Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY, BANGALORE

COURSE PLAN

Academic Year 2019-20

Program:	B E
Semester :	7th
Course Code:	15MEL76
Course Title:	DESIGN LABORATORY
Credit / L-T-P:	2 / 1-0-2
Total Contact Hours:	30 Hrs
Course Plan Author:	Mr. Harendra Kumar H V/ Sagar H N

Academic Evaluation and Monitoring Cell

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INSTRUCTIONS TO TEACHERS

- Classroom / Lab activity shall be started after taking attendance.
- Attendance shall only be signed in the classroom by students.
- Three hours attendance should be given to each Lab.
- Use only Blue or Black Pen to fill the attendance.
- Attendance shall be updated on-line & status discussed in DUGC.
- No attendance should be added to late comers.
- Modification of any attendance, over writings, etc is strictly prohibited.
- Updated register is to be brought to every academic review meeting as per the COE.

Table of Contents

Note : Remove "Table of Content" before including in CP Book
Each Laboratory Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

A. LABORATORY INFORMATION

1. Laboratory Overview

Degree:	B.E	*Program:*	ME
Year / Semester :	4/ 7	*Academic Year:*	2019-20

CourseTitle:	DESIGN LABORATORY	*Course Code:*	15MEL76
Credit / L-T-P:	2 / 1-0-2	*SEE Duration:*	180 Minutes
Total Contact Hours:	30 Hrs	*SEE Marks:*	75Marks
CIA Marks:	20	*Assignment*	1 / Module
Course Plan Author:	Mr. Sagar H N	*Sign*	Dt :
Checked By:	Mr. Harendra Kumar H V	*Sign*	Dt :

2. Laboratory Content

Expt.	Title of the Experiments	Lab Hours	Concept	Blooms Level
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)	3	Vibration	L3 Apply
2	Determination of critical speed of rotating shaft.	3	critical speed	L3 Apply
3	Balancing of rotating masses.	3	Balancing	L3 Apply
4	Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)	3	Photo-elastic	L3 Apply
5	Determination of stress concentration using Photo elasticity for simple components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane hook.	3	stress concentration	L3 Apply
6	Determination of equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.	3	speed	L3 Apply
7	Determination of pressure distribution in Journal bearing	3	Hydrodynamic Lubrication	L3 Apply
8	Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes	3	Strain rosettes	L3 Apply
9	Determination of stresses in curved beam using strain gauge.	3	Strain guage	L3 Apply
10	Experiments on Gyroscope (Demonstration only)	3	Gyroscopic effect	L2 understand

3. Laboratory Material

Books & other material as recommended by university (A, B) and additional resources used by Laboratory teacher (C).

Expt.	Details	Expt. in book	Availability
A	Text books		-
	Design of Machine Elements", V.B. Bhandari, TMH publishing company Ltd, New Delhi, 2 nd Edition 2007.	In Lib	
B	Reference books		
1	[1] "Theory of Machines", Sadhu Singh, Pearson Education, 2 nd Edition, 2007. [2] "Mechanical Vibrations", G.K. Grover, Nem Chand and Bros, 6 th Edition, 1996.	In dept	
2	Others (Web, Video, Simulation, Notes etc.)		
C	**Concept Videos or Simulation for Understanding**		
C1			
D	**Software Tools for Design**	-	-
1			
E	**Recent Developments for Research**	-	-
1			

F	**Others (Web, Video, Simulation, Notes etc.)**	**-**	**-**
1			

4. Laboratory Prerequisites:

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Expt.	Lab. Code	Lab. Name	Topic / Description	Sem	Remarks	Blooms Level
1	15ME52	Dynamics of machinery	Static force Analysis,			L3
1			Dynamic force Analysis	5		L3
1			Balancing of Rotating Masses			L3
6			Governors,Gyroscope			L3
2	10ME72	Mechanical Vibrations	Single Degree of Freedom	7		L3
1			Damped free Vibrations			L3
1			Forced Vibrations			L3

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Expt.	Topic / Description	Area	Remarks	Blooms Level
1	Static force Analysis,	Structure		L3
1	Dynamic force Analysis	Structure		L3
1	Balancing of Rotating Masses	Structure		L3
6	Governors,Gyroscope	Structure		L3
2	Single Degree of Freedom	Vibrations		L3
1	Damped free Vibrations	Vibrations		L3
1	Forced Vibrations	Vibrations		L3

B. Laboratory Instructions

1. General Instructions

SNo	Instructions	Remarks
1	Observation book and Lab record are compulsory.	
2	Students should report to the concerned lab as per the time table.	
3	After completion of the program, certification of the concerned staff in-charge in the observation book is necessary.	
4	Student should bring a notebook of 100 pages and should enter the readings /observations into the notebook while performing the experiment.	
5	The record of observations along with the detailed experimental procedure of the experiment in the Immediate last session should be submitted and certified staff member in-charge.	
6	Should attempt all problems / assignments given in the list session wise.	
7	It is responsibility to create a separate directory to store all the programs, so that nobody else can read or copy.	
8	When the experiment is completed, should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.	
9	Any damage of the equipment or burn-out components will be viewed seriously either	

	by putting penalty or by dismissing the total group of students from the lab for the semester/year	
10	Completed lab assignments should be submitted in the form of a Lab Record in which you have to write the algorithm, program code along with comments and output for various inputs given	

2. Laboratory Specific Instructions

SNo	Specific Instructions	Remarks
1	Student should bring a notebook of 100 pages and should enter the readings /observations into the notebook while performing the experiment.	
2	The record of observations along with the detailed experimental procedure of the experiment in the Immediate last session should be submitted and certified staff member in-charge.	

C. OBE PARAMETERS

1. Laboratory Outcomes

Expt.	Lab Code #	COs / Experiment Outcome	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
-	-	**At the end of the experiment, the student should be able to . . .**	-	-	-	-	-
1	15MEL76	Apply the natural frequency, logarithmic decrement, damping ratio and damping.	03	Vibration	Chalk and Board	Practical record and slip test	L3
2	15MEL76	Apply for different diameter of shaft to find critical speed.	03	critical speed	Chalk and Board	Practical record and slip test	L3
3	15MEL76	Applying the forces and couples in rotating mechanical system.	03	Balancing	Chalk and Board	Practical record and slip test	L3
4	15MEL76	Apply the load on circular disk subjected to diametrical compression, pure bending	03	Photo-elastic	Chalk and Board	Practical record and slip test	L3
5	15MEL76	Apply the load for simple components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane hook.	03	stress concentration	Chalk and Board	Practical record and slip test	L3
6	15MEL76	Apply the equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.	03	speed	Chalk and Board	Practical record and slip test	L3
7	15MEL76	Apply and understand the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing.	03	Hydrodynamic Lubrication	Chalk and Board	Practical record and slip test	L3
8	15MEL76	To measure strain in various machine elements using strain gauges	03	Strain rosettes	Chalk and Board	Practical record and slip test	L3
9	15MEL76	Apply the stresses in curved beam using strain gauge.	03	Strain guage	Chalk and Board	Practical record and slip test	L3
10	15MEL76	understand the working principles of machine elements such as Gyroscopes	03	Gyroscopic effect	Chalk and Board	Practical record	L2
-		**Total**	**30**	**-**	**-**	**-**	**-**

Note: Identify a max of 2 Concepts per unit. Write 1 CO per concept.

2. Laboratory Applications

Expt.	Application Area	CO	Level
1	machinery components,Car Suspension,spring mass system	CO1	L3

2	Bearing,pumps, generator	CO2	L3
3	gas turbines and electric generators	CO3	L3
4	residual stress,glass and polymer,plastics	CO4	L3
5	two dimensional plane stress	CO5	L3
6	automobiles	CO6	L3
7	bearings	CO7	L3
8	plastics,cast iron and magnesium alloys	CO8	L3
9	Transducers, transistors, resistors	CO9	L3
10	Micro-Electro-Mechanical System	CO10	L2

Note: Write 1 or 2 applications per CO.

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Expt.	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
1	CO1	PO1	L2	Knowledge is required to understand the Vibrations	
1	CO1	PO2	L3	Analyzing problem is required to compare values	
2	CO2	PO1	L2	Knowledge is required to understand the Critical Speed	
2	CO2	PO2	L3	Analyzing problem is required to compare values	
3	CO3	PO1	L2	Knowledge is required to understand the Balancing of Mass	
3	CO3	PO1	L3	Analyzing problem is required to compare values	
4	CO4	PO1	L2	Knowledge is required to understand the Photo Elastic y	
4	CO4	PO2	L3	Analyzing problem is required to compare values	
5	CO5	PO1	L2	Knowledge is required to understand the Stress Concentration	
5	CO5	PO2	L3	Analyzing problem is required to compare values	
6	CO6	PO1	L2	Knowledge is required to understand the Speed	
6	CO6	PO2	L3	Analyzing problem is required to compare values	
7	CO7	PO1	L2	Knowledge is required to understand the Lubrication	
7	CO7	PO2	L3	Analyzing problem is required to compare values	
8	CO8	PO1		Knowledge is required to understand the Strain Rosettes	
8	CO8	PO2	L3	Analyzing problem is required to compare values	
9	CO9	PO1	L2	Knowledge is required to understand the Strain Guages	
9	CO9	PO2	L3	Analyzing problem is required to compare values	
10	CO10	PO1	L2	Knowledge is required to understand the Gyroscopic Effect	
10	CO10	PO2	L3	Analyzing problem is required to compare values	

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Experiment Outcomes	Program Outcomes															-
Expt.	CO.#	**At the end of the experiment student should be able to . . .**	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	Level
1	15ME76.1	Apply the natural frequency, logarithmic decrement, damping ratio and damping.	√	√	-	-	-	-	-	-	-	-	-	-	L3			
2	15ME76.2	Apply for different diameter of shaft to find critical speed.	√	√	-	-	-	-	-	-	-	-	-	-	L3			
3	15ME76.3	Applying the forces and couples in rotating mechanical system.	√	√	-	-	-	-	-	-	-	-	-	-	L3			
4	15ME76.4	Apply the load on circular disk subjected to diametrical compression, pure bending	√	√	-	-	-	-	-	-	-	-	-	-	L3			
5	15ME76.5	Apply the load for simple components like Plate with hole	√	√	-	-	-	-	-	-	-	-	-	-	L3			

		under tension or bending, circular disk with circular hole under compression, 2-d crane hook.																
6	15ME76.6	Apply the equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.	√	√	-	-	-	-	-	-	-	-	-	-	L3			
7	15ME76.7	Apply the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing.	√	√	-	-	-	-	-	-	-	-	-	-	L3			
8	15ME76.8	To measure strain in various machine elements using strain gauges	√	√	-	-	-	-	-	-	-	-	-	-	L3			
9	15ME76.9	Apply the stresses in curved beam using strain gauge.	√	√	-	-	-	-	-	-	-	-	-	-	L3			
10	15ME76.10	understand the working principles of machine elements such as Gyroscopes	√	√	-	-	-	-	-	-	-	-	-	-	L2			
11	**15ME76PC.**	Average																

5. Curricular Gap and Experiments

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Expt	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					

Note: Write Gap topics from A.4 and add others also.

6. Experiments Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Expt	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					

D. COURSE ASSESSMENT

1. Laboratory Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Unit	Title	Teaching Hours	No. of question in Exam							CO	Levels
			CIA-1	CIA-2	CIA-3	Asg-1	Asg-2	Asg-3	SEE		
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)	03	1	-	-	-	-	-	1	CO1	L3
2	Determination of critical speed of rotating shaft.	03	1	-	-	-	-	-	1	CO2	L3
3	Balancing of rotating masses.	03	1	-	-	-	-	-	1	CO3	L3
4	Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)	03	1	-	-	-	-	-	1	CO4	L3
5	Determination of stress concentration using Photo elasticity for simple	03	1	-	-	-	-	-	1	CO5	L3

	components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane hook.										
6	Determination of equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.	03	1	-	-	-	-	-	1	CO6	L3
7	Determination of pressure distribution in Journal bearing	03	1	-	-	-	-	-	1	CO7	L3
8	Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes	03	1	-	-	-	-	-	1	CO8	L3
9	Determination of stresses in curved beam using strain gauge.	03	1	-	-	-	-	-	1	CO9	L3
10	Experiments on Gyroscope (Demonstration only)	03	1	-	-	-	-	-	1	CO10	L3
-	**Total**	**30**	**10**	-	-	-	-	-	**10**	**-**	**-**

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	20	CO1, CO2, CO3, CO4	L3
CIA Exam – 2	20	CO5, CO6, CO7,	L3
CIA Exam – 3	0	CO8, CO9,CO10	L3
	-	-	-
Other Activities – define – Slip test	-	-	-
Final CIA Marks	**20**	**-**	**-**

-

SNo	Description	Marks
1	Observation and Weekly Laboratory Activities	04 Marks
2	Record Writing / Viva	08 Marks for each Expt
3	Internal Exam Assessment	08Marks
4	Internal Assessment	20 Marks
5	SEE	80Marks
-	**Total**	**100 Marks**

E. EXPERIMENTS

D. EXPERIMENTS

Experiment 01 : Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)

A. Simple pendulum

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems						
2	Course Outcomes	Apply the natural frequency, logarithmic decrement, damping ratio and damping.						
3	Aim	To study the oscillations of simple pendulum.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Students should write about static equilibrium position, natural frequency, derive expression for natural frequency for free vibrating body, derive expression for springs in series and parallel.						
6	Procedure, Program,	1. Tightly fix the ball with the thread.						

	Activity, Algorithm, Pseudo Code	2 Displace the ball from the equilibrium position. 3. Measure the time required for 10 oscillations. 4. Repeat this procedure by changing the length of the thread.
	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	(see tables below)

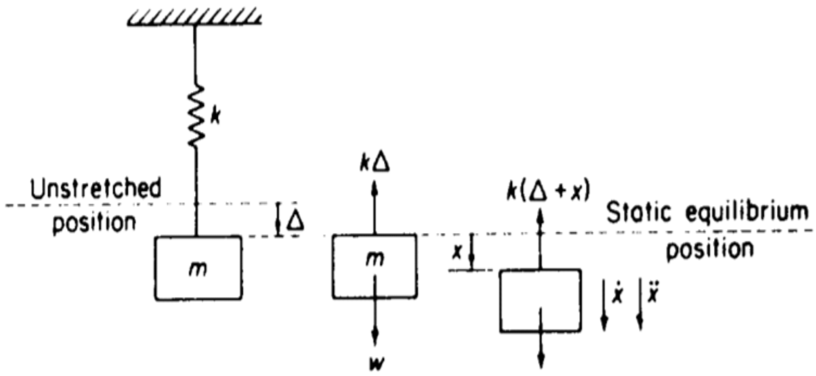
Sl.no	Time for 5 oscillations			T_{exp}) = t/n	f_{exp} = 1/ T_{exp}	$(T_{theo}) = 2\pi\sqrt{\frac{l}{g}}$
	1	2	avg			

Sl.no	Time for 10 oscillations			T_{exp}) = t/n	f_{exp} = 1/ T_{exp}	$(T_{theo}) = 2\pi\sqrt{\frac{l}{g}}$
	1	2	avg			
1						
2						
3						

9	Sample Calculations	1. Actual torsional Vibration (T_{exp}) = t/n 2. Theoretical torsional Vibration (T_{theo}) = $2\pi\sqrt{\frac{l}{g}}$ Where l = length in cms, g= Acceleration due to gravity in cms/sec^2 3. Experimental frequency f_{exp} = 1/ T_{exp} 4. Theoretical frequency f_{theo} = 1/ T_{theo}
10	Graphs, Outputs	☐ - ☐ -
11	Results &Analysis	The percentage error of the system between theoretical and experimental natural uency is ________
12	Application Areas	shaping machinery components,Car Suspension,spring mass system
13	Remarks	
14	Faculty Signature with Date	

B. Forced Damped Vibration of Spring Mass System

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Determination of natural frequency in a single degree of freedom vibrating systems						
2	Course Outcomes	Apply the natural frequency, logarithmic decrement, damping ratio and damping.						
3	Aim	To study the oscillations of simple pendulum.						
4	Material / Equipment Required	Lab Manual						

5	Theory, Formula, Principle, Concept	Students should write about static equilibrium position, natural frequency, derive expression for natural frequency for free vibrating body, derive expression for springs in series and parallel.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1 Fix the given spring to the stud. 2.Measure Initial length of the spring. 3 Attach the weight holder to the spring 4 Attach the weight to spring & Note down the value. 5 Measure the deflection of spring (δ) 6 Allow the oscillations by stretching the spring. 7 Note down time taken for 5 or 10 oscillations. 8 Repeat the experiment with different weights.
	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	

8 Observation Table,

Sl.no	Weights in kgs	Initial Length in mm	Final Length in mm	Static deflection in mm	Time of 5 Oscillations			Spring stiffness in N/mm	T_{exp}	T_{theo}
					1	2	avg			

Average spring stiffness in N /mm:__________

Look-up Table, Output

Sl. no	Weights in kgs	Initial Length in mm	Final Length in mm	Static deflection in mm	Time of 5 Oscillations			Spring stiffness in N/mm	T_{exp}	T_{theo}
					1	2	avg			

Average spring stiffness in N /mm:________

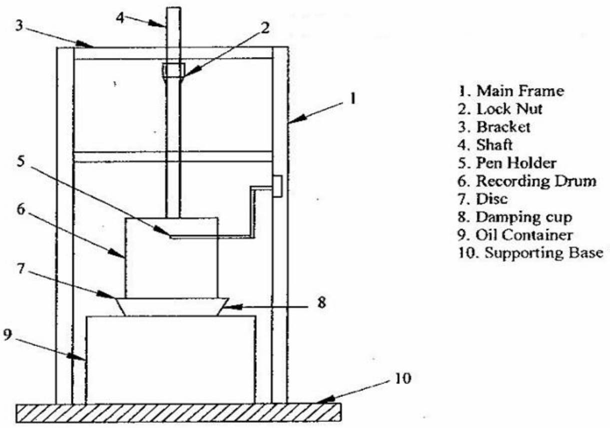
9	Sample Calculations	

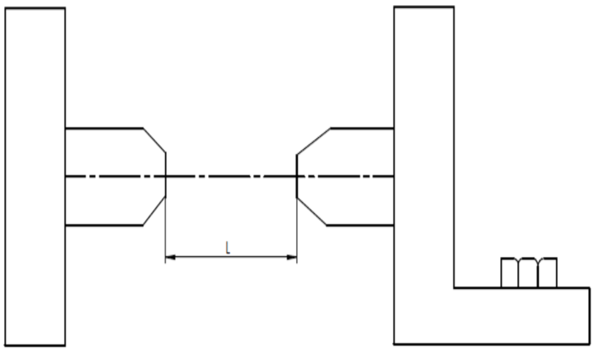
		M = mass attached = ---------------- δ = static deflection ------------------- W = weight attached = mg = ------------ N Stifness of spring K = 100 W / δ N/m where δ is in mm Frequency of oscillation: $F_n = \{(1/2\pi\}\sqrt{K/m}$ Hz $T_{theory} = 2\pi^* \sqrt{M/K}$ Sec T_{exp} =Time for 5 & 10 oscillation
10	Graphs, Outputs	☐ - ☐ -
11	Results &Analysis	
12	Application Areas	shaping machinery components,Car Suspension,spring mass system
13	Remarks	
14	Faculty Signature with Date	

Experiment 02 : Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)

A. Single Rotor System

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems						
2	Course Outcomes	Apply the natural frequency, logarithmic decrement, damping ratio and damping.						
3	Aim	To study the torsional vibrations of single rotor system.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	When the particle of the shaft or disc moves in a circle about the axis of the shaft, then the vibrations are known as Torsional vibration. In torsional vibrations the shaft is twisted & contrasted alternately & torsional shear stresses are induced in the shaft.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. Find The Stiffness Of The Torsion Wire 2. Attach one end of the Torsion Wire to the head & other to the rotor & apparatus is leveled 3. Adjust the length of wire so that rotor is at proper level 4. Check the oil level in the vessel with the rotor dipping in oil 5. The torsion head is rotated slowly until the pointer shows zero degree 6. Disturb the rotor & release the graph pointer 7. Note down the time & inclination 8. Calculate natural frequency , logarmithic decrement , damping ratio & damping co-efficient using equations						
	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph							





8 Observation Table,

1. Diameter of the shaft d = 4 mm,   L = length of Shaft   in m
2. Mass of the disc (smaller) m= 1.7 Kg
3. Diameter of the disc or rotor D = 0.19 m
4. Modulus of rigidity of shaft C= 85x 10^9 N / m2
5. Polar moment of Inertia of the shaft $J = (\pi d^4 / 32) = \pi \times (4\times10^{-3})^4 / 32 = 2.51 \times 10^{-11}\ m^4$
6. Mass moment of Inertia of disc $I = (mxD^2)/8 = 1.7 \times 0.19^2 / 8 = 7.67 \times 10^{-3}$ kg

Look-up Table, Output

SL No	Shaft length in cm	Time for 5 Oscillations			T_o =AVG/5	$F_n = ½ \pi \sqrt{(K_t / I}$	$T_{theo} = 1/F_n$
		1	2	avg			

9 Sample Calculations

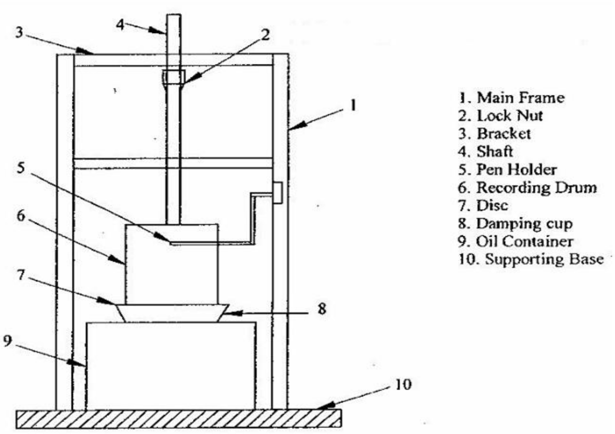
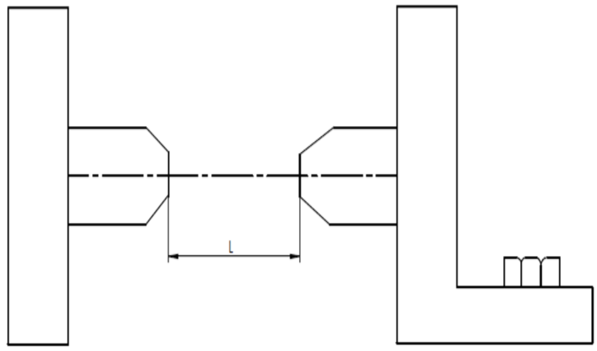
1. logarithmic decrement (δ) = ln (θn/θn+1)
2. logarithmic decrement (δ) = $2\pi\, \xi / (1-\xi^2)$
3. Mass moment of inertia (I) = $½\, mr^2 = mk^2$
4. Natural frequency $F_n = ½ \pi \sqrt{(K_t / I}$

   Where $K_t = C J / L$, and

   $I = \pi D^4 / 4$
5. Natural frequency $(\omega_n) = 2\pi F_n$
6. Critical damping co-efficient $C_c = 2m\omega n$
7. Damping Co-Efficient $C = \xi C_c$
8. Exp. Damped frequency $F_d = 1/t =$ Hz
9. Theoretical Damped frequency $F_d = f \sqrt{1-\xi^2}$ Hz

		10. Damped natural frequency $(\omega_d) = \omega_n \sqrt{(1-\xi^2)}$.
10	Graphs, Outputs	- -
11	Results &Analysis	The percentage error of the system between theoretical and experimental natural uency is ________
12	Application Areas	shaping machinery components,Car Suspension,spring mass system
13	Remarks	
14	Faculty Signature with Date	

B. DOUBLE ROTOR SYSTEM

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems						
2	Course Outcomes	Apply the natural frequency, logarithmic decrement, damping ratio and damping.						
3	Aim	To study the torsional vibrations of two rotor system.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	When the particle of the shaft or disc moves in a circle about the axis of the shaft, then the vibrations are known as Torsional vibration. In torsional vibrations the shaft is twisted & contrasted alternately & torsional shear stresses are induced in the shaft.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. The shaft whose diameter is known is mounted between the two disc. 2. The length of the shaft is measured. 3. The disc are given a small displacement in opposite direction 4. Time taken for 10 oscillations in noted. 5. The procedure can be repeated for different shaft diameter						
	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph							

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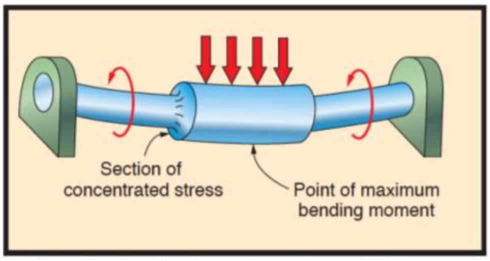
<tr><td></td><td></td><td></td></tr>
<tr><td>8</td><td>Observation Table,

Look-up Table, Output</td><td>Length of the shaft between rotor =
Diameter of shaft d =
Mass of small rotor = ma = 1.7 Kg
Diameter of small rotor = d_a = 0.095 *2 m
Mass of bigger rotor = mb = 2.57 Kg
Diameter of bigger rotor = d_b = 0.11252 * 2 m
Polar moment of Inertia $I_p = (\pi d^4/32)$
Modulus of rigidity of shaft $c = 85*10^9$ N/m^2 .
<table>
<tr><td>SL No</td><td>Shaft length in cm</td><td colspan="3">Time for 5 Oscillations</td><td>T_o =AVG/5</td><td>$F_n = ½ \pi \sqrt{(K_t / I}$</td><td>$T_{theo} = 1/ F_n$</td></tr>
<tr><td></td><td></td><td>1</td><td>2</td><td>avg</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>9</td><td>Sample Calculations</td><td>1. $K_t = G I_p / L$ = N-m
2. $I_A = M_A R_A^2/2$ = Kg-m^2
3. $I_B = M_B R_B^2/2 + 2(W_1 R^2/8)$ = Kg-m^2
4. $T_{th} = 2\pi \sqrt{\frac{I_a I_b}{K_t (I_a + I_b)}}$
5. $f_{th} = 1/ T_{th}$</td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td>□ -
□ -</td></tr>
<tr><td>11</td><td>Results &Analysis</td><td></td></tr>
<tr><td>12</td><td>Application Areas</td><td>shaping machinery components,Car Suspension,spring mass system</td></tr>
<tr><td>13</td><td>Remarks</td><td></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td></td></tr>
</table>

Experiment 03 : Determination of critical speed of rotating shaft.

<table>
<tr><td>-</td><td>Experiment No.:</td><td>2</td><td>Marks</td><td></td><td>Date Planned</td><td></td><td>Date Conducted</td><td></td></tr>
<tr><td>1</td><td>Title</td><td colspan="7">Determination of critical speed of rotating shaft.</td></tr>
<tr><td>2</td><td>Course Outcomes</td><td colspan="7">Apply for different diameter of shaft to find critical speed.</td></tr>
<tr><td>3</td><td>Aim</td><td colspan="7">To determine the critical speed (whirling speed) of a uniform shaft and comparing with the theoretical value.</td></tr>
<tr><td>4</td><td>Material / Equipment Required</td><td colspan="7">Lab Manual</td></tr>
<tr><td>5</td><td>Theory, Formula, Principle, Concept</td><td colspan="7">1. When the speed of an unloaded shaft is gradually increases, at certain speed, the deflection of the shaft becomes very large. This is the critical speed.
2. The shaft defects into a bow and whirls.
3. If this speed is maintained, the very large deflection will results in the fracture of shaft.
4. At the critical speed amplitude of transverse vibration coincides with the natural frequency of transverse vibrations that means ‘resonance’ occurs. Hence in the region of critical speeds shaft may fail. Large amount of force is transmitted to the foundations or bearings.</td></tr>
</table>

<table>
<tr><td>6</td><td>Procedure, Program, Activity, Algorithm, Pseudo Code</td><td>1. Measure diameter, length and mass of the given shaft.
2. Note down end conditions of the shaft.
3. Switch on the motor to get transverse vibrations.
4. Slowly increase the speed of shaft by using dimmerstat till critical speed is achieved. Note down critical speed by using digital tachometer.
5. Compare experimental values with theoretical.
6. Repeat the experiments with different shafts diameter.</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td>


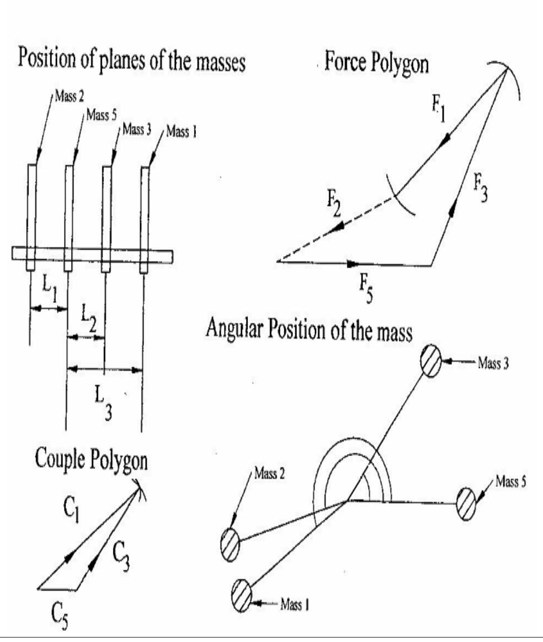
Shafts and axles often have stepped geometry to accommodate gears and pulleys and to restrict axial displacement. These sudden changes in cross section, as well as features like notches and holes, are local stress intensifiers and potential trouble spots for fatigue.
</td></tr>
<tr><td>8</td><td>Observation Table,

Look-up Table, Output</td><td>Type of end conditions: E= Young's modulus of shaft =2.7*11 N/m^2
<table>
<tr><td>Sl. No</td><td>Diameter of shaft D in mm</td><td>Length of Shaft L in mm</td><td>Mass of Shaft M in kg</td><td>Weight/ length Newton/ meter</td><td colspan="2">Critical Speed in rpm</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>N(Theo)</td><td>N(exp)</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
</table></td></tr>
<tr><td>9</td><td>Sample Calculations</td><td>1. Weight per unit length= W/L =(M*g)/L in Newton/meter =
W = weight of shaft,
2. Mass moment of inertia of shaft I ={πd^4}/64 $meter^4$
3. Displacement due to weight of the shaft (uniform distribution load with simply supported end conditions) δ = {5/384}* {{W L^4) / E I)} =
4. Natural frequency of transverse vibrations of shaft (UDL with simply supported end conditions)
f=0.5615 $\sqrt{\delta}$ Hertz Critical speed $N_{c\ (theory)}$ = fx60 rpm .</td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td></td></tr>
<tr><td>11</td><td>Results &Analysis</td><td></td></tr>
<tr><td>12</td><td>Application Areas</td><td>Bearing,pumps, generator</td></tr>
<tr><td>13</td><td>Remarks</td><td></td></tr>
</table>

14	Faculty Signature with Date	

Experiment 04 : Balancing of rotating masses.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Balancing of rotating masses.						
2	Course Outcomes	Applying the forces and couples in rotating mechanical system.						
3	Aim	To determine of four counter balancing weights in rotating mass systems and verifying practically the rotating mass system						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Why balancing is necessary? Different high speed matching have been using in various industries. Every machine has either reciprocating parts or rotary party or both .If there is any unbalanced part mass is present in the machine, the unbalanced mass develops “dynamic forces”. These dynamic forces increases loads on bearings and stresses in various members. Finally it results “unpleasant and dangerous vibrations”. Hence balancing is necessary .						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	**I. STATIC BALANCING** 1. The main frame is suspended from the support frame by bolt and nut in such a way that main frame is perpendicular to supporting frame. 2. Disconnect “belt pulley” from the motor. 3. Attach the cord-ends of the pans to either side of the “combined hook”. 4. Set the pointer to 0 on the circular scale by using locking nut. 5. Attach the block No.1 to the shaft at any convenient place in vertical downward direction. 6. Remove the locking nut and put steel balls one by one in one of the pans (to exactly balance the block on the shaft).till the block starts moving up to 90 when the block reaches to90, noted down number of ball. Repeat this for 2 to3 times and find the average on. of which will gives weight of the block on 1 (W1) 7. Repeat the procedure for other block and find W_1 ,W_2,W_3 and W_4 . **II.DYNAMIC BALANCING** 1. Using the values of W_1, W_2, W_3 and W_4 and its positions draw the “couple polygon” from the couple polygon angular positions of each weighs - θ_1, θ_2, θ_3 and θ_4 are obtained. 2. If weighs, angular positions and planes of three block are known then draw the “force polygon” from the force polygon note down angular position of the fourth block (θ) for balancing of the complete system. 3. From the calculations, clamp the all blocks on the shaft in their appropriate positions. 4. Connect “belt pulley” with the motor. 5. Mainframe is suspended from the support frame by two short links in such a way that both mainframe and supporting frame are in the same plane. 6. Start the motor. 7. Then verify the calculations with perfect balancing. .						

<table>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td>
</td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td>
<table>
<tr><th>SI NO</th><th>Centrifugal Force W_i</th><th>Distance of blocks from reference block X_i</th><th>Couple $C_i = Wi * X_i$</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>9</td><td>Sample Calculations</td><td></td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td></td></tr>
<tr><td>11</td><td>Results &Analysis</td><td></td></tr>
<tr><td>12</td><td>Application Areas</td><td></td></tr>
<tr><td>13</td><td>Remarks</td><td></td></tr>
<tr><td>14</td><td>Faculty Signature with Date</td><td></td></tr>
</table>

Experiment 05 : Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)

A. Calibration under Bending Load

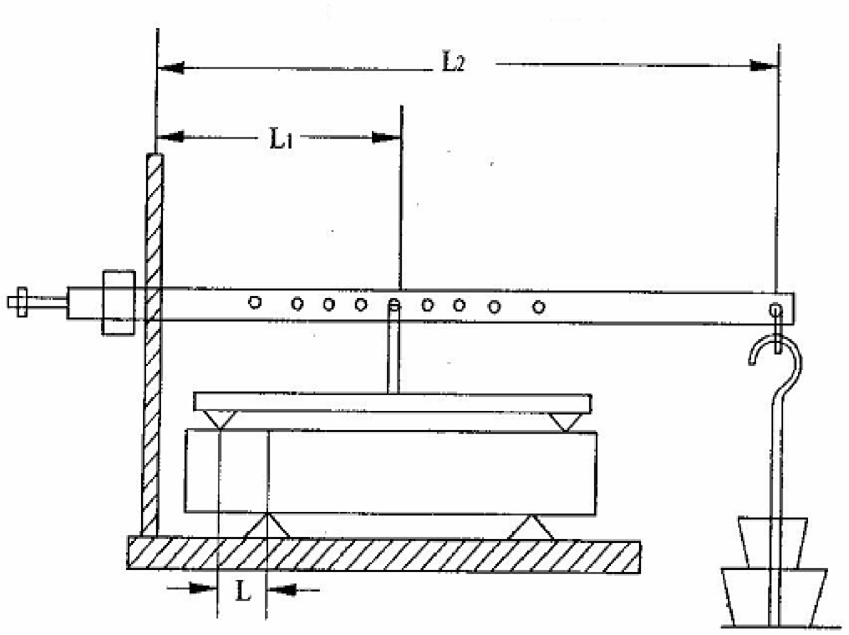
-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)						
2	Course Outcomes	Apply the load on circular disk subjected to diametrical compression, pure bendin						

3	Aim	To calibrate the given photo elastic model subjected to pure bending.
4	Material / Equipment Required	Lab Manual
5	Theory, Formula, Principle, Concept	Beam under pure bending. A rectangular beam may be prepared out of the photo elastic material and subjected to pure bending as shown in fig. 7.14. At a given load the maximum fringe order may be determined and material fringe value is evaluated as explained below. Bending moment, M = Pa , P = Actual Load, a = distance between supports. $\sigma_1 = \frac{My}{I} = \frac{Pa}{\frac{h\omega^3}{12}} * \frac{\omega}{2} = \frac{Pa}{\frac{h\omega^2}{6}}$, ω = width of model specimen, h = thickness of specimen Stress from bending moment ≡ Stress from caliberation constant. Therefore , $\frac{Pa}{\frac{h\omega^2}{6}} = \frac{Nf_\sigma}{h}$, where f_σ = caliberation constant . stress/fringe/thickness. Or $f_\sigma = (\frac{P}{N})(\frac{6a}{\omega^2})$ When the principal stress difference (σ1 – σ2) is either zero or sufficient to produce an integral number of wavelengths of retardation the intensity of emerging from analyzer is zero. The fringe pattern obtained under bending load is seen to get distorted near the point loading and it is somewhat parallel to each other at the center of the model is viewed under monochromatic light. The isometric fringe pattern appears only when the principle stress difference is zero.With monochromatic light source, the individual fringes is an isochromatic fringe pattern remains same, sharp and clear to very high order since the wavelength of light is fixed. Therefore, $\sigma_1 - \sigma_2 = \frac{Pa}{\frac{h\omega^2}{6}} = \frac{Nf_\sigma}{h}$ The number of fringes appearing in an isochromatic fringe pattern is controlled by the principle stress difference ($\sigma_1 - \sigma_2$), thickness h of the material and by the sensitivity of the photo elastic material as denoted by f_σ. The expression for material fringe values and model fringe value can be obtained by Load B = Load at C = $[(w \times L_2 / L_1) + w_b]/2 = P$ Where L_1 = Load lever arm W_b = weight of the beam. Max. bending moment = P.L where L = overhang of load application point over the support point. Bending stresses σ_b is , $\sigma_b = \frac{M_bC}{I} = \frac{PL}{\frac{h\omega^3}{12}} * \frac{h}{2} = \frac{PL}{\frac{h\omega^2}{6}}$ $f_\sigma = (\sigma_b/N).h$ = (Slope) , h = material fringe constant , Model fringe value = f_σ/h.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. Attach the loading bar with counter weight on one side of the bar and hang a pan other side for placing the weights. So as to make lever horizontal. 2. Place the model between the loading arm and the bottom surface of the frame. 3. Measure the distances from the “fulcrum” to the center of specimen (11) and fulcrum to load point (1)

4. Determine the loads required for getting integral fringe orders (0,1,2,3) and count the fringes (either top or bottom which one is first appears) from outer most fibre and tabulate it.
5. Draw a graph between bending stress Vs no. of fringes
6. Calculate the slope of the line.
7. Calculate material fringe constant by using the formula (from graph) .

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph

EXPERIMENTAL SETUP



8 Observation

Table, Look-up Table, Output

Weight of the beam (w_b) = 0.5 kg

SL. NO	Fringe Order (n) $n = \frac{\text{No.of fringe} - 1}{2}$	Load applied (w)		Actual load (P) = $\left[\frac{(w \times L_2)}{L_1} + w_b\right]/2$	Material fringe constant
		Kg	Newton		

9 Sample Calculations

1. Actual load=P= $[(w \times L_2) / L_1 + w_b] /2$
2. Bending stress (σ_b) = $6PL / h\omega^2$ N/mm2
3. Material fringe value (f_σ) = (σ_b /N) .h = slope x h
4. Model fringe value = f_σ /h
5. Slope(from graph bending stress v/s No.of fringes) =

10 Graphs, Outputs

11 Results &Analysis

12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Add required experiments

b. Calibration under Diametrical Compression.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)						
2	Course Outcomes	Apply the load on circular disk subjected to diametrical compression, pure bendin						
3	Aim	To calibrate the given photoelastic material using circular disk under compression						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	The stress distribution along the horizontal diameter in a circular disc under compression is given by, $\sigma_x = \sigma_1 = \left(\frac{2P}{\pi t D}\right)\left(\frac{D^2 - 4x^2}{D^2 + 4x^2}\right)$ and $\sigma_y = \sigma_2 = \left(\frac{2P}{\pi t D}\right)\left(\frac{4D^2 - 1}{D^2 + 4x^2}\right)$, where σ_x and σ_y are principal stresses in x and y directions, D is diameter of circular specimen, x is distance from center, t is thickness of specimen. At the center i.e. x = 0, thus $\sigma_1 = \frac{2P}{\pi t D}$ and $\sigma_2 = \frac{-6P}{\pi t D}$, and $\sigma_1 - \sigma_2 = \frac{8P}{\pi t D}$ ----- (1) From stress optic law for 2 – dimensions : Difference in principal stresses is directly proportional to N , the number of fringes and inversely proportional to the thickeness of specimen – with f_σ the constant of proportionality. ----(2) Therefore, from (1) and (2) $\sigma_1 - \sigma_2 = \frac{N}{t} f_\sigma = \frac{8P}{\pi t D}$ and $f_\sigma = \frac{8P}{\pi D N} = \left(\frac{8}{\pi D}\right)\left(\frac{P}{N}\right) = \frac{8}{\pi D}\frac{\Delta P}{\Delta N}$ N/mm/fringe By knowing the loads required for producing different number of fringes a graph of P vs N, is plotted and slope of this line gives (P/N) which is used to estimate the fringe constant of the material.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. Attach the counter weight on one side of the loading bar and put the weights on the pan 2. Make lever horizontal position by rotating the handle of loading frame						

		3. Place the model between the loading arm and bottom surface of the frame 4. Measure the distances from the "fulcrum" to the center of specimen (L1) and from fulcrum to load point (L) 5. Determine the loads required for getting integral fringe orders (0,1 ,2,3) at the center of circular disc and tabulate 6. Draw a graph between effective load vs no. of fringes. 7. Calculate the slope of the line 8. Calculate material fringe constant by using theoretical and compare it
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	Diameter of specimen (D)= mm Thickness of specimen (t) = mm Length of fulcrum to load (L_1) = cm Length of fulcrum to model (L_2) = cm
9	Sample Calculations	1.Actual load = P = $(w*g)(L_1/L_2)$ = 2. Material fringe constant $f_\sigma = \frac{8}{\pi D}\frac{\Delta P}{\Delta N}$ 3. Model fringe constant $f = f_\sigma/t$ = N/mm^2/Fringe 4.Slope (from graph) = $\Delta P/\Delta N$ =
10	Graphs, Outputs	
11	Results &Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

C. Determination of Stress Concentration Factor for Circular Disc with Circular Hole.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)						
2	Course Outcomes	Apply the load on circular disk subjected to diametrical compression, pure bendin						
3	Aim	To determine stress concentration factor for circular disc with circular hole under diameter compression						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula,	Circular polar scope:						

	Principle, Concept	In addition to all the elements of plane polar scope, the circular polar scope has two more additional elements, i.e. 1st quarter wave plate placed in between the polarizer and the model and whose fast and slow axes are inclined at 45° with the axes of the polarizer and 2nd quarter wave plate placed in between the model and the analyzer and whose fast and slow axes are inclined at 45^o with the axis of the analyzer or the polarizer. Depending upon the relative orientation of the polarizer, analyzer and quarter wave plates, four different set-ups may be obtained. The quarter wave plates are also made out of Polaroid film and produce a path difference of $\frac{\pi}{4}$ in the light vectors passing through them. The four different set-ups are shown in the following table. The crossed polarizer and analyzer are crossed quarter wave plates set-up is known as the standard set-up of a circular polariscope. Effect of a stressed model in a circular polariscope: Consider the standard set-up of a circular polariscope as shown in fig. Then the light vector leaving the polarizer is given by A = a sinωt. In the 1st quarter wave plate (QWP) the components of light vector while entering are: $A_{1e} = a \sin \omega t \cos\frac{\pi}{4} = \frac{a}{\sqrt{2}} \sin \omega t.$ $A_{2e} = a \sin \omega t \cos \frac{\pi}{4} = \frac{a}{\sqrt{2}} \sin \omega t.$ 1st quarter wave plate produces a phase difference of $\frac{\pi}{2}$ and converts plane polarized light into circularly polarized light. Therefore, components of light vector leaving 1^{st} QWP and entering the model are: $A1l = \frac{a}{\sqrt{2}} \sin(\omega t + \frac{\pi}{2}) = \frac{a}{\sqrt{2}} \cos\omega t$. $A2l = a \sin\omega t.$ If the principal axes of the model are inclined at angle θ with the 1st QWP, then the components of the light vector along the principal axis of the model on entering are $Aae = A_1 l \cos\theta - A_2 l \sin\theta$. $= \frac{a}{\sqrt{2}} \cos \omega t. \cos\theta - \frac{a}{\sqrt{2}} \sin \omega t .\sin\theta$. $A_{be} = A_1 l \sin\theta + A_2 l \cos\theta . = \frac{a}{\sqrt{2}} \cos \omega t. \sin\theta + \frac{a}{\sqrt{2}} \sin\omega t .\cos\theta$. The stress distribution along the horizontal diameter in a circular disc under compression is given by $\sigma_x = \sigma_1 = \frac{2P}{\pi D t} \frac{D^2 - 4x^2}{D^2 + 4x^2}$ $\sigma_y = \sigma_2 = -\frac{2P}{\pi D t} \frac{4D^2}{D^2 + 4x^2}$ At the center i.e. x = 0 $\sigma_1 = \frac{2P}{\pi D t}$ and $\sigma_2 = -\frac{6P}{\pi D t}$ Therefore, $\sigma_1 - \sigma_2 = \frac{8P}{\pi D t}$ ---------- (1) From stress optics law for 2 dimensions $\sigma_1 - \sigma_2 = \frac{N f_\sigma}{t}$ ---------- (2) From (1) & (2), $f_\sigma = \frac{8P}{\pi D N} = \frac{8}{\pi D} * \frac{P}{N} = \frac{8}{\pi D} * \frac{\Delta P}{\Delta N}$, and in the case of a central hole through the specimen ,

		$f_\sigma = \frac{8}{\pi(D-d)} * \frac{\Delta P}{\Delta N}$ N/mm/fringes By knowing the loads required for producing different number of fringes, a graph of P vs.N is plotted and the slope of this line gives (ΔP/Δ N) which are used to estimate the fringe constant of the material.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. Make all arrangements are shown in fig. 2. Apply weight gradually. Then measure the fringe order and corresponding loads at the point of interest ie., from inner boundary to outer boundary along horizontal diameter. 3.Take material fringe constant as determined from calibration experiment. Then calculate stress concentration factor (K)
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	Outer diameter of disc D = mm Inner diameter of disc d = mm Thickness of the disc t = mm Length of fulcrum to load (L_1) = cm Length of fulcrum to model (L2) = cm
9	Sample Calculations	1. Effective load P = (w*g)(L_1/L_2) Newtons = 2. Slope = Δ P/ ΔN Newton/Fringe = 3.Material fringe constant $f_\sigma = \frac{8}{\pi(D-d)} \frac{\Delta P}{\Delta N}$ = N/mm/fringe 4. Model fringe value $f = \frac{f_\sigma}{t}$ t = N/mm²/fringe 5. Max. stress (σ_{max}) = N $\frac{f_\sigma}{t}$ = N/mm² 6. Normal stress (σ_{nom}) = P/{D-d)*t} = N/mm 2 7. Stress concentration factor = $K_\sigma = \sigma_{max} / \sigma_{nom}$
10	Graphs, Outputs	
11	Results &Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

D. Determination of Stress Concentration Factor for Rectangular Plate with Central Hole

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)						
2	Course Outcomes	Apply the load on circular disk subjected to diametrical compression, pure bendin						
3	Aim	To determine stress concentration factor in a rectangular plate with the central hole subjected to tensile load.						

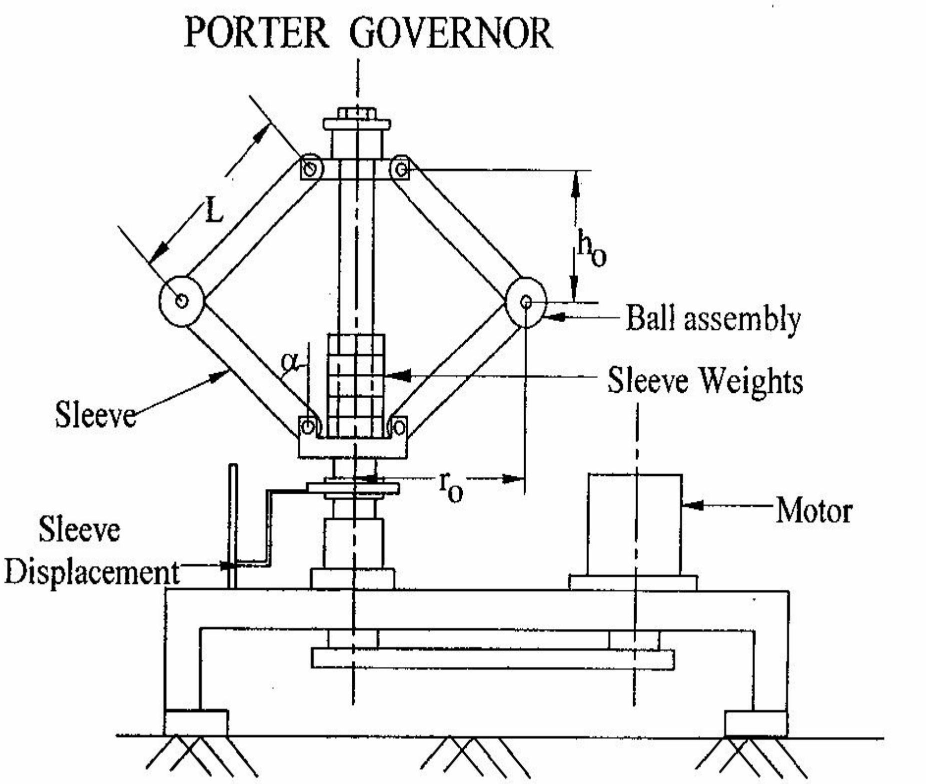
4	Material / Equipment Required	Lab Manual
5	Theory, Formula, Principle, Concept	The stress concentration factor (K_σ)for a given member is defined as the ratio of maximum stress σ_{max} to the normal stress σ_{nom} . $\sigma_{max} = \frac{N f_\sigma}{h}$ σ_{nom} = P / (w-a)h Where N= fringe order f_σ = Material fringe value (N/mm/fringe) P = load on specimen (Newtons) W = width of circular hole (mm) a = Diameter of circular hole (mm) H = Thickness of plate
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1.Keep the polariscope to produce circular polarized light 2.Switch on the sodium vapour lamp, wait for 10-15min, till golden yellow colour is obtained 3.Put the specimen & count the no. of fringes 4.Determine the stress concentration factor & calculate slope from the graph $\Delta P/\Delta N$
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	Outer diameter of disc D = mm Inner diameter of disc d = mm Thickness of the disc t = mm Length of fulcrum to load (L_1) = cm Length of fulcrum to model (L2) = cm
9	Sample Calculations	1. Maximum Stress (σ_{max}) = n f_σ / h 2. Normal Stress (σ_{nom}) = P / (w - a) h 3. Stress concentration factor (K_σ) = (σ_{max} / σ_{nom}) . N/mm^2 6. Normal stress (σ_{nom}) = P/{D-d)*t} = N/mm 2 7. Stress concentration factor = K_σ = σ_{max} / σ_{nom}
10	Graphs, Outputs	
11	Results &Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 06 : Determination of equilibrium speed, sensitiveness, power and effort of/**Porter Governor** Proel Governor.

A. Porter Governor

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	

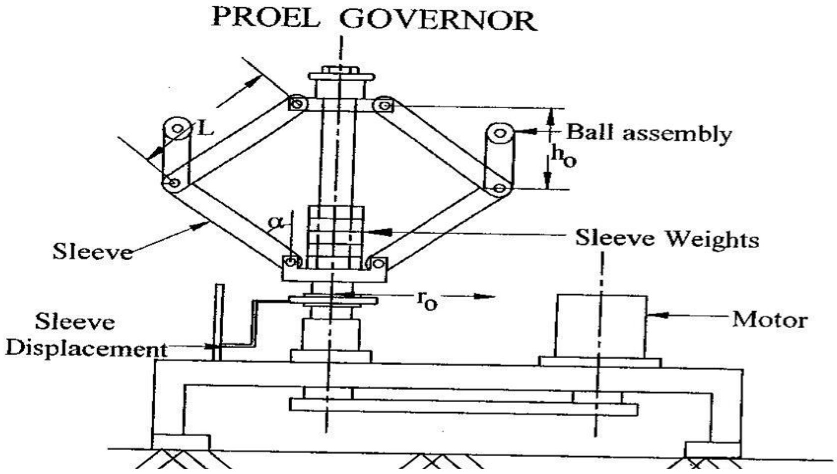
1	Title	Determination of equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.
2	Course Outcomes	Apply the equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.
3	Aim	To determine Frictional force acting on the governor and to draw controlling force curve.
4	Material / Equipment Required	Lab Manual
5	Theory, Formula, Principle, Concept	The function of the governor is to regulate the mean speed of rotation of an engine where there is a variation in load, which may increase or decrease its speed. Hence it is necessary to vary the supply of fuel accordingly, which will be done by the governor. It automatically consists or controls supply of working fluid to engine with varying load columns, keeps the mean speed within certain limits. When the load decreases, the speed increases. Then it's necessary to decrease the supply of the working fluid and vice versa, which is done by the governor. Governors can be spring loaded or dead weight type. A little consideration will show that when the load increases, the configuration of the governor changes and a valve is moved to increase the supply of the working fluid, conversely when the load decreases, the engine speed increases and the governor decreases the supply of the working fluid. The porter governor is a modification of a watt governor, with a control load attached to the sleeve as shown in the figure. The load moves up and down the spindle. The additional downward force increases the speed of revolution required to unable the walls to raise to any pre-determined level. There are several methods of determining the relation between the height of the governor (h) and the angular speed of the ball (w). The following are the two methods: 1. Method of rev. of force. 2. Instantaneous centre method. The governor mechanism under test is fitted with the chosen rotating weights and spring, where applicable and assembles the governor assembly as shown in figure. Connect the motor to speed control unit using 4 way cable provided. Switch in the supply. Increase the speed slowly until the centre sleeve rises off the lower stop and aligns with the first division on the graduated scale. Record the sleeve positioning and speed. Increase the sped in steps to have suitable sleeve movements, and note down the displacement and speed accordingly through out the range of sleeve movement possible.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. Mount the required governor assembly over the spindle. 2. Tighten the necessary bolts. 3. Governor is connected to main supply through dimmerstat. 4. Various parameters of the governor are note down ex. The length of arm, radius of balls etc., 5. Ensure that dimmerstat is at zero position. 6. Switch on the motor and speed is slowly raised through dimmerstat until sleeve begins to life. The speed is allowed to stabilize. 7. Measure the speed and sleeve rise. 8. The speed of motor is further increased and the sleeve rises. After it stabilizes the reading of the speed and lift is noted. 9. Repeat the experiment at different speed, different weights. 10. Calculate frictional forces and control force. 11. Draw the controlling force and frictional forces curves.

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	m = mass of the balls(left side or right side) = M = mass of the sleeve +mass of the collar(m_c) = Distance between governor axis & point of pivot of governor arm(DG)= meter Length of each link (C)= meter Length of sleeve(L)= meter

SL No.	Speed N (Rpm)	Lift X (M)	$C_i = C - (X_i/2)$ (M)	$S_i = \sqrt{L^2 - Ci^2}$ (M)	$R_i = DG + S_i$ (M)	$\Theta = Tan^{-1}$ (C/S)	H= R_i tan Θ (M)	Fr force "f"(N)	Controlling force "F"(N)

9	Sample Calculations	1. For N= rpm 2.Frictional Force(f) ={(N^2*m*g *H_i) / 895 }- {m *g +M*g } 3.Controlling Force F =m $\omega^2 R_i$
10	Graphs, Outputs	1. Sleeve displacement vs. Speed 2. Controlling force vs. Radius of rotation
11	Results &Analysis	1. Controlling Force(F) Vs Speed (N_i) 2 .Controlling Force(F) Vs Height of the governor (H_i) 3. Controlling Force(F) Vs Radius of rotation (R_i) 4. Frictional Force (f) vs Speed (N_i)
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

B. Porter Governor.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Determination of equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.						
2	Course Outcomes	Apply the equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.						
3	Aim	To determine the frictional force and the controlling of force [centrifugal force] and proel (or) draw the Controlling force curves						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	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.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. To mount the proel governor on universal governor Make sure that the dimmer start is at zero position 2. Start the motor and gradually increase the speed and the sleeve start mooing up. 3. Note the speed of the governor and the corresponding sleeve lift. 4. Increase the speed and hence the sleeve lift and note down the corresponding Values. 5. Repeat the procedure for different speeds and weights						
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph							
8	Observation Table, Look-up Table, Output	m = mass of the balls (left side or right side) = M = mass of the sleeve +mass of the collar(m_c) = Distance between governor axis & point of pivot of governor arm(DG) = meter Length of each link (C) = meter Length of sleeve(L) = meter						

SL NO.	Speed N (Rpm)	Sleeve Lift X (M)	$C_i = C-(X_i/2)$ (M)	$S_i = \sqrt{L^2 - Ci^2}$ (M)	$R_i = DG+S_i$ (M)	$\Theta = Tan^{-1}(C/S)$	$H= R_i \tan \Theta$ (M)	Fr force “f” (N)	Controllingforce “F” (N)

9	Sample Calculations	For N= rpm frictional force(f) $=\{(N^2 * M*g *H_i) / P*895\} - \{m *g +M*g\}$ Where P=b/a b= distance between C.F & sleeve a= distance between sleeve & ball
10	Graphs, Outputs	1.Controlling force(F) vs Speed(N_i) 2 .Controlling force(F) vs Height of the govrner(H_i) 3. Controlling force(F) vs Radius of rotation(R_i) 4.Frictional Force (f) vs Speed (N_i)
11	Results &Analysis	1. Sensitiveness of governor = ____________ 2. Governor effort = ____________________
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 07: Determination of pressure distribution in Journal bearing

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	

1	Title	Determination of pressure distribution in Journal bearing
2	Course Outcomes	Apply and understand the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing.
3	Aim	To study the pressure distribution in Journal Bearing under different experimental conditions(load,speed or clearance) and verify the same theoretically.
4	Material / Equipment Required	Lab Manual
5	Theory, Formula, Principle, Concept	➢ A journal bearing supports a shaft and permits rotary motion. ➢ Due to friction between contact surfaces there is a wearing of surfaces and generation of heat. It results loss of power. ➢ To minimize this, lubricating oil is introduced in the clearance between the journal and bearing . This provides a thin film, separating the contact surfaces. ➢ The amount of separation depends upon the thickness of the film formed. ➢ Thickness of film depends upon pressure developed in the annular clearance. ➢ Magnitude of pressure is a function of dimension of bearing, speed of rotation, load on the bearing properties of lubricant and oil leakage from the surfaces. ➢ The study of pressure distribution and variables associated with the bearing can be used for design purposes.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. Fill the oil tank with lubricating oil(SAE 30) under test & position the tank at desired height. 2. Drain out air bubbles from all the manometer tubes as well as from the inlet tube. 3. Ensure that that level of oil in manometer tubes and supply tank is same. Note down the initial manometer reading(P_o). 4. Check and ensure that the dimmer stat knob is at zero position. 5. Switch on the motor and note down the direction of rotation. 6. Rotate the dimmer stat knob gradually till the desired speed is reached.

9		7. Add desired loads and adjust the balancing weights provided, so that the loading arm is vertical. (This provision not available). 8. Run the set-up at this speed and load till the oil levels in all the manometer tubes are in steady state. 9. Note down the pressure of oil in all manometer tubes and tabulate them. 10. Change the speed or load or clearance and repeat the experiment if necessary. 11. After the experiments is over remove the load. 12. Bring down the speed to zero and switch of the motor and main supply. 13. The difference in manometer pressure at each tapping to be plotter.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	Direction of rotation of bearing: Supply head(P_o): Speed of rotation: Load on the bearing:

Tape No.	Pressure head (P) in cm	($P-P_o$) in cm
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

9	Sample Calculations	
10	Graphs, Outputs	1. Graph to be plotted for pressure head of oil above the supply head in cm of oil at angular intervals of 30^o of oil film. 2. Graph to be plotted for pressure head vs pressure taping in axial directions.

11	Results &Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 08 : Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes						
2	Course Outcomes	To measure strain in various machine elements using strain gauges						
3	Aim	To determine the magnitude of principle stresses & its direction						
4	Material / Equipment Required	Lab manual						
5	Theory, Formula, Principle, Concept	The purpose of rosette apparatus is to determine the magnitudes & directions of principal stresses σ_1 & σ_2 under bi-axial state of stress (plane stress condition). One of the popular methods of strain analysis is by using the electrical resistance strain gauges. The gauges work on the principle that when a thin resistance wire undergoes deformation, its resistance changes in proportion to the amount of strain it undergoes. Actual strain is calculated directly by measuring change in resistance & by using equations governing the relationship between strain & resistance change. Electric circuits like wheat stone's bridge or potentiometer are also used in the analysis by strain gauges. In direction of principal stresses, strain gauges should be aligned in the direction of principal stresses. However, often we encounter situations in which direction of principal stresses are unknown. In these situations, use of strain gauge rosette is made. A group of 3 to 4 strain gauges arranged in some configuration is called as a rosette. Gauges are placed at certain angular rotation. Theoretically, gauges in the rosette can be placed at any angle but due to practical considerations, 2 or 3 sets of values are used. In the 3-element strain rosette, the rectangular and delta configurations are employed. In the former, 2 gauges are placed at right angles while the 3rd gauge makes an angle of 45º with both gauges. In the delta configuration, gauges are placed in a 60º angle. The strain is defined as the ratio of change in mechanical property to the original property. Since the change in length of the material is very small, so it's always read in terms of micro strain. Since it's difficult to measure the length resistance, strain gauges are used to measure strain in material directly. It is necessary to measure 3 strains at a point completely defined by either stress or strain fields. The different arrangements are:- a. 3 element rectangular rosette. b. 3 element delta rosette. c. 4 element rectangular rosette etc. $\xi_A = \xi_{XX}\cos^2\theta_A + \xi_{YY}\sin^2\theta_A + \gamma_{XY}\sin\theta_A\cos\theta_A$. $\xi_B = \xi_{XX}\cos^2\theta_A + \xi_{YY}\sin^2\theta_A + \gamma_{XY}\sin\theta_B\cos\theta_B$. $\xi_C = \xi_{XX}\cos^2\theta_A + \xi_{YY}\sin^2\theta_A + \gamma_{XY}\sin\theta_C\cos\theta_C$. But $\theta_A = 0^O$, $\theta_B = 45^O$, $\theta_C = 90^O$. If $\theta_A = 0^O \Rightarrow \xi_A = \xi_{XX}\cos 2\theta = \xi_{XX}$. $\theta_B = 45^O \Rightarrow \xi_B = [\xi_{XX} + \xi_{YY} + \gamma_{XY}]^{1/2}$. $\theta_C = 90^O \Rightarrow \xi_C = \xi_{YY}$. $\gamma_{XY} = 2\xi_B - \xi_{XX} - \xi_{YY}$. $\gamma_{XY} = 2\xi_B - \xi_A - \xi_B$. Principle strains are: $\xi_{1,2} = [\xi_{XX} + \xi_{YY}]/2 \pm 1/2\sqrt{}\ (\xi_{XX} - \xi_{YY})^2 + \gamma^2_{XY}$. $\xi_{1,2} = [\xi_A + \xi_C]/2 \pm 1/2\sqrt{}\ (\xi_A - \xi_C)^2 + (2\xi_B - \xi_A - \xi_C)^2$.							

		Orientation: - $\theta = \frac{1}{2}\tan^{-1}[\sqrt{\gamma_{XY}}/(\xi_{XX} - \xi_{YY})]$. $= \frac{1}{2}\tan^{-1}[(2\xi_B - \xi_A - \xi_C/(\xi_A - \xi_C)]$. Principle stresses: - $\sigma_1 = \frac{E\ (\xi_1 + \gamma\xi_2)}{(1-\gamma^2)}$, $\sigma_2 = \frac{E\ (\xi_2 + \gamma\xi_1)}{(1-\gamma^2)}$,
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. Switch ON the apparatus 2. Set the apparatus of the strain indicator to Zero for no load condition 3. Apply the load on specimen & notedown the strain in different direction 4. Repeat this procedure for different loads. 5. Calculate the stress & angular inclinations in different loads.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	Young's Modulus(E)= $2X10^5$ N/mm^2 Poisson's ratio (□)= 0.3

Sl. No.	Pressure Applied 'P'Kg/m^2	Strain $\square_a$	Strain $\square_b$	Strain $\square_c$	$\square_1$	$\square_2$	□

9	Sample Calculations	**1.** Stress($\square_{1,2}$) = $E[(\square_a + \square_c)/2(1-\square) \pm \frac{1}{2(1+\square)}\square\ (\square_a + \square_c)^2 + (2\square_b - \square_a - \square_c)^2]$ $2(1+\square)$ **2.** Tan $2\square = (2\square_b - \square_a - \square_c)/(\square_a - \square_c)$
10	Graphs, Outputs	
11	Results &Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

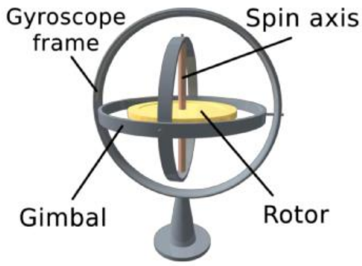
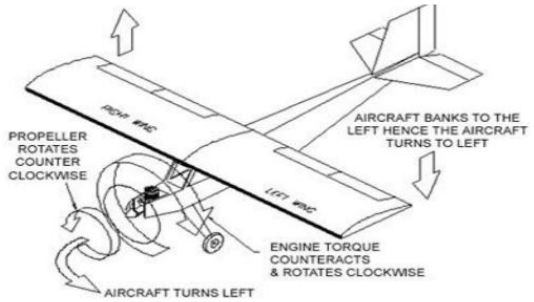
Experiment 09 : Determination of stresses in curved beam using strain gauge.

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Determination of stresses in curved beam using strain gauge.						
2	Course Outcomes	Design the logic for a given problemTo determine principle stress and strain in a member subjected to combined loading using strain gauges.						
3	Aim	To determine principle stress and strain in a member subjected to combined loading using strain gauges.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	A beam in which the neutral axis in the unloaded condition is curved instead of straight or if the beam is originally curved before applying the bending moment, are termed as "Curved Beams Curved beams find applications in many machine members such as c – clamps, crane hooks frames of presses, chains, links, and rings						
6	Procedure, Program, Activity, Algorithm,	1. Measure dimensions of the curved beam and the location and the orientation of each strain gauge.						

	Pseudo Code	2. Number strain gauges and connect them to the strain gage indicator in the same order. 3. Balance the circuit for each strain gage. If it is not possible to set zero in the indicator, record the initial reading. 4. Set the gage factor for the strain gages used in this experiment. 5. Apply load gradually on the curved beam by adding weights and record the final strain readings at that load. 6. Determine the stresses at inner and outer layer of beam.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	1. Outer radius of beam, ro=_______ mm 2. Inner radius of beam, ri=________mm 3. Radius of beam to central axis, rc=______mm 4. Young‟s modulus, E= 210GPa
9	Sample Calculations	1. Neutral radius, mm 2. Eccentricity, e = rc-rn mm 3. Distance from neutral axis to inner radius, Ci = rn-ri , mm 4. Distance from neutral axis to outer radius, Co = ro-rn , mm 5. Stress at inner layer, 6. Stress at outer layer, 7. Experimental stress, $\sigma = E\times\varepsilon$ N/mm2
10	Graphs, Outputs	
11	Results &Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 10 : Experiments on Gyroscope (Demonstration only)

-	Experiment No.:	1	Marks		Date Planned		Date Conducted	
1	Title	Experiments on Gyroscope (Demonstration only)						
2	Course Outcomes	understand the working principles of machine elements such as Gyroscopes						
3	Aim	To study the gyroscopic behavior of rotating masses.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	The earliest observation and studies on gyroscopic phenomenon carried out during Newton‟s time. These were made in the context of the motion of our planet which in effect in a massive gyroscopic. The credit of the mathematical foundation of the principles of gyroscopic motion goes to Euler who derived at set of dynamic equation relating applied mechanics and moment inertia, angular acceleration and angular velocity in many machines, the rotary components are forced to turn about their axis other than their own axis of rotation and gyroscopic effects are thus setup. The gyroscopes are used in ships to minimize the rolling & pitching effects of water. A Gyroscope is a spinning body mounted universally to turn with an angular velocity of precession in a direction at right angles to the direction of the moment causing it but its center of gravity will be in a fixed position. The gyroscope has 2 degrees of freedom. The first axis is OX called spin axis on which the body is spinning. The second axis is OY called Torque axis. Third axis OA is called precession axis on which the body moves opposing the original motion. All the 3 axis are mutually perpendicular. Such a combined effect is known as Gyroscopic effect. The analyses of gyroscopic principles are based on Newton's Laws of Motion and inertia. When the rotor is spinned, the gyroscope exhibits the following two important characteristics: 1. Gyroscopic Inertia 2. Precession						

6	Procedure, Program, Activity, Algorithm, Pseudo Code	1. Connect the motor of the gyroscope to an A.C. supply through dimmer stat. 2. Using spirit level, check the rotor for vertical position. Adjust the balance weight slightly if required using the bottom clamp screws. 3. Set the dimmer at zero position and put ON the supply. 4. Start the motor by applying the voltage of around 170(for instant build up of voltage) and then reduce gradually. 5. Adjust the rotor speed if required 6. Note down the rotor speed with the help of a tachometer when it becomes steady. 7. Place the required wt. on the wt. stud and at the same instant start the stop watch. Note down the time required for □ degree of precession. 8. Repeat the procedure for different weights and precessions. 9. Measure and record the distance between the center of the disc and center of weight stud. 10. Tabulate the results. 11. Determine and compare the gyroscopic couple with that of applied torque and plot the following curves: i. Calibration curve ii. Gyroscopic couple Vs Precession.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	 
8	Observation Table, Look-up Table, Output	Rotor Diameter = 245 mm Rotor thickness = 10 mm M.I. of all Rotating Parts = 0.02986 Nm- sec 2 Sri Jayachamarajendra College of Engineering, Mysuru-06 Page 17Department of Mechanical Engineering Design Lab Manual Distance from centre of Disc to Centre of Dead Weights = 0.155 m Motor speed Max = 6000 rpm

peed of motor N rpm	Applied load W		Angle of precession □ Degrees	Time taken for precession „t" Sec	Angular velocity □ rad / s	Torque applied T Nm	Experiment velocity of precession □ Pe rad / s	Theoretical velocity of precession □ PT rad / s
	K	N						

9	Sample Calculations	

10	Graphs, Outputs	
11	Results &Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

F. Content to Experiment Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Expt-#	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)	3	L3 (Apply)	L3 (Apply)	Vibration	Demonstrate	Viva & presentation
2	Determination of critical speed of rotating shaft.	3	L3 (Apply)	L3 (Apply)	critical speed	Demonstrate	Viva & presentation
3	Balancing of rotating masses.	3	L3 (Apply)	L3 (Apply)	Balancing	Demonstrate	Viva & presentation
4	Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)	3	L3 (Apply)	L3 (Apply)	Photo-elastic	Demonstrate	Viva & presentation
5	Determination of stress concentration using Photo elasticity for simple components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane hook.	3	L3 (Apply)	L3 (Apply)	stress concentration	Demonstrate	Viva & presentation
6	Determination of equilibrium speed, sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.	3	L3 (Apply)	L3 (Apply)	speed	Demonstrate	Viva & presentation
7	Determination of pressure distribution in Journal bearing	3	L3 (Apply)	L3 (Apply)	Hydrodynamic Lubrication	Demonstrate	Viva & presentation
8	Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes	3	L3 (Apply)	L3 (Apply)	Strain rosettes	Demonstrate	Viva & presentation
9	Determination of stresses in curved beam using strain gauge.	3	L3 (Apply)	L3 (Apply)	Strain guage	Demonstrate	Viva & presentation
10	Experiments on Gyroscope (Demonstration only)	3	L2 understand	L2 understand	Gyroscopic effect	Demonstrate	Viva & presentation

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Expt - #	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology,	Course Outcome **Student Should be able to ...**

				for learning or outcome)	4.Benchmark)	
A	I	J	K	L	M	N
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping Co-efficient in a single degree of freedom vibrating systems (longitudinal and torsional)	Vibration	Vibration	Apply the natural frequency, logarithmic decrement, damping ratio and damping.	Action Verb : Understanding Knowledge : condition : Vibration	Apply the natural frequency, logarithmic decrement, damping ratio and damping.
2	Determination of critical speed of rotating shaft.	critical speed	critical speed	Apply for different diameter of shaft to find critical speed.	Action Verb : Analyzing Knowledge : Record structure Speed	Apply for different diameter of shaft to find critical speed.
3	Balancing of rotating masses.	Balancing	Balancing	Applying the forces and couples in rotating mechanical system.	Action Verb : Evaluate Knowledge of Balancing	Applying the forces and couples in rotating mechanical system.
4	Determination of fringe constant of Photo-elastic material using Circular disk subjected diametric compression, Pure bending specimen (four point bending)	Photo-elastic	Photo-elastic	Apply the load on circular disk subjected to diametrical compression, pure bending	Action Verb : Evaluate Knowledge : PhotoElasticity	Apply the load on circular disk subjected to diametrical compression, pure bending
5	Determination of stress concentration using Photo elasticity for simple components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane hook.	stress concentration	stress concentration	Apply the load for simple components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane hook.	Action Verb : Analyzing Knowledge Stress Concentration	Apply the load for simple components like Plate with hole under tension or bending, circular disk with circular hole under compression, 2-d crane hook.
6	Determination of equilibrium speed,	speed	speed	Apply the equilibrium speed, sensitiveness, power and effort	Action Verb : Creating Knowledge of Speed	Apply the equilibrium speed, sensitiveness, power and effort

	sensitiveness, power and effort ofPorter/ Proel / Hartnell Governor.			ofPorter/ Proel / Hartnell Governor.		ofPorter/ Proel / Hartnell Governor.
	Determination of pressure distribution in Journal bearing	Hydrodynamic Lubrication	Hydrodynamic Lubrication	Apply and understand the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing.	Action Verb : Analyzing Knowledge Hydrodynamic Lubrication	Apply and understand the minimum film thickness, load carrying capacity, frictional torque and pressure distribution of journal bearing.
	Determination of principle stresses and strain in a member subjected to combined loading using strain rosettes	Strain rosettes	Strain rosettes	To measure strain in various machine elements using strain gauges	Action Verb : Analyzing Knowledge Strain rosettes	To measure strain in various machine elements using strain gauges
	Determination of stresses in curved beam using strain gauge.	Strain guage	Strain guage	Apply the stresses in curved beam using strain gauge.	Action Verb : Analyzing Knowledge Strain guage	Apply the stresses in curved beam using strain gauge.
	Experiments on Gyroscope (Demonstration only)	Gyroscopic effect	Gyroscopic effect	understand the working principles of machine elements such as Gyroscopes	Action Verb : Analyzing Knowledge Gyroscopic effect	understand the working principles of machine elements such as Gyroscopes