ATME College of Engineering

13th KM mile stone, Mysuru-Kanakapura Road, Mysuru-28

Department of Mechanical Engineering

DESIGN LAB

(BME606L)

MANUAL

For

VI SEMESTER

2024-2025

Name of the Student: ______________________________

University Seat No.: ______________________________

*Semester:*________________ *Batch No.* : _____________

DEPARTMENT OF MECHANICAL ENGINEERING
ATME COLLEGE ENGINEERING
13^{th} K.M Mile stone, Mysuru-Kanakapura Road, Mysuru

LABORATORY CERTIFICATE

This is to certify that Mr. /Miss..

Bearing USN:.......................................has satisfactorily completed the course of experiments in practical **Design Lab (BME606L)** prescribed by the Visvesvaraya Technological University for the VI semester B.E. course during the year 2024-25.

Signature of staff **Signature of H.O.D**

ATME COLLEGE OF ENGINEERING

VISION

Development of academically excellent, culturally vibrant, socially responsible and globally competent human resources.

MISSION

- To keep pace with advancements in knowledge and make the students competitive and capable at the global level.
- To create an environment for the students to acquire the right physical, intellectual, emotional and moral foundations and shine as torch bearers of tomorrow's society.
- To strive to attain ever-higher benchmarks of educational excellence.

DEPARTMENT OFMECHANICAL ENGINEERING

VISION

To impart excellent technical education in mechanical engineering to develop technically competent, morally upright and socially responsible mechanical engineering professionals.

MISSION:

- To provide an ambience to impart excellent technical education in mechanical engineering.

- To enable the students to acquire skill development, knowledge of Research and recent trends in Mechanical Engineering which will help them in lifelong learning.

- To engage students in co-curricular and extra-curricular activities to impart social & ethical values and imbibe leadership qualities.

PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

After successful completion of the program, the graduates will be

PEO 1: Graduates will be able to have successful professional career in the allied areas and be proficient to perceive higher education.

PEO 2: Attain the ability to understand the need, technical ability to analyze, design and manufacture the product.

PEO 3: Work effectively, ethically and socially responsible in allied fields of mechanical engineering.

PEO 4: Work in a team to meet personal and organizational objectives and to contribute to the development of the society in large.

PROGRAM OUTCOMES (PO'S)

The Mechanical engineering program students will attain:

PO1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2.Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO3.Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

PO4.Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO6.The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO7.Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

PO11.Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO12.Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAM SPECIFIC OUTCOMES (PSO'S)

After successful completion of the program, the graduates will be

PSO 1: Apply and interpret the acquired mechanical engineering knowledge for advancement in Industrial, Societal, and Environmental arenas.

PSO 2: Meet the needs of Industries in the field of design, manufacturing and testing using mechanical engineering software.

DESIGN LAB

SEMESTER – VI

Subject Code	BME606L	IA Marks	50
Labs / Tutorial Hours/Week	03	Exam Marks	50
Total Number of Lecture Hours		Exam Hours	03

Prerequisites: Knowledge of Dynamics and Machines and Design of Machine Elements.

COURSE OBJECTIVES:

Students are expected-

1. To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
2. To understand the techniques of balancing of rotating masses.
3. To verify the concept of the critical speed of a rotating shaft.
4. To illustrate the concept of stress concentration using Photo elasticity.
5. To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
6. To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.

PART – A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Balancing of rotating masses.
3. Determination of critical speed of a rotating shaft

PART – B

4. Determination of equilibrium speed, sensitivity, power and effort of Porter/Proell /Hartnel Governor.
5. Determination of Fringe constant of Photo-elastic material using.
   a) Circular disc subjected to diametral compression.
   b) Pure bending specimen (four-point bending).
6. Determination of Pressure distribution in Journal bearing

COURSE OUTCOMES

At the end of the course, the students will be able to:

CO1: Compute the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.

CO2: Carry out balancing of rotating masses.

CO3: Analyse the governor characteristics.

CO4: Determine stresses in disk, beams, plates and hook using photo elastic bench.

CO5: Determination of Pressure distribution in Journal bearing

CO6: Analyse the stress and strains using strain gauges in compression and bending test and stress distribution in curved beams.

Ref Books:

[1] **"Shigley's Mechanical Engineering Design"**, Richards G. Budynas and J. Keith Nisbett, McGraw-Hill Education, 10th Edition, 2015.

[2] **"Design of Machine Elements"**, V.B. Bhandari, TMH publishing company Ltd. New Delhi, 2ndEdition 2007.

[3] **"Theory of Machines",** Sadhu Singh, Pearson Education, 2nd Edition, 2007.

[4] **"Mechanical Vibrations",** G.K. Grover, Nem Chand and Bros, 6th Edition, 1996.

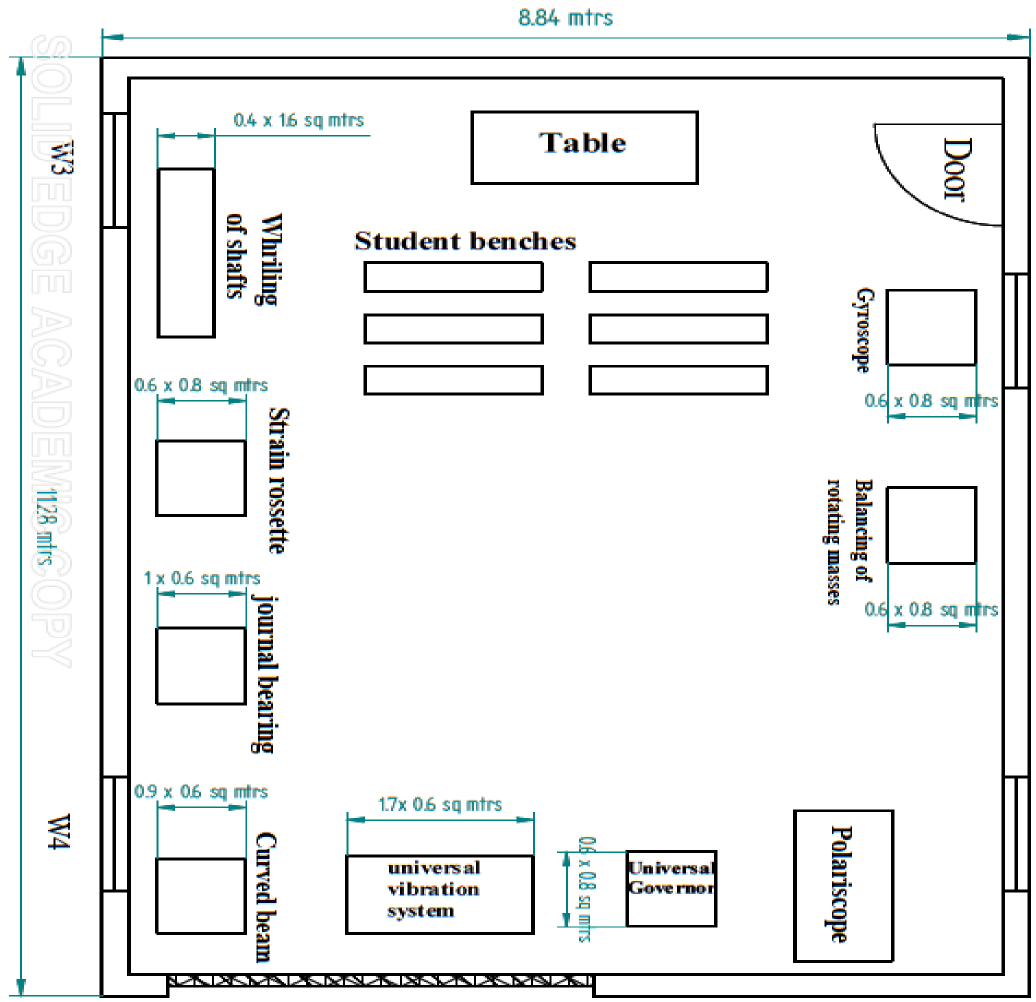
INDEX

Sl. No.	List of Experiments	Date of Submission	Marks Obtained	Initials of Staff
	PART - A			
01	SPRING MASS SYSTEM			
02	TORSIONAL VIBRATION			
03	SIMPLE PENDULUM			
04	BALANCING OF MASSES			
05	WHIRLING SPEED OF SHAFTS			
	PART - B			
06	PORTAL GOVERNOR			
07	JOURNAL BEARING			
08	STUDY OF CAMS			
09	CAM PROFILE FOR TWO TYPES OF FOLLOWERS			
10	DETERMINATION OF PHOTO ELECTRIC MATERIAL USING PLORISCOPE			
	Grand Total			

CLO & CO’s: DESIGN LAB

PART - A
EXPERIMENT-1: DURATION:3Hours
Objective: To determine the Vibration parameters in a single degree of freedom system with longitudinal vibration.
Generic Skills / Outcomes:
Student will be able to understand the concept of vibration and determine the natural frequency and time period in a single degree of freedom system with longitudinal vibration.
EXPERIMENT-2: DURATION:3Hours
Objective: To determine the Vibration parameters in a single degree of freedom system with torsional vibration.
Generic Skills / Outcomes:
Student will be able to understand the concept of vibration and determine the natural frequency and time period in a single degree of freedom system with torsional vibration.
EXPERIMENT-3: DURATION:3Hours
Objective: To determine the Vibration parameters in a single degree of freedom system with angular motion due to vibration.
Generic Skills / Outcomes:
Student will be able to understand the concept of vibration and determine the natural frequency and time period in a single degree of freedom system with angular motion due to vibration.
EXPERIMENT-4: DURATION:3Hours
Objective: To conduct experiments on Balancing of rotating masses.
Generic Skills / Outcomes:
Students will able to understand the concepts of balancing and its importance.
EXPERIMENT-5: DURATION:3Hours
Objective: Determination of critical speed of a rotating shaft.
Generic Skills / Outcomes:
Student will able to determine the critical speed of a rotating shaft.
PART - B
EXPERIMENT-6: DURATION:3Hours
Objective: To find the fringe order for specimen under compressive loading.
Generic Skills / Outcomes:
Student will be able to determine the material fringe order.
EXPERIMENT-7: DURATION:3Hours
Objective: Determination of Controlling force of Porter Governor.
Generic Skills / Outcomes:
Student will be able to determine Controlling force of Porter Governor.
EXPERIMENT-8: DURATION:3Hours
Objective: Determination of Pressure distribution in Journal bearing.
Generic Skills / Outcomes:
Student will be able to determine Pressure distribution in Journal bearing.
EXPERIMENT-9: DURATION:3Hours
Objective: Determination of Principal Stresses and strains in a member subjected to combined

loading using Strain rosettes.
Generic Skills / Outcomes:
Student will be able to determine Principal Stresses and strains in a member subjected tocombined loading using Strain rosettes.
EXPERIMENT-10: DURATION:3Hours
Objective: Determination of stresses in Curved beam using strain gauge.
Generic Skills / Outcomes:
Student will be able to determine stresses in Curved beam using strain gauge.



NAME:	DESIGN LAB	Department of Mechanical Engineering, ATME College of Engineering, Mysuru	
LOCATION:	GROUND FLOOR	FILE NO.:	Area 99.69 sq.mtrs

Experiment No-1

SPRING MASS SYSTEM

Aim of the experiment:-To determine the natural frequency and time period of undamped free vibration of a helical spring.

Learning Objective:-To determine the Vibration parameters in a single degree of freedom system with longitudinal vibration.

Theory:-

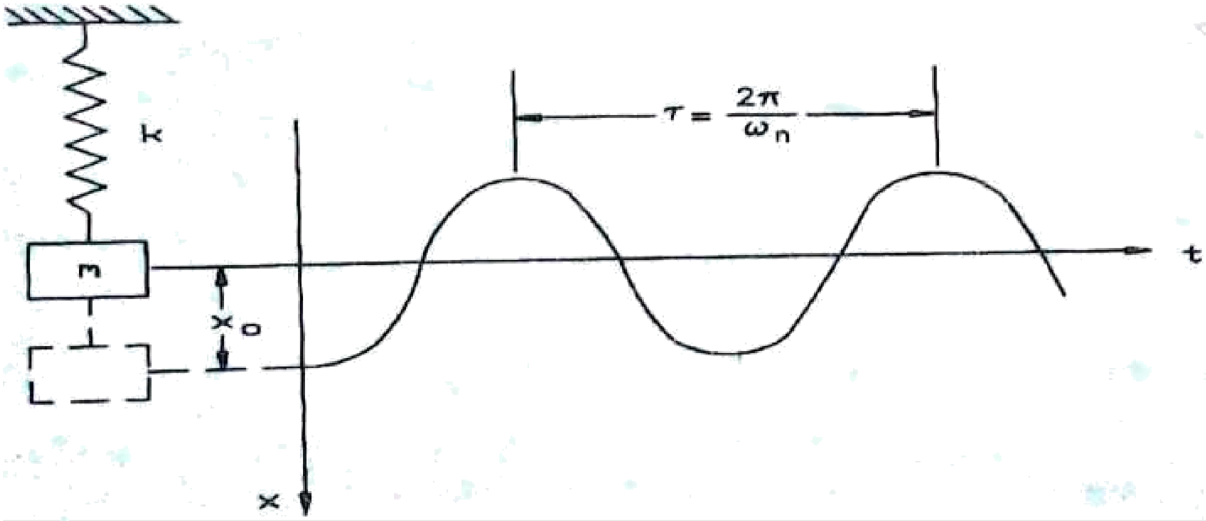


Fig-1- Time displacement curve for an undamped free vibration

Degree Of freedom (DOF):

The number of independent co-ordinates required to specify completely the geometric location of the mass of the system in space. Single DOF means only one co-ordinate is required to define the geometric configuration of the system. The experiment which is going to be conducted is a single degree of freedom.

Natural frequency (ω):

When an initial displacement is applied on a body as a disturbance and left, the body starts to vibrate itself. This vibration is called free vibration and its frequency as natural frequency.

Time period (T):

Time taken to complete one cycle.

Basic set up:-

This experiment is one of the universal vibration apparatus shown in fig-2. In this experiment one end of the open coil spring is fixed to screw can be adjusted vertically and other end carries platform to carry weights.

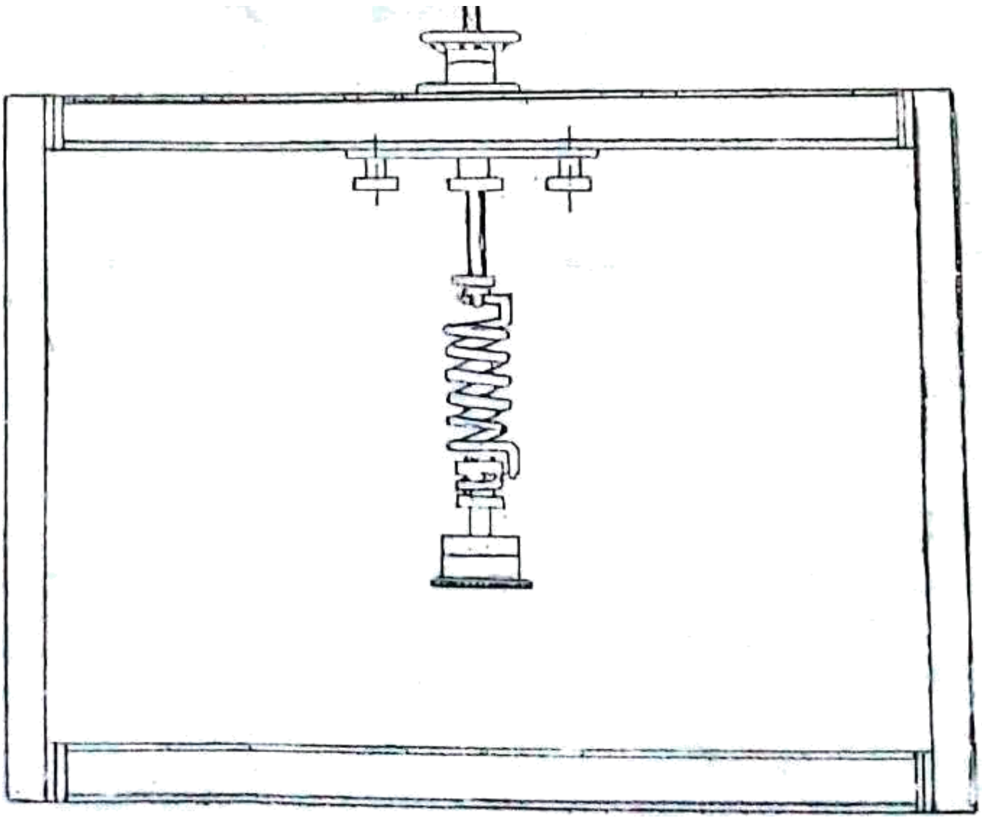


Fig-2-Apparatus

Procedure:

1. One end of the open coil spring is fixed to the nut having a hole.
2. The nut is fixed on the main (frame) another end of the spring coil is attached to the pan or hanger it's carrying the weights.
3. The initial length of spring is noted.
4. The standard mass is attached to the mass hanger of the spring and final length is noted.
5. Using initial and final length the deflection is calculated.
6. The spring is now set in to the motion by elongating it slightly.
7. The time period of vibration can be calculated by measuring the number of oscillations and time taken for them.
8. This procedure is repeated for different masses attached to the spring.

Observation:-

Tabular column

Sl No	Initial Length of spring L_1 in 'm'	Mass attached to spring 'm' in Kg	Stretched length of spring (L_2) in 'm'	Deflection of spring $= L_2-L_1$ in 'm'	Stiffness of the spring $K = m/\delta$ in N/m	Number of oscillation (n)	Time for 'n' oscillation 't' in sec	Experimental time period T_{exp} in sec (t/n)
1								
2								
3								

Calculation:-

1. Experimental period of vibration as oscillation.

$$T_{exp} = \frac{t}{n}\ in\ sec$$

t =time taken for n oscillation

2. Theoretically period of vibration of oscillation.

$$T_{the} = 2\pi\sqrt{\frac{m}{K}}\ in\ sec$$

m= mass attached in Kg

K= $\frac{mg}{\delta}$ in N/m

δ=final length of the spring – initial length of the spring

3. f_{nexp} = experimental natural frequency = $\frac{1}{T_{exp}}$ in Hertz(Hz)
4. f_{nthe}= theoretical natural frequency = $\frac{1}{T_{the}}$ in Hertz(Hz)
5. Percentage difference in frequency =

$$\frac{f_{the} - f_{exp}}{f_{the}} \times 100$$

Note-To find the stiffness of the spring we have to convert the mass unit to Newton

Result:-

Sl No	Experimental natural frequency f_{nexp}	Theoretical natural frequency f_{nthe}	% error in frequency
1			
2			
3			

Graph:-

Frequency v/s mass

Time period v/s mass

Outcome: Student will be able to understand the concept of vibration and determine the natural frequency and time period in a single degree of freedom system with longitudinal vibration.

VIVA QUESTIONS:

1. How vibrations are classified?
2. Define Natural frequency, Time period, Simple Harmonic motion.
3. State &explain the types of free vibrations.
4. What is the natural frequency equation for spring mass system with and without damper?

UNIVERSITY QUESTIONS:

1. Conduct experiment on spring mass system and determine natural frequency and time period.
2. Write types of vibration.

Experiment No-2

TORSIONAL VIBRATION

Aim of the experiment:-To study the undamped free torsional vibrations of a single rotor system.

Learning Objective:-To determine the Vibration parameters in a single degree of freedom system with torsional vibration.

Theory:-

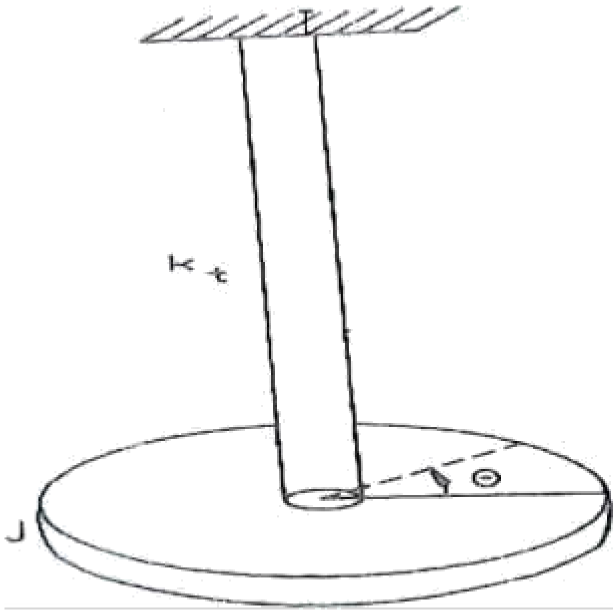


Fig-1-Torsional system

When a rotor is displaced slightly in an angular manner about the axis of the shaft and released, it executes torsional oscillations. The differential equation to find out the natural frequency is given by,

$$J\ddot{\theta} + K_t\theta = 0$$

$$\ddot{\theta} + \frac{K_t}{J}\theta = 0$$

$$\ddot{\theta} + \omega_n^2\theta = 0$$

Therefore,

Natural frequency,

$$\omega_n = \sqrt{\frac{K_t}{J}} \ rad/sec$$

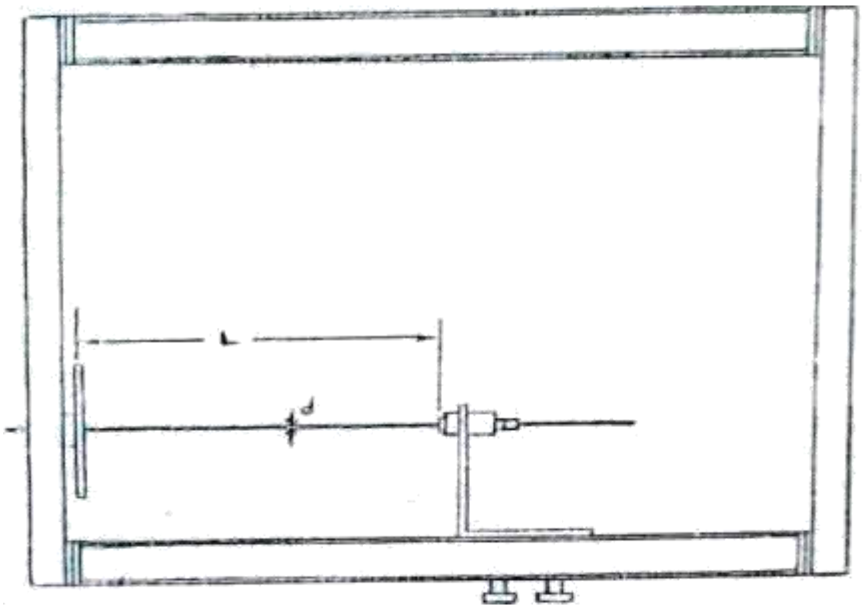
Where,

K_t=torsional stiffness in N-m.

J = mass moment of inertia in Kg-m^2

Apparatus:-

Figure-2 shows the general arrangement for carrying the experiment. One end of the shaft is gripped in the collet chuck fixed to the (L-clamp) and the other side in a similar collet chuck fixed into a heavy flywheel (rotor disc). The rotor along with this end of the shaft is free to rotate in a sleeve about a ball bearing fixed in line with the shaft to the vertical arm (or side member) of the test rig. The length of the shaft can be varied by moving the bracket to any convenient position along the frame, and then clamping it. The ball bearing provides negligible damping.



Procedure:-

1. Fix the bracket along any convenient position along the lower beam.
2. Grip one end of the shaft in the bracket with the help of the collet chuck.
3. Fix the rotor disc to the other end of the shaft using collet chuck provided in the ball bearing of the side member.
4. Note down the length of the shaft between supports.
5. Note down the diameter of the rotor disc.
6. Twist the rotor through some angle and then release.
7. Note down the time required for ‘n’ oscillations.
8. Repeat the experiment for different lengths of the shafts.

Observation:-

Given data

1. Shaft diameter ‘d’ =
2. Length of the shaft ‘l’ =
3. Diameter of the rotor disc ‘D’ =
4. Mass of the disc ‘m’ =
5. Rigidity modulus of the shaft material ‘G’ =

Tabular column

Sl No	Shaft length (l)	Torsional stiffness (k_t)	Number of oscillation (n)	Time for 'n' oscillation 't' in sec	Experimental time period T_{exp} in sec (t/n)	Theoretical time period T_{the} in sec
1						
2						
3						

Calculation:-

1. Polar moment of inertia 'I_P'

$$I_p = \frac{\pi d^4}{32} \ \ in \ \ m^4$$

2. Torsional stiffness of the shaft material 'K_t' =

$$K_t = \frac{GI_p}{l} \ \ in \ N - m$$

3. Mass moment of inertia 'J'

$$J = \frac{1}{2} mR^2 \ \ in \ Kg - m^2$$

4. Experimental time period 'T_{exp}'

$$T_{exp} = \frac{t}{n} \ \ in \ sec$$

t =time taken for n oscillation

5. f_{nexp} = experimental natural frequency = $\frac{1}{T_{exp}}$ in Hertz(Hz)
6. Theoretical time period 'T_{the}'

$$T_{the} = 2\pi \sqrt{\frac{J}{K_t}} \text{ in sec}$$

7. f_{nthe}= theoretical natural frequency = $\frac{1}{T_{the}}$ in Hertz(Hz)
8. Percentage difference in frequency =

$$\frac{f_{the} - f_{exp}}{f_{the}} \times 100$$

Result:-

Sl No	Experimental natural frequency f_{nexp}	Theoretical natural frequency f_{nthe}	% error in frequency
1			
2			
3			

Outcome: Student will be able to understand the concept of vibration and determine the natural frequency and time period in a single degree of freedom system with torsional vibration.

VIVA QUESTIONS:

1. Distinguish between the Free, Force & Torsional vibration.
2. Distinguish between Linear & Nonlinear vibrations.
3. Define Damping ratio & Logarithmic decrement.
4. What is natural frequency equation for torsional vibration system?

UNIVERSITY QUESTIONS:

1. Conduct experiment on torsional vibration and determine natural frequency and time period.

Experiment No-3

SIMPLE PENDULUM

Aim of the experiment:-

To study the free vibration of a simple pendulum

Learning Objective:-To determine the Vibration parameters in a single degree of freedom system with angular motion due to vibration.

Theory:-

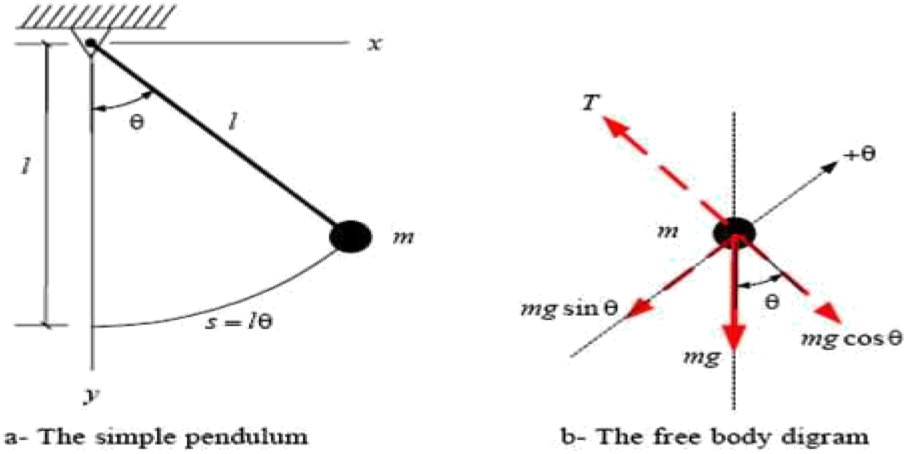


Fig-1- Simple pendulum

A pendulum is a body suspended by a fixed point so it can swing back and forth under the influence of gravity. Pendulums are frequently used in clocks because the interval of time for each complete oscillation, called the **period**, is constant. The period of this pendulum can be made longer by increasing its length, as measured from the point of suspension to the middle of the suspended body, or bob. This simple pendulum consists of a bob suspended at the end of a cord. Its period is based on length, not amplitude.

The equation of motion for the pendulum is given by,

$$ml^2\ddot{\theta} + mgl\theta = 0$$

$$\ddot{\theta} + \frac{mgl}{ml^2}\theta = 0$$

$$\ddot{\theta} + \frac{g}{l}\theta = 0$$

Therefore,

Natural frequency,

$$\omega_n = \sqrt{\frac{g}{l}}\ rad/sec$$

Where,

g = gravity in m/s^2

Procedure:-

1. Fix the ends of the thread with a body of mass 'm' and another end to a fixed support.
2. Measure the length for first trial.
3. Now with an initial displacement oscillate the setup.
4. Note down the time taken for 5 oscillations.
5. Repeat the experiment for different length of thread.

Observation:-

Given data

1. Mass of the ball 'm' =

Tabular column

Sl No	Length of the string (l)	Number of oscillation (n)	Time for 'n' oscillation 't' in sec	Experimental time period T_{exp} in sec (t/n)	Theoretical time period T_{the} in sec
1					
2					
3					

Calculation:-

1. Experimental time period 'T_{exp}'

$$T_{exp} = \frac{t}{n} \text{ in sec}$$

t =time taken for n oscillation

2. f_{nexp} = experimental natural frequency = $\frac{1}{T_{exp}}$ in Hertz(Hz)

3. Theoretical time period 'T_{the}'

$$T_{the} = 2\pi\sqrt{\frac{l}{g}} \text{ in sec}$$

4. f_{nthe}= theoretical natural frequency = $\frac{1}{T_{the}}$ in Hertz(Hz)

6. Percentage difference in frequency =

7.

$$\frac{f_{the} - f_{exp}}{f_{the}} \times 100$$

Result:-

Sl No	Experimental natural frequency f_{nexp}	Theoretical natural frequency f_{nthe}	% error in frequency
1			
2			
3			

Outcome:-Student will be able to understand the concept of vibration and determine the natural frequency and time period in a single degree of freedom system with angular motion due to vibration.

VIVA QUESTIONS:

1. How natural frequency and time period changes with length of the pendulum.

UNIVERSITY QUESTIONS:

1. Conduct experiment on simple pendulum and determine natural frequency and time period.

Experiment No-4

BALANCING OF MASSES

Aim of the experiment:-

To determine the balancing masses required to minimize the effect of vibration caused by the disturbing masses on a shaft.

Learning Objective: -To conduct experiments on Balancing of rotating masses.

Theory:-

Balancing is an essential technique applied to mechanical parts of rotational functionality *(wheels, shafts, flywheels…)*, in order to eliminate the detected irregularities found within it, and that may cause excessive vibrations during operation, and act as undesirable disturbances on the system being in use. Such irregularities may rise due to the inhomogeneous distribution of material within the part, bending and deflection of rotating shafts, and eccentricity of mass from the axis of rotation of the rotating disks and rotors.

These irregularities lead to small eccentric masses that disturb mass distribution of the part, and the last generate *centrifugal forces* when the part is in rotation; the magnitude of these forces increases rapidly with speed of rotation, and enhances vibrations level during operation, and cause serious problems.

Dynamic Balancing differs from static balancing in that the mass distribution of the part is detected in all directions, and not only about the central axis; and so, not only the magnitude of the unbalanced mass and its distance from the axis of rotation are to be determined, but also its position in the axial *(longitudinal)* direction of the rotational part.

This shown in fig-1

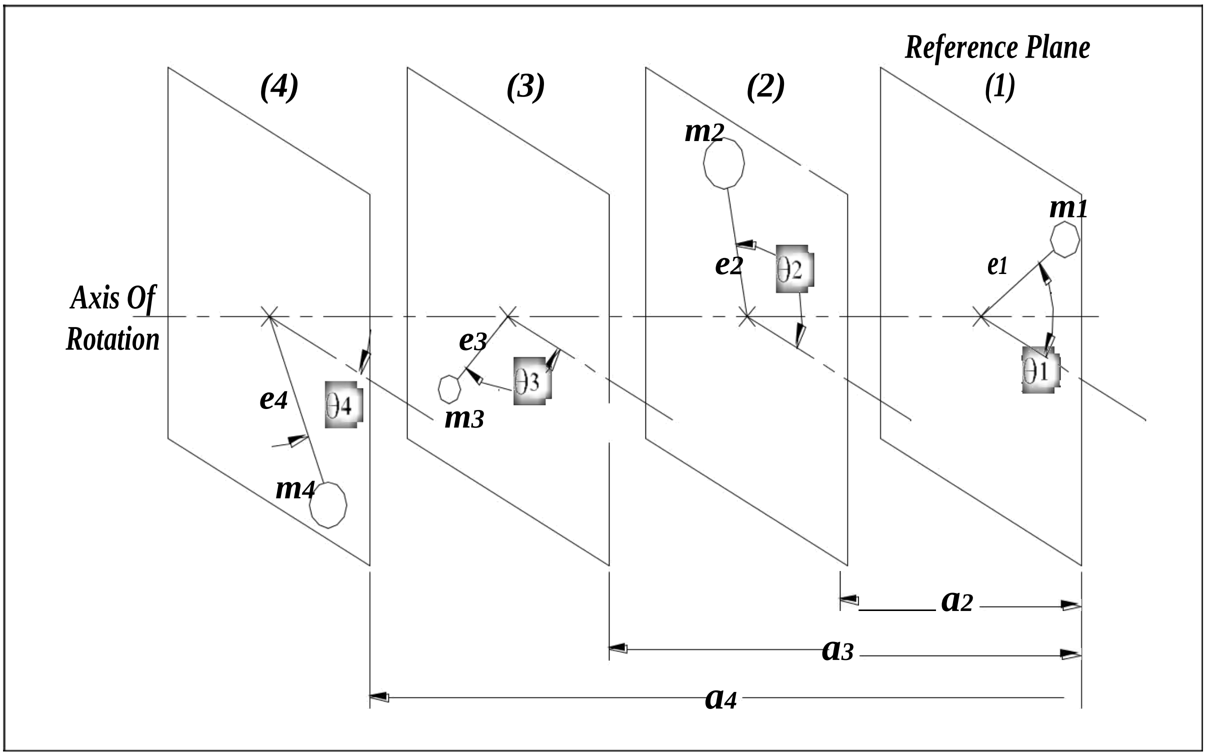


Figure-1- Dynamic balancing of masses

Procedure:-

1. Place the disturbing masses at a convenient distance and angles along the shaft.
2. For the placed disturbing masses, find out the balancing masses and their positions by plotting couple polygon and force polygon.
3. Finally place the balancing masses at the calculated positions and run the shaft to check whether the shaft is balanced or not.

Observation:-

Tabular column

Masses	Masses in Kg (m)	Angle (ɵ)	Length of the masses with respect to reference plane in mm (l)	Radius of rotation of masses (r)	Force (F=mr)	Couple (C=mrl)
A						
B						
C						
D						

Calculation:-

1. Plot the couple polygon
2. Plot the force polygon

3. Result:-

Outcome:-Students will able to understand the concepts of balancing and its importance.

VIVA QUESTIONS:

1. Why balancing is necessary?
2. Explain the static and dynamic balancing?
3. What are the parameters that affect balancing of Rotating masses?

UNIVERSITY QUESTIONS:

1. Explain types of balancing.

2. What do mean by balancing of several masses rotating in different plane.

Experiment No-5

WHIRLING SPEED OF SHAFT

Aim of the experiment:-

To determine the whirling speed of shaft and its critical frequency under whirling speed conditions.

Learning Objective:-Determination of critical speed of a rotating shaft.

Theory:-

A uniformly loaded shaft may be made to vibrate transversely in just the same way similar to a shaft which gives a single concentrated load. This shaft has theoretically infinite number natural frequency. The speed at which the shaft runs so that the additional deflection of the shaft from the axis of rotation becomes infinite is known as critical speed, it is equal to the natural frequency of transverse vibrations.

Procedure:-

1. Note down the specifications and observations of the shaft set-up.
2. Calculate the critical frequencies for different modes.
3. Switch on the motor, adjust the dimmer start for the shaft to attain calculated critical speed
4. Observe the modes when the shaft is rotating.
5. Note down the speed of it and compare the calculate speed.

Observation:-

Given data

1) Diameter of shaft ‘d’=
2) Length of shaft ‘L’=
3) Elastic modulus of shaft material ‘E’=
4) Density of shaft material ‘ρ’ =

Tabular column

Mode No.	End Condition	Theoretical Freq Hz (f_n)	Critical speed RPM ($60xf_n$)	Experimental speed (rpm)
1	Fixed- Fixed end			
2	Fixed- fixed end			

Calculation:-

1. Theoretical natural frequency (w_n) in rad/sec

$$w_n = K_n^2 \sqrt{\frac{EI}{\rho A}}$$

Where,

$$K_n = \frac{5}{4} \times \frac{n\pi}{L}$$

$$I = \frac{\pi \times d^4}{64}$$

Where,

n= mode number

2. Theoretical natural frequency (f_n) in hertz

$$f_n = \frac{1}{2\pi} \times K_n^2 \sqrt{\frac{EI}{\rho A}}$$

Result:-

Mode No.	Critical speed RPM ($60xf_n$)	Experimental speed (rpm)
1		
2		

Outcome:-Student able to determine the critical speed of a rotating shaft.

VIVA QUESTIONS:

1.Define critical speed of a shaft.
2. Explain the factors affecting the critical speed**.**

UNIVERSITY QUESTIONS:

1. Determine critical speed of a shaft.

Experiment No-6

PORTER GOVERNOR

Aim of the experiment:-To determine the Controlling force of the governor.

Learning Objective:-Determination of Controlling force of Porter governor.

Theory:-

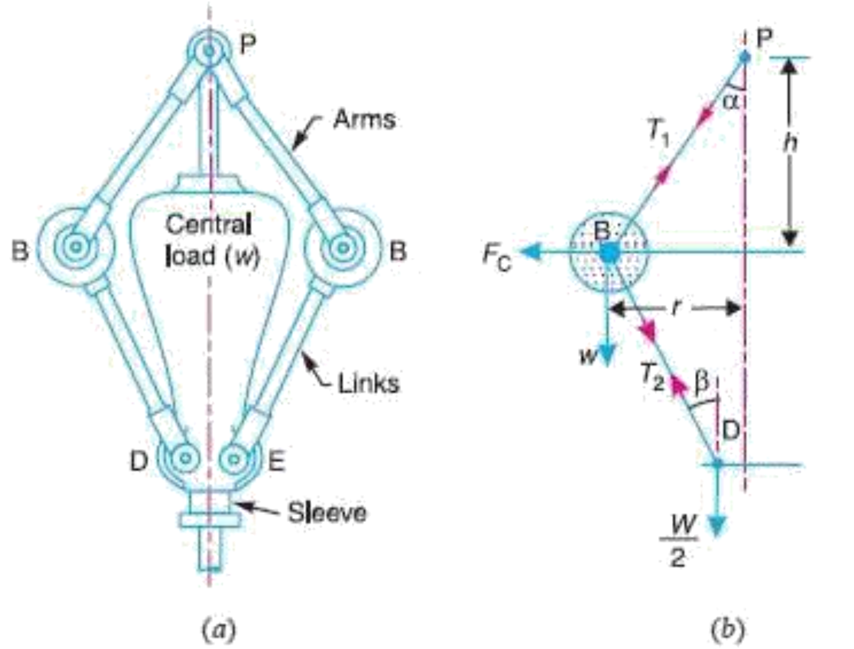


Fig-1- Porter governor

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

The governors may, broadly, be classified as

1. Centrifugal governor
2. Inertia governor

The centrifugal governors, may further be classified as follows:

1. Pendulum type (Watt governor)
2. Loaded type
   - (i) Dead weight governor (Porter governor and Proell governor)
   - (ii) Spring controlled governors (Hartnell governor, Hartung governor, Wilson-Hartnell governor and Pickering governor)

Porter Governor: - The porter governor is a modification of a Watt's governor, with central load attached to the sleeve as shown in fig-1. The load moves up down the central spindle. This additional downward force increases the speed of revolution required to enable the balls to rise to any to any pre-determined level.

Procedure:-

1. Fix the balls to the governor arms.
2. Take the reading of the length of the links
3. Take the reading of the initial height of the governor.
4. Place a weight of 3kg on the sleeve.
5. Then give rotation to the governor and note down the rpm reading for every 1cm lift.

Observation:-

Given data

1. Mass of the ball (m in Kg) =
2. Initial Height of the governor (h_o in meter) =
3. Mass of the central load (M in Kg) =
4. Length of the arm = length of the link (L_a in m) =

Tabular column

Sl No	Sleeve lift (X in m)	Speed in rpm (N)	Angle of inclination $\alpha = \cos^{-1}\left[\frac{h}{L_a}\right]$	Height of the governor $h = h_o - \frac{X}{2}$ (in m)	Controlling force in N
1					
2					
3					

Calculation:-

1. Height of Governor 'h' = $h_0 - \frac{x}{2}$
Where x = Sleeve movement

2. Radius of rotation (r)
r = 0.05 + $L_a \sin\alpha$
Where $\alpha = \cos^{-1}\left[\frac{h}{La}\right]$

3. Controlling Force (F_C) = $m\omega^2 r$ Newton
Where $\omega = \frac{2\pi N}{60}$ rad/sec

Result:-

Sl No	Speed in rpm	Controlling force in N
1		
2		
3		

Plot the graph for Controlling force v/s Speed

Outcome:-Student will be able to determine Controlling force of Porter Governor.
.

VIVA QUESTIONS:

1. Define function of governor.
2. Define the terms Sensitiveness, Hunting & Effort with respect to governors?
3. Explain the term the stability of the governor?
4. What do you mean by isochronous condition in governors?
5. Differentiate Governor and Gyroscope.

UNIVERSITY QUESTIONS:

1. How the governors are classified?
2. Conduct experiment on porter governor and determine controlling force.

Experiment No-7

JOURNAL BEARING

Aim of the experiment:-Determination of a pressure distribution in a journal bearing.

Learning Objective:-Determination of Pressure distribution in Journal bearing.

Theory:-

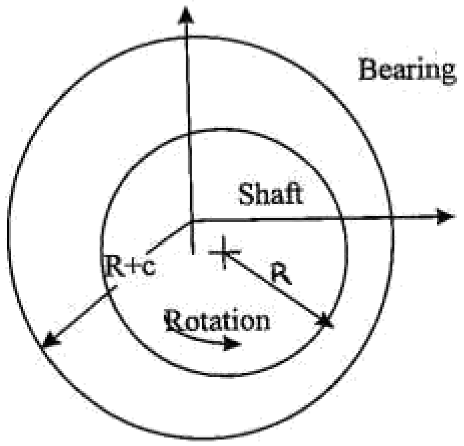


Fig-1-Plain journal bearing

A journal bearing supports a shaft and permits rotating motion. These causes wear of surfaces due to friction between the contact surfaces and heat is generated. Resulting in loss of power, to minimize this Lubricating oil is introduced in the clearance between the journal and bearing. Pressure developed in the oil film due to viscous force while the journal is rotating and this separates the contact surfaces. To study the pressure distribution and variables associated with the bearing design of bearings concept can be used.

Procedure:-

1. Fill the oil tank with lubricating oil.
2. Drain out the oil bubbles from all manometer tubes.
3. Open the inlet valve and note down the initial manometer reading after getting uniform level.
4. Check and ensure that the dimmer start is at zero position.
5. Rotate the dimmer start knob gradually till the desired speed is reached.
6. Run the set –up at this speed for some time.
7. Note down the pressure of oil in all the manometer tubes and tabulate them.
8. Bring down the speed to zero and switch off the motor.
9. The difference in manometer pressure at each tapping is plotted.

Observation:-

Given data

1. Diameter of journal. d =
2. Inside diameter of bearing. d_b =
3. Bearing length l =
4. Speed of the journal N = $n = \frac{N}{60} rps$
5. Lubricating oil used =

Tabular column

Sl No	Tube number	Position of the tube in degrees	Initial pressure head(P_I) in cm	Final pressure head(P_F) in cm	Difference in Pressure Head in cm = Final(P_F)-Initial(P_I)
1	1	0			
2	2	30			
3	3	60			
4	4	90			
5	5	120			
6	6	150			
7	7	180			
8	8	210			
9	9	240			
10	10	270			
11	11	300			
12	12	330			

Result:-

Plot the pressure distribution curve.

Outcome:-Student will be able to determine Pressure distribution in Journal bearing.

VIVA QUESTIONS:

1.What do you mean by journal bearing?

2. Define Hydrodynamic lubrication.

UNIVERSITY QUESTIONS:

1. How the bearings are classified?

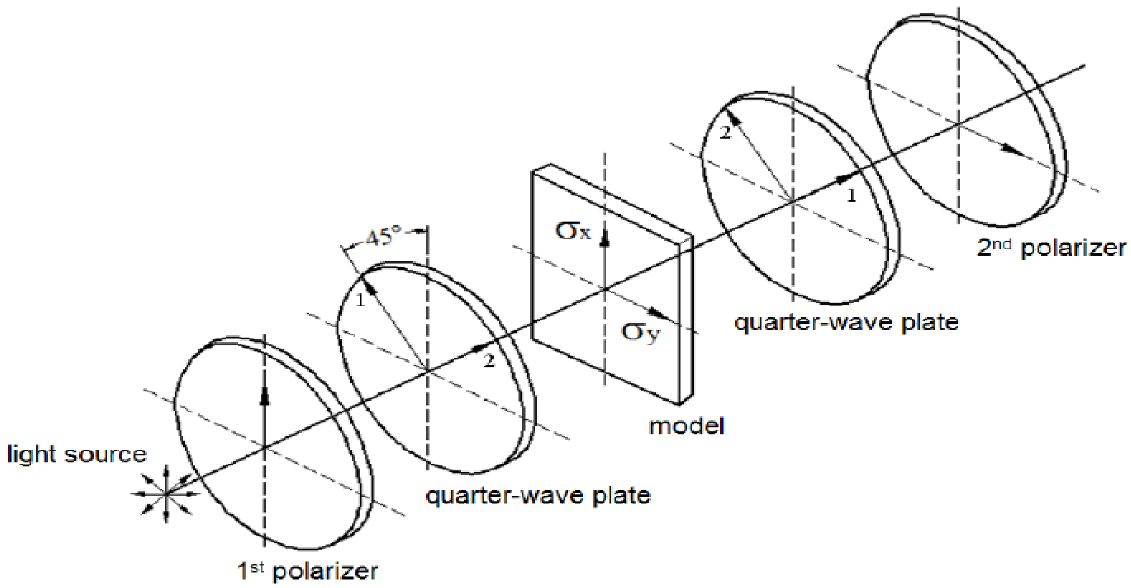
2. Conduct experiment on journal bearing and plot pressure distribution curve.

Experiment No-08

POLARISCOPE

AIM: To Calculate the material fringe order for Circular disk under compression.

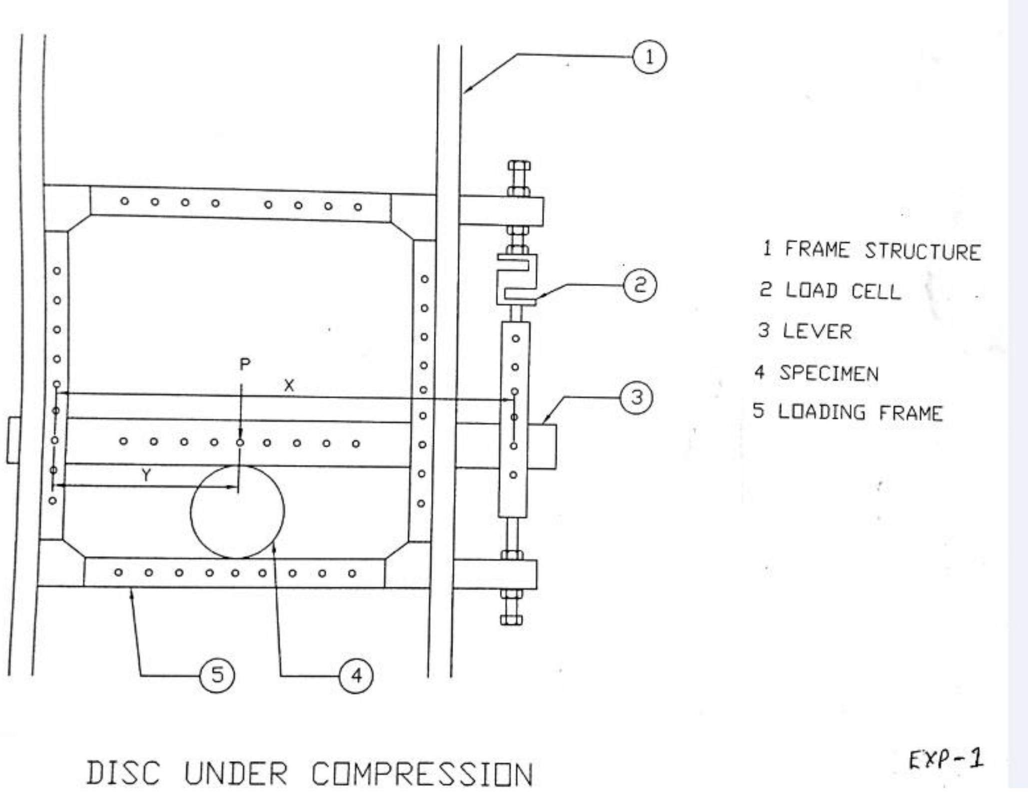
Learning Objective: To find the fringe order for specimen under compressive loading.



APPARATUS:
1) Circular disc prepared out of Photo elastic model material.
2) Universal Loading Frame
3) 12" Diffused Light Transmission Polariscope.

PROCEDURE

1. Load the disc in universal loading frame, under diametrical compression by putting pin on 2nd hole on right hand side and 7th hole on left hand side.
2. The distances 'X' and 'Y' must be measured initially.
3. Apply light load and Plain Polariscope (D) arrangement.
4. Observe the isoclinic fringe pattern and note the isoclinic reading for the point of interest 'P' on the model.
5. In this case as the point of interest 'P' which is at the center of the disc, the isoclinic reading automatically becomes zero.
6. Now apply known value of load at the end of lever and set to circular polariscope (M) arrangement.
7. Use white light and identify the fringe order at the point "P".
8. Use Tardy's Method, if required, to find fractional fringe order at the center point 'P'
9. Go on increasing the load in steps and note down fractional fringe order at the center point "P".
10. After measuring the diameter of the disc proceed to calculate material fringe value.



OBSERVATION:

1. Distance ‘X’ = _______________ cm
2. Distance ‘Y’ = _______________ cm
3. Diameter of Disc ‘D’ = ____________cm
4. Thickness of disc‘t’ = _________________cm

Tabular Column

Load Applied “m” Kg On Load Cell	Load on Model P	Lower Fringe Order	Higher Fringe Order	Fractional Fringe order	Actual Fringe Order=Higher fringe order- Fractional fringe order or Lower fringe order+ Fractional fringe order	Material Fringe Order ‘f’	Average Fσ Kg/cm

CALCULATIONS:

1. Load on Model,

$$P = \frac{WX}{Y}$$

2. For a disc under diametrical compression;

$$f = \frac{8P}{\pi DN}$$

where
D = Dia of disk in cm
N = Fractional fringe order

Outcome:-Student will be able to determine the material fringe order.

VIVA QUESTIONS:

1. Differentiate between plain and circular polari scope.
2. Name the Photo elastic material used in our lab?
3. What is the importance of Material fringe constant?

UNIVERSITY QUESTIONS:

1. What is Photo elasticity?

Experiment No-09

MOTORIZED GYROSCOPE

AIM: To study the gyroscopic principle and verify the relation between the applied torque, Spin velocity and Precessional velocity in case of free precession and forced precession.

Learning Objective: To study Gyroscopic couple and its effect

DESCRIPTION:
The motor is coupled to the disc rotor, which is balanced. The disc shaft rotates about XX axis in two ball bearings housed in the frame No. 1. This frame can swing about Y - Y axis in bearings provided in the yoke type frame No.2. In steady position, frame No. 1. is balanced by providing a weight pan on the opposite side of the motor. The yoke frame is free to rotate about vertical axis Z-Z. Thus freedom of rotation about three perpendicular axis is given to the rotor.

TECHNICAL DATA:

1. Weight of Rotor:
2. Rotor Diameter:
3. Rotor Thickness: **________mm**
4. Distance of bolt of Weight pan from disc Center :**cms**
5. Motor-Fractional H.P. single phase/6000 rpm -AC/DC

PROCEDURE:

Part I:

The spinning body exerts a torque or a couple in such a direction which tends to make the axis of spin coincides with that of the precession. To study the phenomenon of forced precession following procedure is adopted.

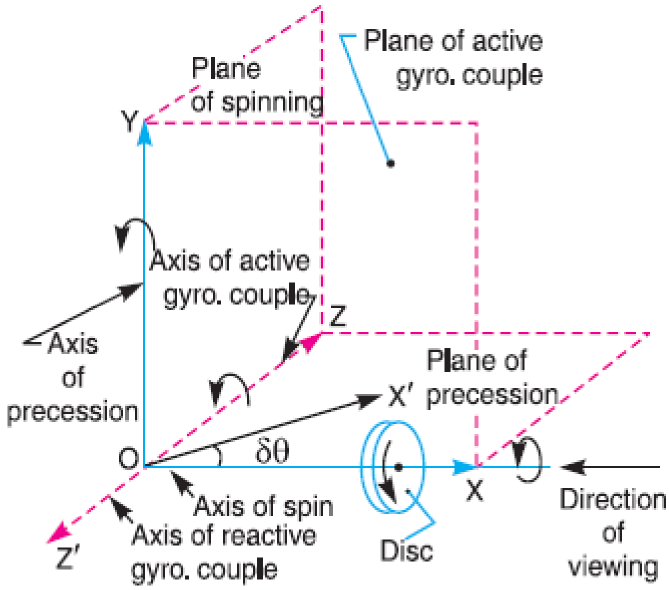
1. Balance initial horizontal position of rotor.
2. Start the motor and adjust the voltage to get the constant speed.
3. Press the yoke frame about the vertical axis by applying the necessary force by hand in the clockwise direction viewed from the top.
4. It will be observed that rotor frame swing about the horizontal axis so that the motor side moves upwards.
5. Rotating the yoke axis in the opposite direction causes the rotor frame to move in the opposite direction.

Part II:

The spinning body processes in such a way that to make the axis of spin to coincide with that of the applied couple.
The direction is verified by following the procedure given below and using the apparatus as well as the relation for the magnitude of the couple.

1. Balance the rotor in the horizontal plane.
2. Start the motor and adjust the speed with the help of voltage regulation. The speed is measured using a tachometer.
3. Put weights on the side opposite to the motor.
4. The yoke start processing.

5. Note down the direction of precession.
6. Verify this direction.
7. Measure the velocity of precession using the pointer provided the yoke and stop watch.
8. Verify the relation given for gyroscopic couple, G.



Course Outcome: Students will be able to know the Gyroscopic couple and its effect