection.

5. Mention the disadvantages of CMM.

(i) The table and probe may not be in perfect alignment.(ii) The stylus may have run out.(iii) The stylus moving in z- axis may have some perpendicularity errors.(iv) Stylus while moving in x and y direction may not be square t o each other.(v) There may be errors in digital system .

6. Mention the application of CMM.

(i) CMM's to find application in automobile, machine to,electronics, space andmany other large companies.
(ii) These are best suited for the test and inspection Of test equipment, gauges andtools.
(iii) For aircraft and space vehicles of hundred Percent inspections is carried out byusing CMM.
(iv) CMM can be used for determining dimensional accuracy of the component.
(v) CMM can also be used for sorting tasks to achieve optimum pacing ofcomponents within tolerance limits.

7. Describe the features of a flexible inspection system.

(i) A powerful computer serves as a real time processor to handle part dimensionaldata and as a multi 'programming system to perform such tasks as manufacturingprocess control.(ii) The terminal provides interactive communication with personnel Computer wherethe programmes are stored.(iii) Input devices microprocessor based gauges and other inspection devices areused in CMM.

8. What are load cells?

Load cells are devices for the measurement of force through indirect methods

9.State any four advantages of reed type mechanical comparator.

- It is usually robust, compact and easy to handle.
- There is no external supply such as electricity, airrequired.

10. Classify pneumatic comparators.

(i) Flow or Velocity type. (ii) Back pressure type

Ex.No: 6 b ***Date:***

SURFACE FINISH MEASURING EQUIPMENT

AIM

To measure the surface roughness of the given specimen using roughness testing device.

APPARATUS REQUIRED

Surface roughness tester Work piece

TECHNICAL PARAMETERS

Measurement parameters (R_a , R_z)

Traversed length l = 6 mm

Cut off length = 0.25 + 0.80 mm

Measuring range = 2.5 mm

R_a = 0.05 – 6.5 N/m

R_z = 0.1 -50 N/m

PROCEDURE

1. Clean the given work piece to be measure.
2. Switch on the device and the device is leading to work with screen displaying the measuring parameters and cut off length of the previous test.
3. Before starting the pickup choose the desired parameter R_a (or) R_z and proper cutoff length 2.5, 0.8, 0.25
4. After switch on the devices lighting press the select button and choose R_a (or) R_z lighting press select button and choose l_1, l_2, l_3 (0.25, 0.8, 2.5)
5. After the parameter and cut-off length are taken measurement may start.
6. The measurement end's and the screen display the measured value.

TABULATION (Surface Finish Measuring Equipment**)**

S.No	Parameter	Cut off length	Roughness Value (N/m)

RESULT

Thus the surface roughness of the given specimen is using roughness tester device.

Viva Questions

1. What are the factors affecting surface roughness?

a) Vibrations. b) Material of the work piece. c) Tool d) Machining type.

2. What are the methods used for evaluating the surface finish?

a) Peak to valley height method. b)The average roughness method. c) Form factor method.

3. Define fullness and emptiness in form factor.

Degree of fullness (K)= area of metal /Area of enveloping rectangle Degree of emptiness = 1K.

4. What are the methods used for measuring surface roughness?

a) Inspection by comparison b) Direct instrument measurements.

5. What are the stylus probe instruments?

a) Profile meter .b) Taylor Hobson Talysurf. c) Tomlinson surface meter.

6. Define: Straightness of a line in two planes.

A line is said to be straight over a given length, of the variation of the distance of its points from two planes perpendicular to each other and parallel to the direction of a line remaining with in the specified tolerance limits.

7. Define: Roundness.

Name the four measurement of roundness. It is a surface of revolution where all the surfaces intersected 'by any plane perpendicular to a common axis in case of, cylinder and cone. a. Heart square circle. b. Minimum radial separation circle. c. Maximum inscribed circle. d. Minimum circumscribed circle.

8. Name the devices used for measurement of roundness.

1. Diametral.2. Circumferential confining gauge.3. Rotating on center.4. V-Block.5. Three point probe.6. Accurate spindle.

9. What is run out?

Run out. -Total range of reading of a fixed indicate Or with the contact points applied to a Surface rotated, without axial movement, about 3 fixed axis.

10. Explain briefly the three important fields of machine vision system?

Inspection: it is the ability of an automated vision system to recognize well-defined pattern and if these pattern match these stored in the system makes machine vision ideal for inspection of raw materials, parts, assemblies etc.