I

Name _____

Roll No. _____ Year 20____20____

Exam Seat No. _____

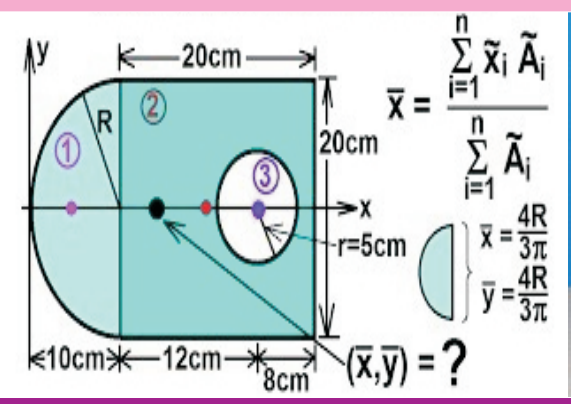
CIVIL, MECHANICAL & CHEMICAL GROUPS | SEMESTER - II | DIPLOMA IN ENGINEERING AND TECHNOLOGY

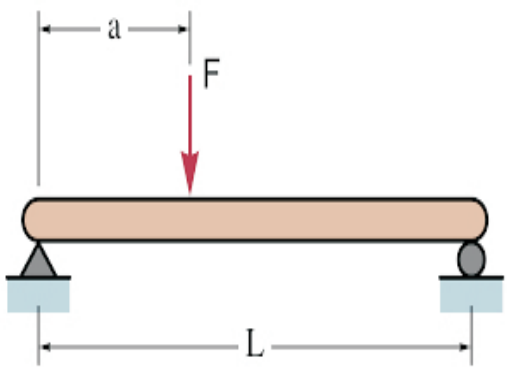
A LABORATORY MANUAL

FOR

APPLIED MECHANICS

(22203)





MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual for

Applied Mechanics

(22203)

Semester-II

(CE/CR/CS/ME/AE/PG/PT/FG/CH)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on December, 2017)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms. …… Roll No. ……., of First Semester of Diploma in…….. …… of Institute,…….…….. …… (Code: ……...) has completed the term work satisfactorily in Subject **Applied Mechanics (22203)** for the academic year 20…….. to 20…….. as prescribed in the curriculum.

Place: …… Enrollment No:……

Date: …… Exam. Seat No: ……

Subject Teacher **Head of the Department** **Principal**

Seal of Institution

Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

In day-to-day working we come across different types of structures created for different purposes and functions. While designing the structures, analysis of forces and stresses is an important and prerequisite step. Correct analysis is possible only when one knows the types and effects of forces acting on the structures. This course provides the scope to understand fundamental concepts of laws of mechanics and their applications to different engineering problems. This course is designed to provide basic understanding about the different types of forces, moments and their effects on structural elements, which will analyse different structural systems.

Although best possible care has been taken to check for errors (if any) in this laboratory manual,perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Programme Outcomes (POs) to be achieved through Practical

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to dayengineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

PO 4. Engineering tools: Apply Mechanics related technologies and tools with its limitations.

PO 5. The engineer and society: Assess social, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Engineering mechanics.

PO 6. Environment and sustainability: Apply basic engineering solutions also for sustainable development practices in social and environmental contexts usingLaws of Mechanics.

PO 7. Ethics: Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of Engineering mechanics.

PO 8. Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO 9. Communication: Communicate effectively in oral and written form.

PO10.Life-long learning: Engage in independent and life-long learning activities in the context of technological changes in the engineering and allied industries.

PSO2. Equipment and Instruments: Maintain machine, equipment and instrumentsrelated to Mechanical Engineering.

Practical- Course Outcome matrix

Course Outcomes (COs):

- **a.** Identify the force systems for given conditions by applying the basics of mechanics.
- **b.** Select the relevant simple lifting machine(s) for given purposes.
- **c.** Determine unknown force(s) of different engineering systems.
- **d.** Check the stability of various force systems.
- **e.** Apply the principles of friction in various conditions for useful purposes.
- **f.** Find the centroid and centre of gravity of various components in engineering systems.

Sr. No.	Title of the Practical	CO a.	CO b.	CO c.	CO d.	CO e.	CO f.
1.	Identify various Equipment related toApplied Mechanics.	√	-	-	-	-	-
2.	Use Differential Axle and Wheel.	-	√	-	-	-	-
3.	Use Simple Screw Jack.	-	√	-	-	-	-
4.	Use Worm and Worm Wheel.	-	√	-	-	-	-
5-A	Use Single Purchase Crab.	-	√	-	-	-	-
5-B	Use DoublePurchase Crab.	-	√	-	-	-	-
6-A	Use Weston's Differential Pulley Block.	-	√	-	-	-	-
6-B	Use of Wormed Geared Pulley Block.	-	√	-	-	-	-
7. & 8.	Use Force Table to Determine Resultant of Concurrent Force system applying Law of Polygon of Forces.	-	-	√	-	-	-
9.	Graphically DetermineResultant of ConcurrentForce system.	-	-	√	-	-	-
10.	Graphically DetermineResultant of ParallelForce system.	-	-	√	-	-	-
11.	Use Law of Moment Apparatus to Determine unknown Forces.	-	-	√	-	-	-
12.	Apply Lami'sTheorem to Determine unknown Force.	-	-	-	√	-	-
13.	Determine Support Reactions for Simply Supported Beam.	-	-	-	√	-	-
14.	Determine Coefficient of Friction for Motion on Horizontal Plane.	-	-	-	-	√	-
15.	Determine Coefficient of Friction for Motion on Inclined Plane.	-	-	-	-	√	-
16.	DetermineCentroid of Geometrical Plane Figures.	-	-	-	-	-	√

List of Industry Relevant Skills

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences. **Use principles of applied mechanics to solve broad-based engineering related problems.**

The practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented relevantskills*** associated with the above mentioned competency.

1 Identify the force systems for given conditions by applying the basics of mechanics.

2 Select the relevant simple lifting machine(s) for given purposes.

3 Determine unknown force(s) of different engineering systems.

4 Check the stability of various force systems.

5 Apply the principles of friction in various conditions for useful purposes.

6 Find the centroid and centre of gravity of various components in engineering systems.

Guidelines to Teachers

1. Learning Overview**:** To develop better understanding of importance of the subject through intellectual skills and motor skills.
2. Know your laboratory work**:** To understand the layout of laboratory, specifications of equipment/instrument/materials, procedure, working in groups, planning time etc. also to know total amount of work to be done in the laboratory.
3. Teachers shall ensure that required equipment are in working condition before start each experiment, also keep operating instruction manual available.
4. Explain prior concepts to the students before starting of each experiment.
5. While taking reading /observation each student shall be given a chance to perform/observe the experiment.
6. Teachers shall allot the question to the students from the list given at the end of experiment/exercise.
7. If the experiment set up has variations in the specifications of the experiment, the teachers are advised to make the necessary changes, wherever needed.
8. Time to Time continuous assessment of the students should be done.
9. Teacher should ensure that the respective skills are developed in the students after the completion of the practical exercise.
10. Focus should be given on development of enlisted skills rather than theoretical knowledge.
11. Teachers should organized Group discussions/brain storming sessions/seminars to facilitate the exchange of knowledge amongst the students.

Instructions for Students

Students shall read the points given below for understanding the theoretical concepts and practical applications.

1. Student shall undergo study visit of the laboratory for types equipment,instrument,materialto be used,before performing experiments.
2. Organize the work in the group and make a record of all observations.
3. Students should not hesitate to ask any difficulty faced during conduct of practical hours if possible or afterwards but immediately.
4. Write the answers of questions given in the laboratory manual and practice to write the answers to these questions.
5. Student should develop the habit of pear discussions/group discussion related to the experiment/exercise so that exchanges of knowledge /skills could take place.
6. Student shall attempt to develop related hands-on skills and gain confidence.
7. Students shall visit the nearby workshop,workstation,industries,laboratories,technical exhibitions,trade fair etc.even not included in the lab manual .In short,students should have exposure to the area of work right in the student hood.
8. Students should develop the habit of not to depend totally on teachers but to develop self-learning techniques.
9. Student should develop habit to submit the practical exercise continuously and progressively on the scheduled dates and should get the assessment done.

Content Page

List of Practicals and Progressive Assessment Sheet

Sr. No.	Title of the practical	Page No.	Date of performance	Date of submission	Assessment marks (25)	Dated sign. of Teacher	Remarks (if any)
1.	Identify various Equipments related to Applied Mechanics.	1					
2.	Use Differential Axle and Wheel.	10					
3.	Use Simple Screw Jack.	19					
4.	Use Worm and Worm Wheel.	27					
5-A.	Use Single Purchase Crab.	36					
5-B.	Use Double Purchase Crab.	45					
6-A.	Use Weston's Differential Pulley Block.	55					
6-B.	Use of Wormed Geared Pulley Block.	64					
7. & 8.	Use Force Table to Determine Resultant of Concurrent Force system applying Law of Polygon of Forces.	73					
9.	Graphically Determine Resultant of Concurrent Force system.	82					
10.	Graphically Determine Resultant of Parallel Force system.	90					
11.	Use Law of Moment Apparatus to Determine unknown Forces.	99					
12.	Apply Lami's Theorem to Determine unknown Force.	105					
13.	Determine Support Reactions for Simply Supported Beam.	114					
14.	Determine Coefficient of Friction for Motion on Horizontal Plane.	121					
15.	Determine Coefficient of Friction for Motion on Inclined Plane.	129					
16.	Determine Centroid of Geometrical Plane Figures.	137					
Total							

* To be transferred to proforma of CIAAN 2017.

Practical No. 01: Equipments Related To Applied Mechanics

I Practical Significance

In Civil Engineering to solve problems we need knowledge of machines, equipment which are used in practice. Many times there is a need to lift the loads. Depending upon the type of load, intensity of load and other site conditions different lifting machines are used. After performing this experiment Diploma Engineer able to decide the suitability of machine.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments relatedto Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Identify the force systems for given conditions by applying the basics of mechanics.

IV Practical Outcome

Identify various equipment related to Applied Mechanics.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

Identifying various equipments in the laboratory.

VI Relevant Affective domain related

Follow safety practices.

VII Minimum Theoretical Background

Equipments Related to Applied Mechanics:

Engineering Mechanics: Mechanics is a branch of science which deals with the study of forces and their effects on bodies either at rest or in motion.

Force: A force can be defined as an external stimulus (or action) which tends to change the state of body.

Force system: The two or more forces acting on a body forms the system of forces.

Classification of force system: Coplanar and Non coplanar force system**.**

Equilibrium: When the system of forces acting on the body keeps the body at rest condition it is said to be in equilibrium.

Machine: A machine is a device which receives energy in some form and utilizes this energy doing some useful work. A simple machine is a mechanical device which can change

the direction and magnitude of a force or effort and makes work easier. Before starting the study of simple machine we need know some basic terms which are needed for analysis and problem solving purposes.

Effort: A machine is driven by applied force. This applied force is called the Effort.

Load: The resistance of force which is overcome is hoisted up to a certain distance is called theLoad.

Mechanical Advantage: The ratio of output force to input force is called as Mechanical Advantage**.**

Velocity Ratio: The ratio of distance moved by effort to the distance moved by load is called as Velocity Ratio.

Efficiency: The ratio of output of machine to its input is calledmechanical Efficiency.

Loss of Energy: Loss of energy mainly occurs due to friction and also due to deformation and wear.

Ideal Machine: An ideal machine is hypothetical system, where energy and power are neither lost nordissipated through friction, deformation and wear.

Reversibility: Some times, a machine is also capable of doing some work in the reverse direction, afterthe effort is removed. Such machine is called reversible machine and its action is known as reversibility of the machine. (Its efficiency is more than 50%)

Irreversibility: Some times, a machine is not capable of doing some work in the reverse direction, afterthe effort is removed. Such machine is called Non-reversible machine or self locking machine. (Its efficiency is less than 50%)

Law of Machine: The relationship between load and effort is called law of machine.

Mathematically: $P = (m\ W) + C$

Where,

P = Effort applied on the machine.

W= Load lifted by machine.

m and C are constants

VIII Experimental Set-up

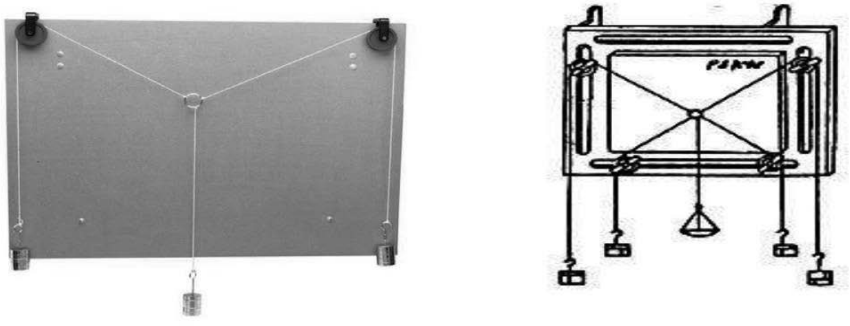
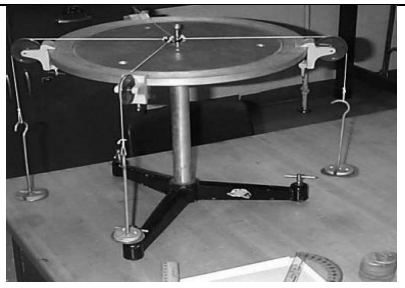
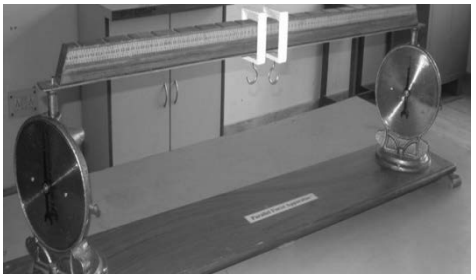
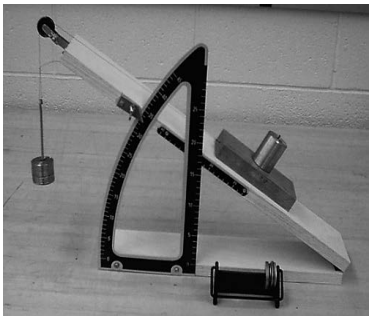
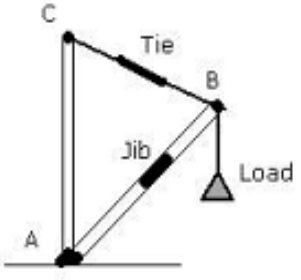
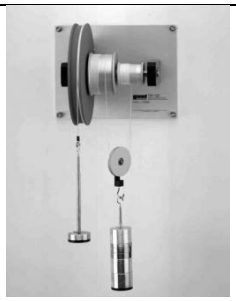
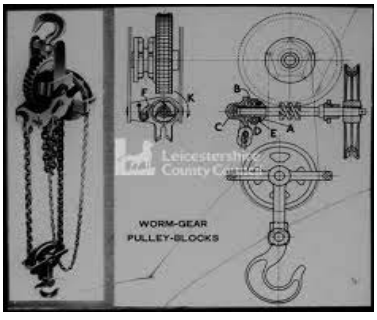
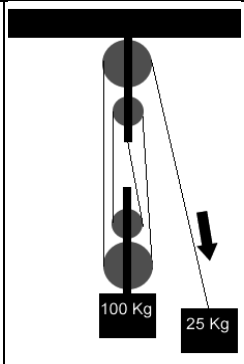
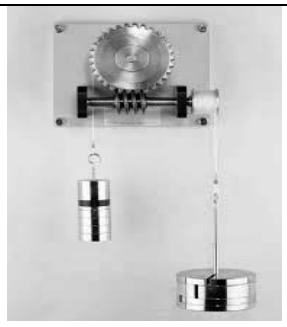
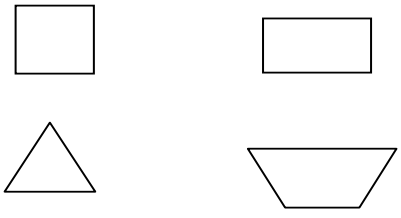


Figure: Lami's Theorem Apparatus & Polygon law Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark (Photos)
1	Universal Force Table Apparatus	Universal Force Table (Consists of a circular 40 cm dia. Aluminum disc, graduated into 360 degrees.) with all accessories.	01	
2	Beam Reaction Apparatus	Beam Reaction apparatus (The apparatus is with two circular dial type 10 kg.)	01	
3	Inclined Plane Friction Apparatus	Friction apparatus for motion along horizontal and inclined plane (base to which a sector with graduated arc and vertical scale is provided. The plane may be clamped at any angle up to 45 degrees. Pan. Two weight boxes (each of 5 gm,10 gm, 2-20 gm, 2-50 gm, 2-100 gm weight)	01	
4	Jib Crane Apparatus	Jib crane consist of compression member 16mm dia. of aluminum pipe with 10kg capacity . Tie member-having chain with spring balance 10 kg capacity. Vertical post with wooden base. Weights 1 to 10kg.	01	 Experimental setup

5	Differential Axle and Wheel	Differential axle and wheel (wall mounted unit with the wheel of 40 cm diameter and axles are insteps of 20 cm and 10 cm reducing diameter .	01	
6	Weston's Differential Pulley Block	Weston's Differential pulley block (consisting of two pulleys; one bigger and other smaller.	01	
7	Geared Pulley Block	Weston's Differential worm geared pulley block (Consists of a metallic (preferably steel) cogged wheel of about 20 cm along with a protruded load drum of 10 cm diameter to suspend the weights of 10 kg, 20 kg-2 weights and a 50 kg weights)	01	
8	Simple Screw Jack	Simple Screw Jack (Table mounted metallic body , screw with a pitch of 5 mm carrying a double flanged turn table of 20 cm diameter.	01	
9	Single Purchase Crab	Single Purchase Crab winch (Table mounted heavy cast iron body. The effort wheel is of C.I. material of 25 cm diameter mounted on a shaft of about 40mm dia. on the same shaft a geared wheel of 15 cm dia.	01	

10	Double Purchase Crab	Double Purchase Crab winch (Having assembly same as above but with double set of gearing arrangement.)	01	
11	Two Sheave and Three Sheave Pulley Block	Two sheave pulley blocks with string weights and spring balance. Three sheave pulley blocks with string weights and spring balance.	01	
12	Worm and Worm Wheel	Worm and worm wheel (wall mounted unit with threaded spindle, load drum, effort wheel; with necessary slotted weights, hanger and thread)	01	
13	Geometrical Figures	Geometrical figures. (Square, Rectangle, Triangle. Trapezium etc. made of plywood.	01Set	

X Procedure:-

1. Conduct the visit to the laboratory.
2. Give introduction of each machine and apparatus.
3. Categorize the various lifting machine.
4. Demonstrate the application of forces and loads.
5. Student will apply force to the hangers to lift the load.

XI Precautions to be followed

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XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Identify different machines and apparatus in the laboratory and name different parts of machines and apparatus.

XVI Results

1. Name of identified machine a) ……
2. Names of identified parts a) …… b) …… c) …… d) ……

XVII Interpretation of results(Give meaning of the above obtained results)

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……

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. How many lifting machines are there in laboratory? Name them.
2. Name the lifting machines which can be used to lift heavy load.
3. Name the lifting machines which can be used to lift light weight load.
4. Name any two lifting machines with gears.
5. Name a lifting machine with two sets of gears.
6. Name the lifting machines in which load goes back after removing effort?
7. What is maximum load carrying capacity of beam apparatus on dial?
8. Identify the type of support for a beam which is in laboratory.
9. How many forces are acting in Lami's experiment?
10. How many forces are acting in Polygon Law of Forces?
11. Name the type of force system in Lami's experiment and Polygon law of forces.
12. Wedge is a machine. Justify.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	BhattacharyyaBasudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the lifting machine.	5%
2	Identifying the apparatus other than lifting machine.	20%
3	Identifying the different parts of equipments.	20%
4	Applying load and effort to any one lifting machine.	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
1	Answers to practical related questions.	30%
2	Submission of report in time.	10%
Total: 25 Marks		**100%**

List of Student Team Members

1……..

2……..

3……..

4……..

5……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 02: Differential Axle and Wheel

I Practical Significance

Many times there is a need to lift the loads and depending upon the type of load, intensity of load and other site conditions different lifting machines are used. Differential Axle and Wheel machine is used to lift the smaller loads with constraint of space. After performing this experiment a Diploma Engineer will able to decide the suitability of Differential Axle and Wheel based on the given load lifting situation.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Select the relevant simple lifting machine for a given purpose.

IV Practical Outcome

Use Differential Axle and Wheel machine to lift smaller load.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices and precautions.

b. Demonstrate working as a leader/a team member.

c. Maintain tools and equipment.

VII Minimum Theoretical Background

Differential axle and wheel: It is different from simple axle and wheel machinebecause of its axle configuration. Instead of prismatic single axle in simple wheel and axle, step down axles are used in differential axle and wheel. This machine has a better mechanical advantage as compared to single axle and wheel.

Two axles of different diameters are coaxially fitted with the spindle, with which a wheel is also coaxially attached. The effort is applied through a wrapped string wound around this

wheel. Another string is wound over two axles and carries load with the help of movable pulley. The rope on the wheel and smaller axle are wound in the same direction, whereas that on the larger axle is in opposite direction. When an effort is applied through the wheel, the rope on the wheel and smaller axle gets unwound but gets wound on the larger axle, thus lifting the load.

$$\text{Velocity Ratio} = \frac{\text{Distance Travalled by Effort}}{\text{Distance Travalled by Load}}$$

$$= \frac{\pi D}{\frac{\pi(d_1 - d_2)}{2}} = \frac{2D}{(d_1 - d_2)}$$

Where,

D = Diameter of effort wheel.
d_1= Diameter of larger axle.
d_2= Diameter of smaller axle.

VIII Experimental Set-up

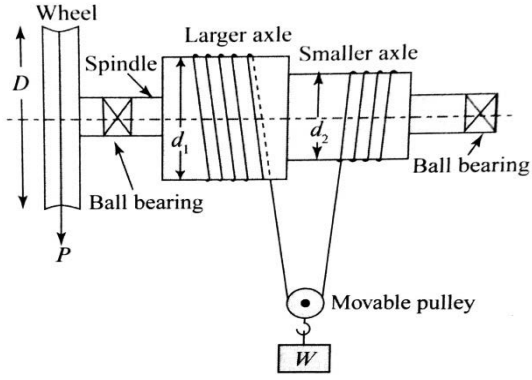

Figure: Differential Axle and Wheel

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Differential Axle and Wheel	Differential axle and wheel (wall mounted unit with the wheel of 40 cm diameter and axles are insteps of 20 cm and 10 cm reducing diameter .	01 for Group of 4 to 5 students	

X Procedure

1 Observe the machine carefully and identify the various components of machine.

2 Set the machine and check the reversibility of machine.

3 Calculate friction in the machine at zero load.

4. Apply the load starting with smaller magnitude.

5. Apply the effort for each corresponding load.

6. Record the observations of load and effort in observation table.

7. Take at least five readings.

8. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction.

9. Plot graphs viz. load against effort and load against efficiency.

XI Precautions to be followed

1 The reading must be taken and noted down carefully.

2 The load and effort should move slowly.

3 Effort must be applied gradually.

4 Any overlapping of the string must be avoided.

5 There should be no knot in the string.

6 Only light weights must be used during the course of experiment.

XII Actual procedure followed(Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

……
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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

$$VR = \frac{2D}{(d_1 - d_2)} =$$

1. D = ……..*mm*
2. d_1= ……..*mm*
3. d_2= ……..mm

Observation Table

Sr. No.	Load W (N)	Effort P (N)	M.A.	Velocity Ratio	Efficiency η (%)	Ideal Effort Pi (N)	Effort Lost in Friction P_f(N)
1							
2							
3							
4							
5							

Sample Calculations:

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{W}}{\text{P}} =$$

$$\text{Efficiency}(\eta) = \frac{\text{M.A.}}{\text{V.R.}} \times 100\% =$$

$$P_i = \frac{\text{W}}{\text{V.R.}} =$$

$$P_f = P - P_i =$$

Law of machine is $P = mW + C$

Where,

$$m = \text{Slope} = \frac{P_2 - P_1}{W_2 - W_1} =$$

C = Y intercept (i.e. Machine Friction) = ...N

XVI Results

1. The law of machine is $P = (.....).W + (.....)N$
2. The average efficiency of machine is =…… %

XVII Interpretation of results(Give meaning of the above obtained results)

1 Machine is ……

2 Friction loss is (i.e. Y- intercept = ……) reduced by …… the machine.

3 The graph between load and effort is a straight line which indicates…….

4 The graph between load and efficiency is a curve which indicates…….

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Write four field applications of Differential Axle and Wheel.
2. Can this machine is used to lift heavy load?
3. Weather the given machine is reversible or not? Give reason.
4. Write the principle used in increasing VR of differential axle and wheel than the simple axle wheel.
5. Write the purpose of using different sizes of axles.
6. What will happen if same sizes of axles are used?
7. Calculate maximum M.A. and maximum efficiency of machine from graph.
8. Determine the effort required to lift the load of 100kN from law of machine.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

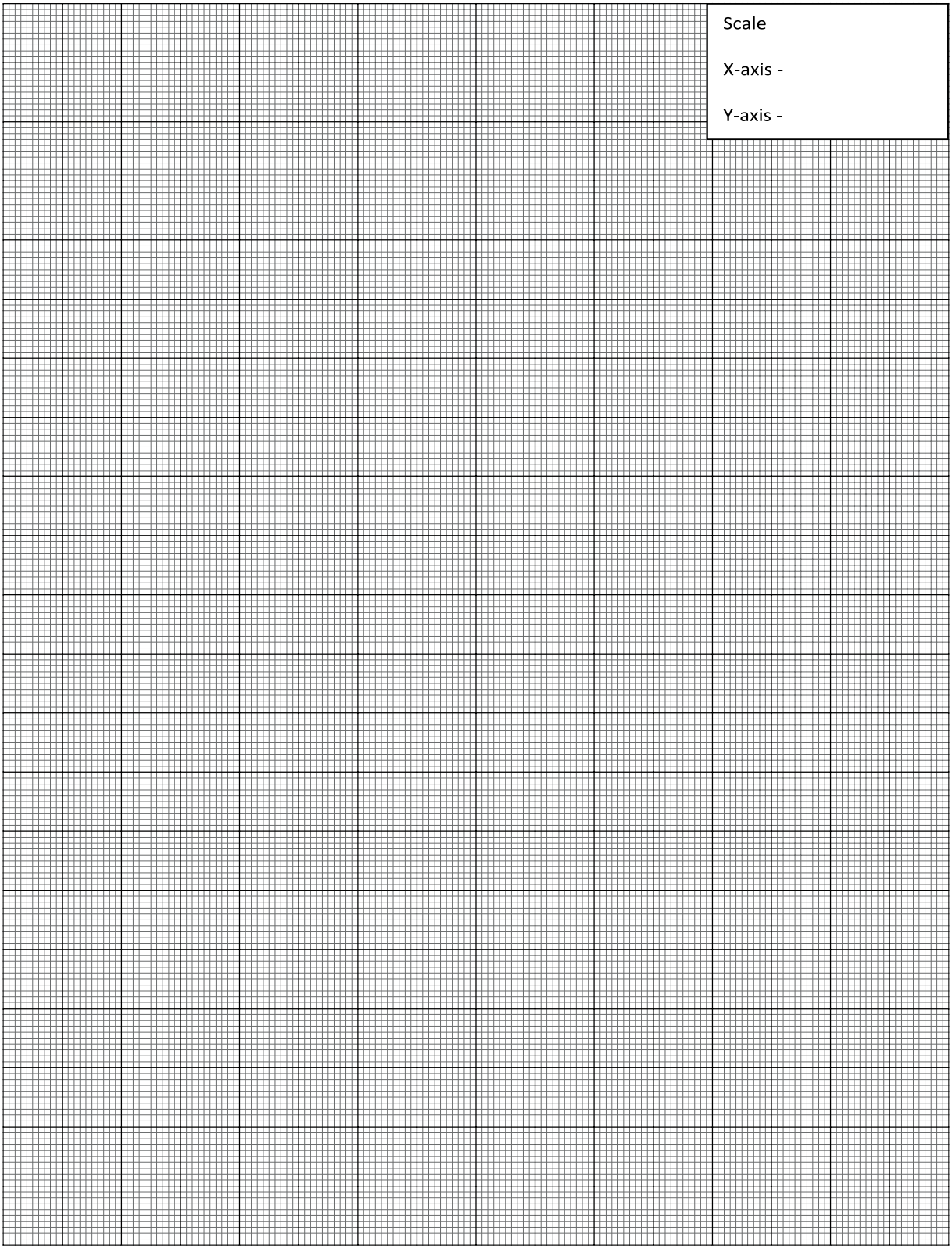
XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Determination of V.R. of machine.	10%
3	Applying load and determine effort of machine.	20%
4	Identify the type of machine i.e. Reversible or self locking.	10%
5	Calculation of parameters concerned.	10%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1 ……..
2 ……..
3. ……..
4.. ……..
5. ……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Practical No. 03: Simple Screw Jack

I Practical Significance

Many times there is a need to lift the loads and depending upon the type of load, intensity of load and other site conditions different lifting machines are used. Simple Screw Jack machine is used to lift heavy loads with constraint of space. After performing this experiment a Diploma Engineer will be able to decide the suitability of screw jack based on the given load lifting situation.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Select the relevant simple lifting machine for a given purpose.

IV Practical Outcome

Use Simple screw jack machine to lift heavy load.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Simple Screw Jack: A screw jack is a simple device which is used to lift heavy loads such as large vehicles. It mainly consists of three parts. A nut attached to a pedestal or stand, a large screw fitted within the nut and lever attached to the head of the screw. The weight which is to be lifted is placed on either on the head of the screw or on the platform attached to the screw. Sometimes a wheel is fixed at top and effort is applied tangentially to the circumference of the wheel. A screw thread is cut just like an inclined plane. The distance which the screw advances in one turn is called lead distance and distance measured between two consecutive threads is called pitch distance. The screw jack works on the principle similar to that of an inclined plane.

$$\text{Velocity Ratio} = \frac{\text{Distance Travelled by Effort}}{\text{Distance Travelled by Load}}$$

$$VR = \frac{2\pi R}{p}$$

Where, R =Length of Arm or Radius of Wheel

p = Pitch of the screw.

VIII Experimental Set-up

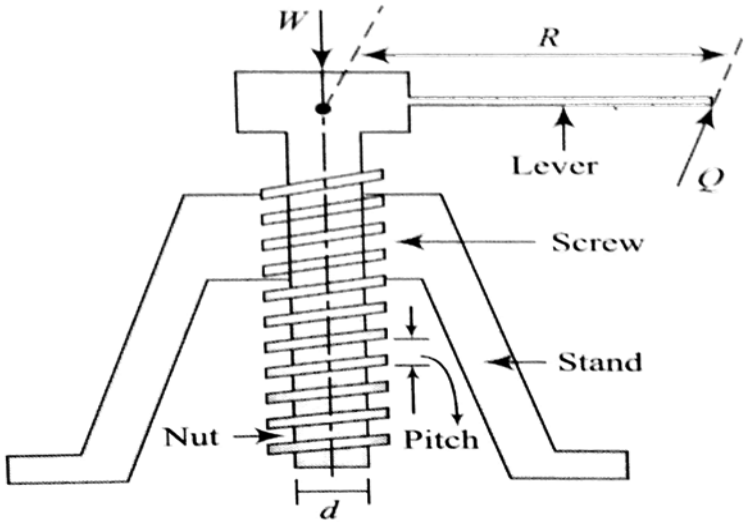

Figure: Simple Screw Jack

IXResources required

Sr.	Particulars	Specification	Quantity	Remark
1	Simple Screw Jack	Tablemounted Metallicbody, screw with a pitch of 5 mm carryingadouble flangedturn table of20 cm diameter.	01 forGroup of 4 to 5students	

X Procedure

1. Observe the machine carefully and identify the various components of machine.
2. Set the machine and check the reversibility of machine
3. Calculate friction in the machine at zero load.
4. Apply the load starting with smaller magnitude.

5. Apply the effort for each corresponding load.
6. Record the observations of load and effort in observation table. Take at least five readings.
7. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction for given screw jack.
8. Plot graphs load against effort and load against efficiency.

XI Precautions to be followed

1. Effort must be applied gradually.
2. The reading must be taken and recorded carefully.

XII Actual procedure followed(Use blank sheet provided if space not sufficient)

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XIII Resources used

	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
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XIIIV Precautions followed (To be written by students)

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XV Observations and Calculations(Use blank sheet provided if space not sufficient)

1. R = ……mm
2. P = ……mm

$$VR = \frac{2\pi R}{p} =$$

Observation Table

Sr. No.	Load W (N)	Effort P (N)	M.A.	Velocity Ratio	Efficiency η(%)	Ideal Effort Pi (N)	Effort Lost in Friction P_f(N)
1							
2							
3							
4							
5							

Sample Calculations:-

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{W}}{\text{P}} =$$

$$\text{Efficiency}(\eta) = \frac{\text{M.A.}}{\text{V.R.}} \times 100\% =$$

$$P_i = \frac{\text{W}}{\text{V.R.}} =$$

$$P_f = P - P_i =$$

Law of machine is $P = mW + C$

Where,

$$m = \text{Slope} = \frac{P_2 - P_1}{W_2 - W_1} =$$

C = Y intercept (i.e. Machine Friction) = ...N

XVI Results

1. The law of machine is $P = (.....).W + (.....)N$
2. The average efficiency of machine is =……. %

XVII Interpretation of results

a) Machine is ……

b) Friction loss is (i.e.Y- intercept = ……) reduced by …… the machine.

c) The graph between load and effort is straight line which indicates…….

d) The graph between load and efficiency is curve which indicates…….

XVIII Conclusions and Recommendations (if any)

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XIX Practical Related Questions

***Note**: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Write four field applications of screw jack.
2. What is the maximum load lifting capacity of given screw jack?
3. Can this machine is used to lift smaller loads?
4. Weather the given machine is reversible or not? Give reason.
5. Explain self locking condition is achieved? Is it advantageous?
6. Which is modified version of inclined plane?

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Determination of V.R. of machine.	10%
3	Applying load and determine effort of machine.	20%
4	Identify the type of machine i.e. Reversible or self locking.	10%
5	Calculation of parameters concerned.	10%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


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Y-axis -


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Y-axis -

PracticalNo. 04: Worm and Worm Wheel

I Practical Significance

Many times there is a need to lift the loads and depending upon the type of load, intensity of load and other site conditions different lifting machines are used. Worm and worm wheel machine is used to lift heavy loads with constraint of space. After performing this experiment a Diploma Engineer will be able to decide the suitability of Worm and worm wheel depending upon the given lifting situation.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3-Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Select the relevant simple lifting machine for a given purpose.

IV Practical Outcome

Use Worm and worm wheel machine to lift load.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices and precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Worm and Worm Wheel: A worm is square-threaded screw and worm wheel is a toothed wheel. Inthis machine, a worm and worm wheel are geared together maintaining their axes at right angles to each other. An effort wheel or pulley is attached to the worm coaxially so that effort can be applied through a rope wound over the pulley. A load is securely mounted

coaxially on worm wheel and load is connected with a separate rope wound around the load drum.

For single rotation of effort wheel, effort traverses a distance=πD. For an *n*- threaded worm, worm pushes the worm wheel through one tooth during single rotation of effort wheel. If the total number of teeth in a worm wheel is *T* push of one tooth means the load drum traverses through (*n/T*) rotations.

Thus, when the radius of load drum is *r,* distance moved by the load = $2\pi r \times (n/T)$.

Therefore, the velocity ratio,

$$VR = \frac{\pi D}{2\pi r\left(\frac{n}{T}\right)} = \frac{DT}{2nr}$$

Where,

D = diameter of effort wheel.

r = Radius of pulley.

T = No. of teeth on the worm wheel.

VIII Experimental Set up

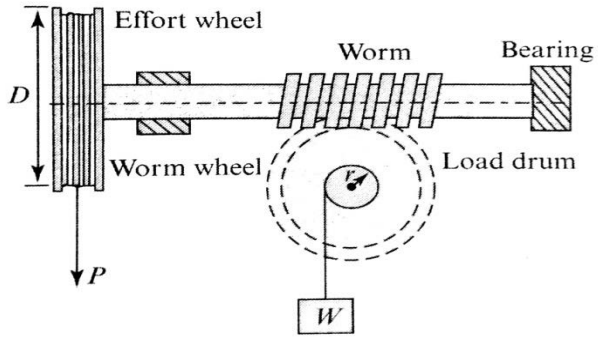

Figure: Worm and Worm Wheel

IX Resource Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Worm and Worm Wheel	Worm and worm wheel (wall mountedUnitthreaded spindle,loaddrum, effortwheel; with necessary slotted weights, hanger and thread).	01 set for Group of 4 to 5 students	

X Procedure

1. Observe the machine carefully and identify the various components of machine.
2. Set the machine and check the reversibility of machine.
3. Apply the load on load drum starting with smaller magnitude.
4. Apply the effort to the effort wheel for each corresponding load.
5. Record the observations of load and effort in observation table. Take at least five readings.
6. Measure the radius of the load drum and the radius of effort wheel.
7. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction.
8. Plot graphs viz. load against effort and load against efficiency.

XI Precautions to be followed

1. Effort must be applied gradually.
2. Overlapping of string should be avoided.
3. Lubricate the screw before starting the experiment.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed (To be written by students)

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

1. D = ……..mm
2. r = ……mm
3. T = ……..No.

$VR = \frac{DT}{2nr} =$

Observation Table

Sr. No.	Load W (N)	Effort P (N)	M.A.	Velocity Ratio	Efficiency η(%)	Ideal Effort Pi (N)	Effort Lost in Friction P_f(N)
2							
3							
4							
5							

Sample Calculations:

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{W}}{\text{P}} =$$

$$\text{Efficiency}(\eta) = \frac{\text{M.A.}}{\text{V.R.}} \times 100\% =$$

$$P_i = \frac{\text{W}}{\text{V.R.}} =$$

$$P_f = P - P_i =$$

Law of machine is $P = mW + C$

Where,

$m = \text{Slope} = \frac{P_2 - P_1}{W_2 - W_1} =$

C = Y intercept (i.e. Machine Friction) = ...N

XVI Results

1. The law of machine is $P = (.....).W + (.....)N$
2. The average efficiency of machine is =……. %

XVII Interpretation of results(Give meaning of the above obtained results)

1. Machine is ……
2. Friction loss is (i.e. Y- intercept = ……) reduced by …… the machine.
3. The graph between load and effort is straight line which indicates…….
4. The graph between load and efficiency is curve which indicates…….

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1 Write four field applications of worm and worm wheel.

2 Can this machine is used to lift heavy loads?

3 State the given machine is reversible or not. Give reason.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

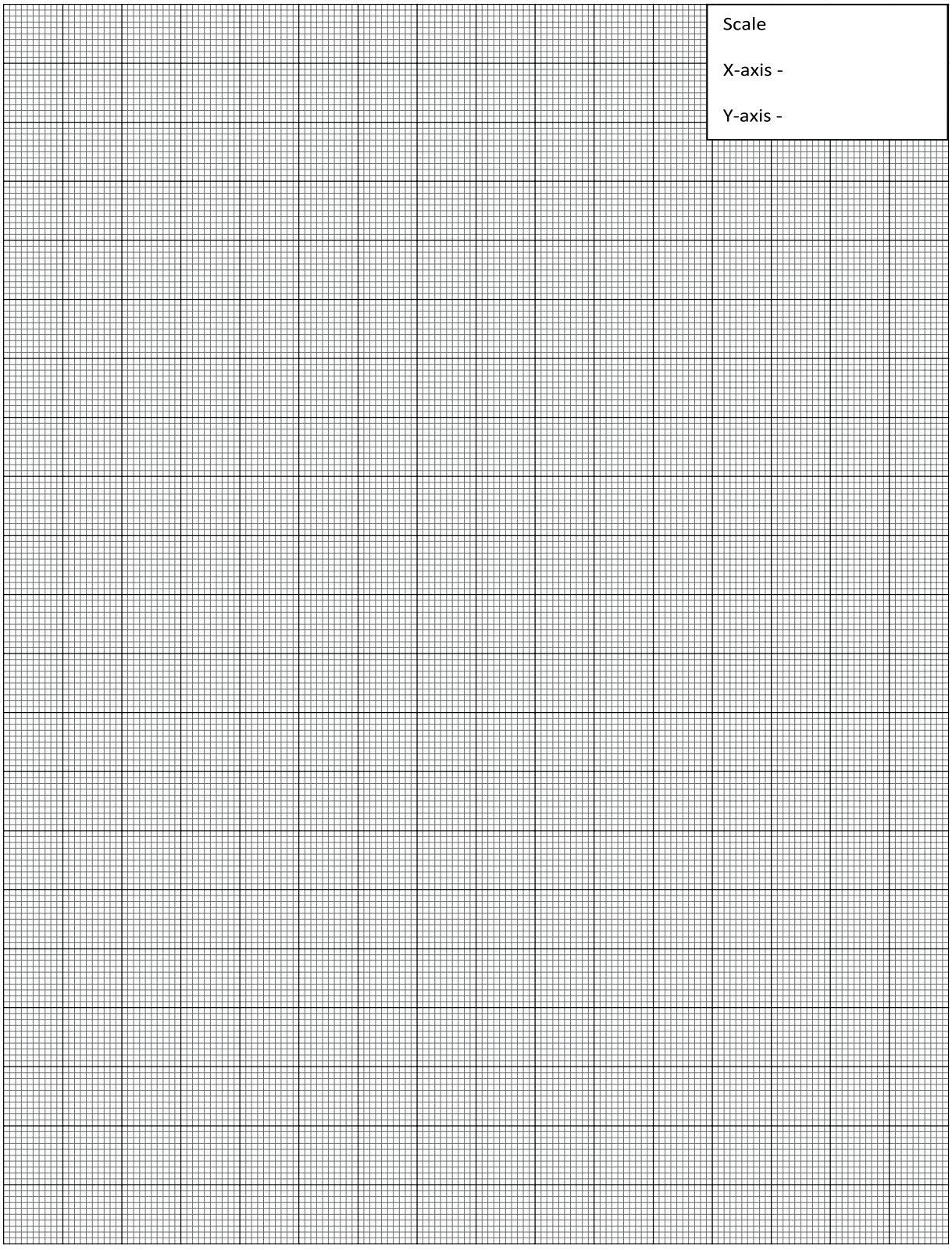
XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Determination of V.R. of machine.	10%
3	Applying load and determine effort of machine.	20%
4	Identify the type of machine i.e. Reversible or self locking.	10%
5	Calculation of parameters concerned.	10%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1……..
2……..
3……..
4……..
5……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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PracticalNo. 05-A: Single Purchase Crab

I Practical Significance

Many times there is a need to lift the loads and depending upon the type of load, intensity of load and other site conditions different lifting machines are used. Single Purchase Crab machine is used to lift heavy loads with constraint of space. After performing this experiment a Diploma Engineer will be able to decide the suitability of Single Purchase Crab based on the given lifting situation.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Select the relevant simple lifting machine for a given purpose.

IV Practical Outcome

Use Single Purchase Crab machine to lift heavy load.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices and precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Single Purchase Crab: Crab and winch are machines used for hoisting heavy loads applying smalleramount of effort. These machines use gear systems in order to augment velocity ratio. Depending on the number of gear assemblies, crab and winch systems can be classified into two types single and double purchase crab.

In single purchase crab, one set of gears, one pinion of teeth T_1 and one spur wheel of teeth T_2 are deployed. The pinion is fixed coaxially with the effort axle and effort pulley. Generally a rope is wound around the effort wheel of diameter *D* through effort is applied. Effort then moves the pinion and thereby the spur wheel gets rotated. As the spur wheel is mounted coaxially with the load drum of diameter *d,* the load drum will get rotated. A strong rope is attached with load drum, at the end of which load is connected. Thus the load is lifted by the rotation of the effort wheel.

For a single rotation of effort wheel, distance travelled by effort= πD. For single rotation of pinion, spur wheel and thereby the load drum rotate= T_1/T_2 times. So displacement of load= πd x $(T1/T_2)$

$$Hence,\ \text{Velocity Ratio} = \frac{DT_2}{dT_1}$$

Where, *D* =Diameter of effort wheel.

d = diameter of load drum.

T_1= No. of teeth on pinion wheel.

T_2= No. of teeth on spur wheel.

VIII Experimental Set-up

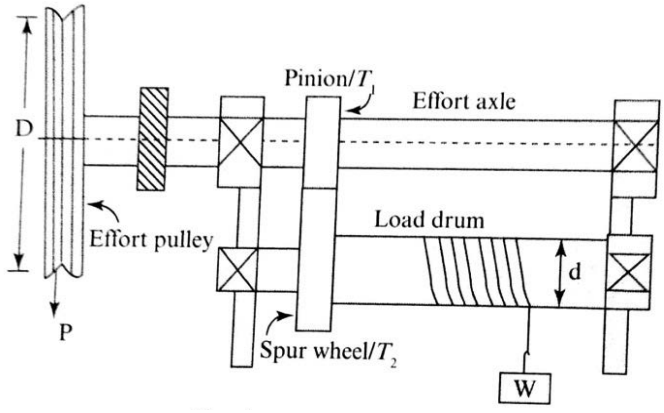

Figure: Single Purchase Crab

IX **Resources required:**

Sr. No.	Particulars	Specification	Quantity	Remark
1	Single Purchase Crab	Single Purchase Crab winch (Tablemounted heavy Castiron body. The effort wheelis of C.I. material of 25 cmdiameter mounted on a shaftof about 40mm dia. On thesame shaft a geared wheel of15 cm diameter.	01 for Group of 4 to 5 students	

X Procedure

1. Observe the machine carefully and identify the various components of machine.
2. Set the machine and check the reversibility of machine. Also calculate friction in machine at zero load.
3. Apply the load starting with smaller magnitude.
4. Apply the effort for each corresponding load.
5. Record the observations of load and effort in observation table. Take at least five readings.
6. Measure the radius of effort wheel and load drum. Count number of teeth on pinion gear and spur wheel.
7. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction for given Single Purchase Crab.
8. Plot graphs load against effort and load against efficiency.

XI Precautions to be followed

1. Effort should not be pulled suddenly.
2. Friction in pulley should be less.
3. String should not be extensible and weightless.
4. Any overlapping of the string should be avoided.
5. Lubricate the screw before starting the experiment.
6. Trapping should be done after adding the weight in the effort hanger.

XII Actual procedure followed

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed (To be written by students)

……...……
……...……
……...……..

XV Observations and Calculations

1. D =……mm

2. d= ……mm

3. T1 = ……..No.

4. T2 = ……..No.

$$Velocity\ Ratio = \frac{DT_2}{dT_1} =$$

Observation Table

Sr. No.	Load W(N)	Effort P (N)	M.A.	Velocity Ratio	Efficiency η (%)	Ideal Effort P_i (N)	Effort Lost in Friction P_f(N)
1							
2							
3							
4							
5							

Sample Calculations:

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{W}}{\text{P}} =$$

$$\text{Efficiency}(\eta) = \frac{\text{M.A.}}{\text{V.R.}} \times 100\% =$$

$$P_i = \frac{\text{W}}{\text{V.R.}} =$$

$$P_f = P - P_i =$$

Law of machine is $P = mW + C$

Where,

$$m = \text{Slope} = \frac{P_2 - P_1}{W_2 - W_1} =$$

C = Y intercept (i.e. Machine Friction) = ...N

XVI Results

1. The law of machine is *P*= (.....).*W*+(.....)*N*
2. The average efficiency of machine is =…… %

XVII Interpretation of results(Give meaning of the above obtained results)

1 Machine is ……
2 Friction loss is (i.e.Y- intercept = ……) reduced by …… the machine.
3 The graph between load and effort is a straight line which indicates…….
4 The graph between load and efficiency is a curve which indicates…….

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Pinion wheel is smaller than spur wheel. Give reason.
2. Write the minimum changes in set up to increase velocity ratio of single purchase crab.
3. Write the necessity of teeth's provided on pinion and spur wheel.
4. Write the law of single purchase crab.
5. Write two field applications of single purchase crab.
6. Can this machine is used to lift smaller loads? If no give reason.
7. Weather the given machine is reversible or not? Give reason.
8. Name the types of gear teeth used for single purchase crab in laboratory.
9. State which single purchase crab is preferred at construction site
   i. VR=50 ii) VR=70

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Determination of V.R. of machine.	10%
3	Applying load and determine effort of machine.	20%
4	Identify the type of machine i.e. Reversible or self locking.	10%
5	Calculation of parameters concerned.	10%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1……..

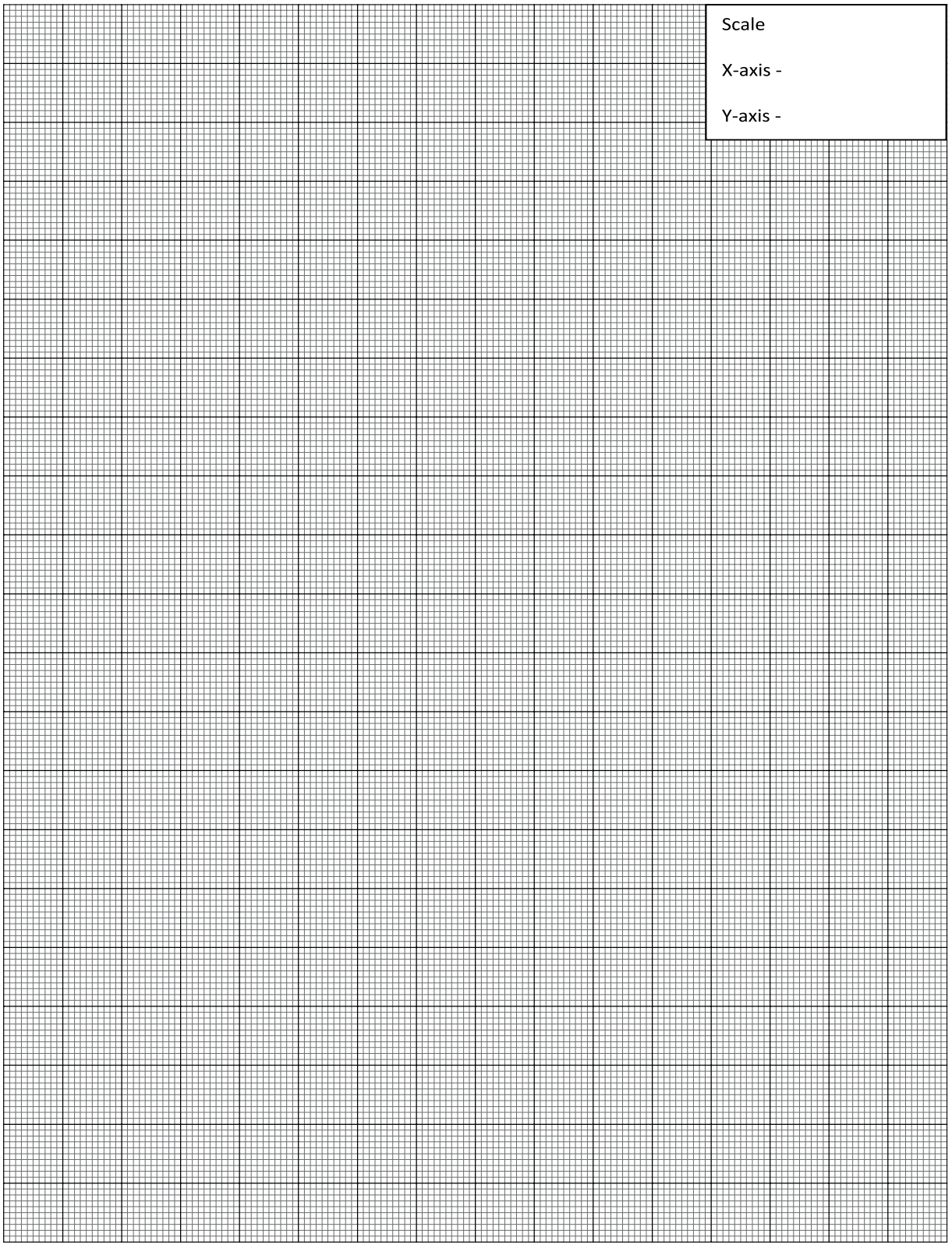
2……..

3…….

4……

5……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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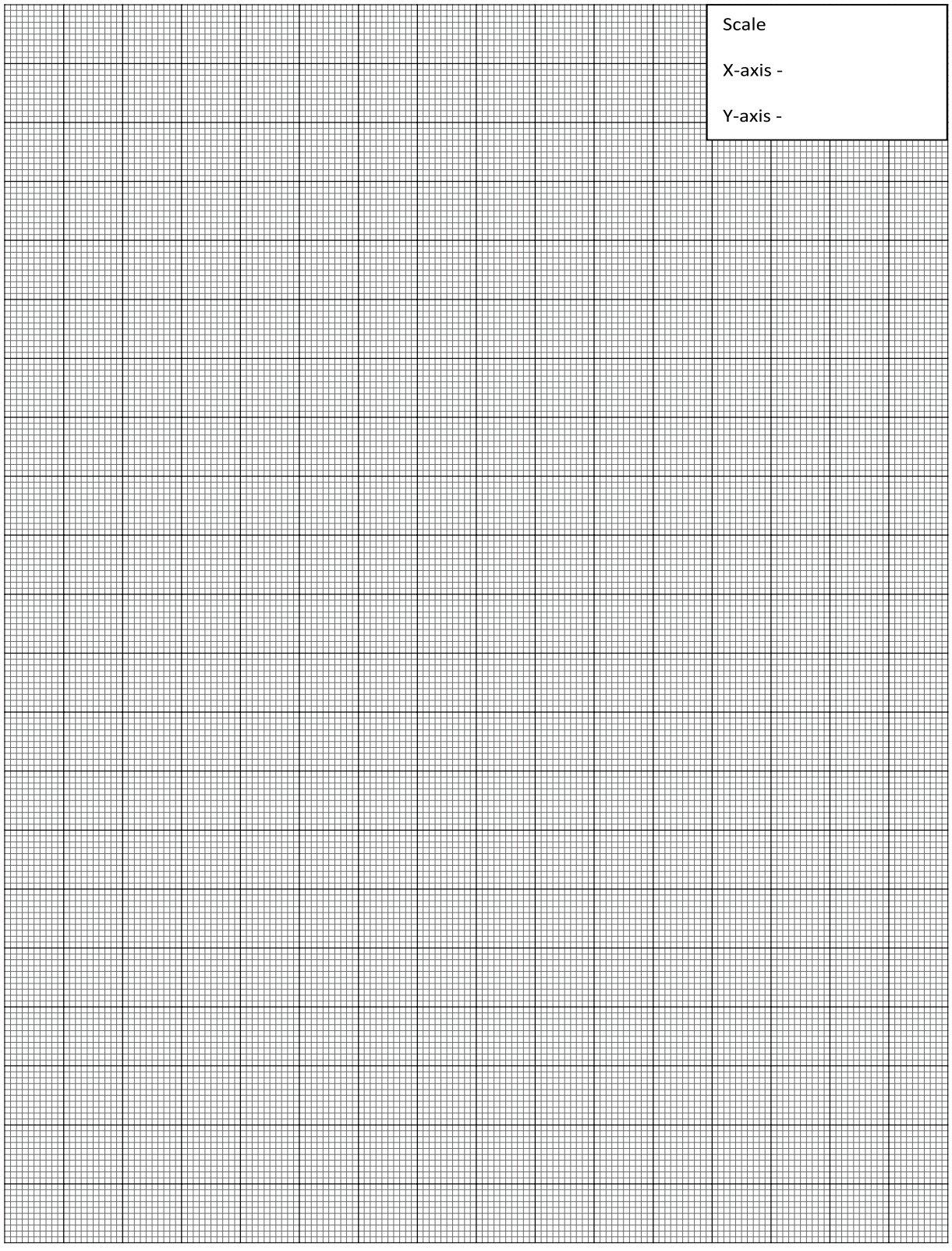
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Practical No. 05-B: Double Purchase Crab

I Practical Significance

Many times there is a need to lift the loads and depending upon the type of load, intensity of load and other site conditions different lifting machines are used. Double Purchase Crab machine is used to lift heavy loads with constraint of space. After performing this experiment a Diploma Engineer will be able to decide the suitability of Double Purchase Crab based on the given lifting situation.

II Relevant Program Outcomes (POs) (from programmestructure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Select the relevant simple lifting machine for a given purpose.

IV Practical Outcome

Use Double Purchase Crab machine to lift heavy load.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Double Purchase Crab: Crab and winch are machines used for hoisting heavy loads applying smalleramount of effort. These machines use gear systems in order to augment velocity ratio. Depending on the number of gear assemblies, crab and winch systems can be classified into two types single and double purchase crab.

In double purchase crab machine, two sets of gear assemblies are used. One additional axle, called an intermediate axle, is deployed. The pinion of teeth T_1 mounted on effort wheel axle meshes with spur wheel of teeth T_2 mounted on the intermediate axle.

Similarly, the pinion of teeth T_3onintermediate axle meshes with spur wheel of teeth T_4 mounted on the load drum. A rope is wound around the effort wheel of diameter D through effort is applied and load is attached to another rope wound around the load drum. Effort then moves the pinion and thereby the spur wheel gets rotated. As the spur wheel is mounted intermediate axle it gets rotated. As intermediate axle rotates the load drum of diameter d, will get rotated. A strong rope is attached with load drum, at the end of which load is connected. Thus the load is lifted by the rotation of the effort wheel.

For a single rotation of the effort wheel, distance travelled by effort= πD. For single rotation of pinion, on effort axle, spur wheel on intermediate axle rotates= T_1/T_2 times. Now the pinion on the intermediate axle also rotates= T_1/T_2 times. So, the spur wheel of the load drum rotates= (T_1/T_2) x (T_3/T_4) times. Thus the displacement of load= πdx(T_1/T_2) x (T_3/T_4)

$$Hence,\ Velocity\ Ratio = \frac{\pi \mathrm{D}}{\pi \mathrm{d}\left(\frac{\mathrm{T_1}}{\mathrm{T_2}}\right)\left(\frac{\mathrm{T_3}}{\mathrm{T_4}}\right)} = \frac{D \times T_2 \times T_4}{d \times T_1 \times T_3}$$

Where, D =Diameter of effort wheel.

d = diameter of load drum.

$T_1$and T_3= No. of teeth on pinion wheel.

$T_2$and T_4= No. of teeth on spur wheel.

VIII Experimental Set-up

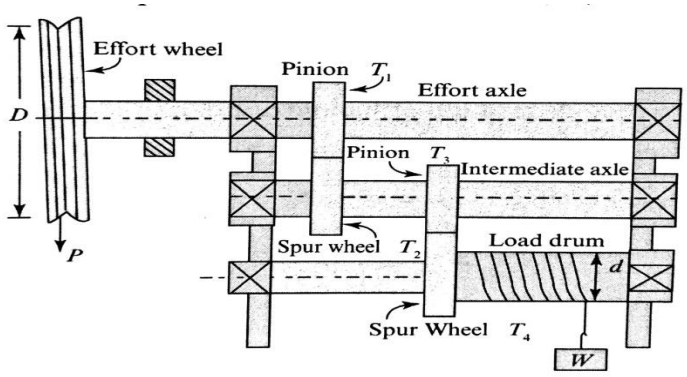

Figure: Double Purchase Crab

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Double Purchase Crab	Double Purchase Crab winch(Having assembly same assingle purchase crab but withdouble set ofgearing arrangement)	01 for Group of 4 to 5 students	

X Procedure

1. Observe the machine carefully and identify the various components of machine.
2. Set the machine and check the reversibility of machine.
3. Calculate friction in the machine based on zero load.
4. Apply the load starting with smaller magnitude.
5. Apply the effort for each corresponding load.
6. Record the observations of load and effort in observation table. Take at least five readings.
7. Measure the radius of effort wheel and load drum. Count number of teeth on pinion gear and spur wheels.
8. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction for given Double Purchase Crab.
9. Plot graphs viz. load against effort and load against efficiency.

XI Precautions to be followed

1. Effort should not be pulled suddenly.
2. Friction in pulley should be less.
3. String should not be extensible and weightless.
4. Any overlapping of the string should be avoided.
5. Lubricate the screw before starting the experiment.
6. Trapping should be done after adding the weight in the effort hanger.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed (To be written by students)

……...……

……...……

XV Observations and Calculations(Use blank sheet provided if space not sufficient)

1. D =…….mm
2. d =……..mm
3. T_1=……..mm
4. T_2 =…….mm
5. T_3=…….....mm
6. T_4=…….....mm

$$Velocity\ Ratio\ = \frac{D \times T_2 \times T_4}{d \times T_1 \times T_3} =$$

Observation Table

Sr. No.	Load W (N)	Effort P (N)	M.A.	Velocity Ratio	Efficiency η (%)	Ideal Effort Pi (N)	Effort Lost in Friction P_f(N)
1							
2							
3							
4							
5							

Sample Calculations:

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{W}}{\text{P}} =$$

$$\text{Efficiency}(\eta) = \frac{\text{M.A.}}{\text{V.R.}} \times 100\% =$$

$$P_i = \frac{\text{W}}{\text{V.R.}} =$$

$$P_f = P - P_i =$$

Law of machine is $P = mW + C$

Where,

m = Slope $= \frac{P_2 - P_1}{W_2 - W_1} =$

C = Y intercept (i.e. Machine Friction) = ...N

XVI Results

1. The law of machine is P= (.....)W+(.....)N
2. The average efficiency of machine is =……. %

XVII Interpretation of results(Give meaning of the above obtained results)

1. Machine is ……
2. Friction loss is (i.e.Y- intercept = ……) reduced by …… the machine.
3. The graph between load and effort is straight line which indicates…….
4. The graph between load and efficiency is curve which indicates…….

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Differentiate between single and double purchase crab machine.

2. Two spurs and two pinions are provided in double purchase crab. Give reason.
3. Write the minimum changes in set up to increase velocity ratio of double purchase crab.
4. Write the law of double purchase crab machine.
5. Calculate the friction in the machine at zero load.
6. Write two field applications of double purchase crab.
7. Can this machine is used to lift smaller loads? If no give reason.
8. Weather the given machine is reversible or not? Give reason.
9. State, single or double purchase crab machine is preferred at construction site. Give reason.

Space to Write Answers

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XX References / Suggestions for further Reading

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2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

The given performance indicators should serve as a guideline for assessment regarding process and product related marks.

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Determination of V.R. of machine.	10%
3	Applying load and determine effort of machine.	20%
4	Identify the type of machine i.e. Reversible or self locking.	10%
5	Calculation of parameters concerned.	10%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1……..

2……..

3……..

4……..

5 ……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
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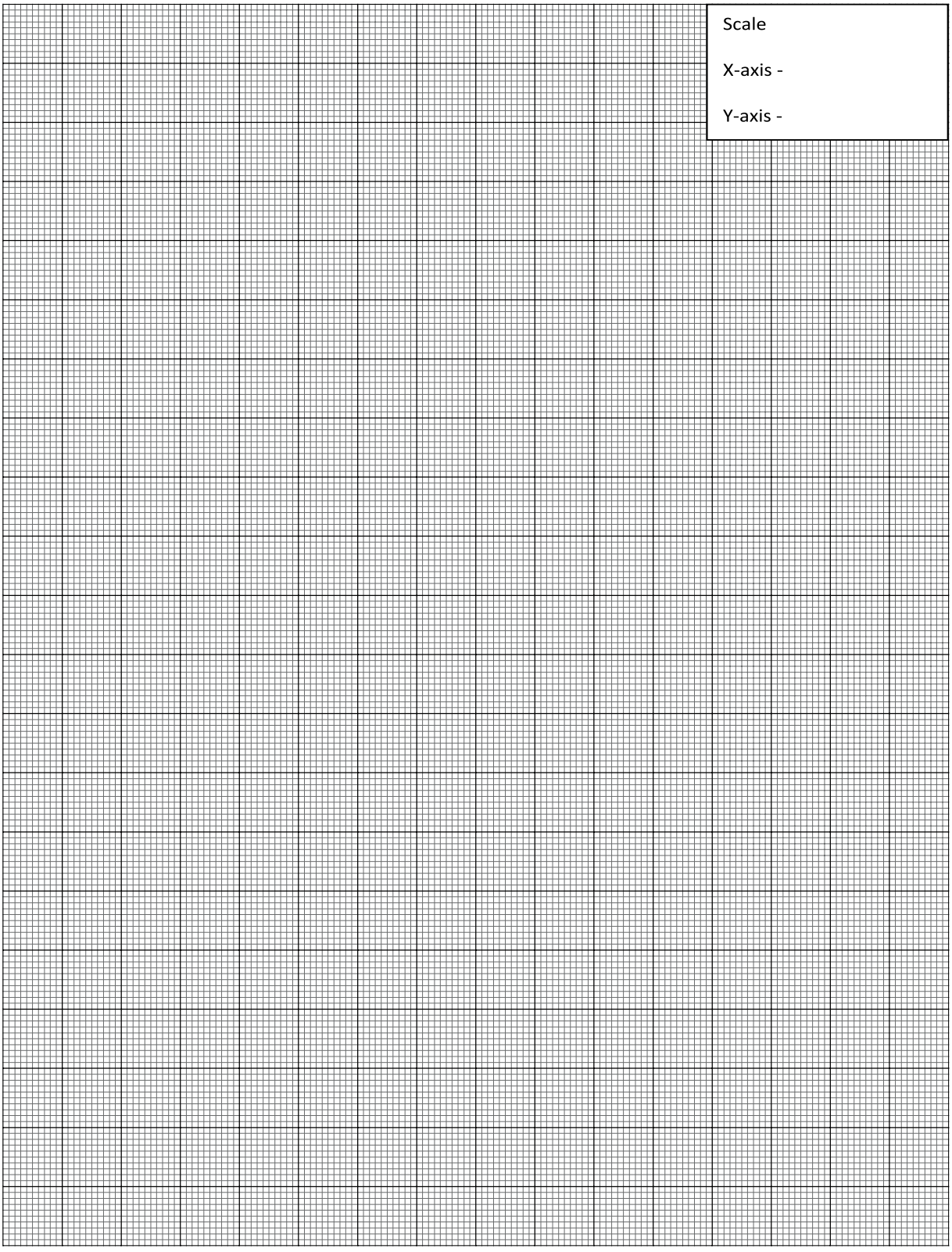
Y-axis -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Practical No. 06-A: Weston's Differential Pulley Block

I Practical Significance

Many times there is a need to lift the loads and depending upon the type of load, intensity of load and other site conditions different lifting machines are used. Weston's differential pulley block is used to lift heavy loads with constraint of space. After performing this experiment a Diploma Engineer will be able to decide the suitability of Weston's differential pulley block based on the given lifting situation.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

II Relevant Course Outcomes (from course details)

Select the relevant simple lifting machine for a given purpose.

IV Practical Outcome

Use Weston's differential pulley block to lift very large heavy load.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices and precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Weston's Differential Pulley Block: This differential pulley block was invented by Thomas AldridgeWeston from king's Norton, England, in 1854. Hence, this simple machine is also called as Weston's differential pulley block. This is a special type of pulley system, which is normally used to hoist very large masses to small distance, for example, the pulley system is used for manually lifting car engines.

This system consists of two fixed pulleys of unequal radii, which are coaxially attached to each other and can rotate together and are fixed to the support, a single pulley hanging at the bottom and holding load and an endless rope wrapped around the pulleys. In order to avoid slipping, generally rope is substituted by a chain and connected to pulleys by sprockets (i.e. tooth or cogs on pulleys).

The displacement of the effort in one revolution of upper pulley block = πD. This is also equal to length of the chain pulled over the large pulley. Since the smaller pulley also turns with the larger one, therefore length of the chain released by the smaller pulley = πd. Net shortening of the chain = $\pi D - \pi d = \pi(D-d)$. This shortening of chain will be equally divided between the portions of the chain,supporting the load. Therefore the distance the load moves up by a distance $\pi(D-d)/2$.

$$\text{Velocity Ratio} = \frac{\text{Distance moved by the effort}}{\text{Distance moved by the load}}$$

$$Velocity\ Ratio = \frac{2D}{D-d} \text{ or } \frac{2T_1}{T_1 - T_2}$$

Where,

D=Diameter of pulley P_1.
d= Diameter of pulley P_2.
T_1=No. of teeth or cogs of pulley P_1.
T_2 = No. of teeth or cogs of pulley P_2.

VIII Experimental Set-up

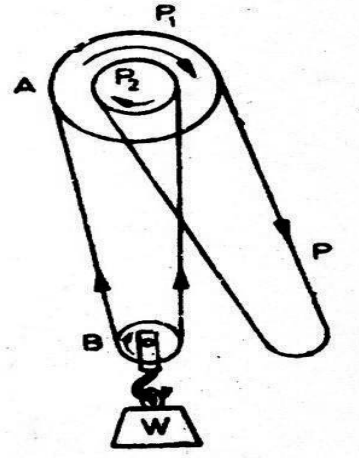

Figure: Weston's Differential Pulley Block

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Weston's Differential Pulley block.	Weston's Differential pulleyblock (consisting oftwopulleys; one bigger and other smaller.	01 for Group of 4 to 5 students	

X Procedure

1. Observe the machine carefully and identify the various components of machine.
2. Set the machine and check the reversibility of it.
3. Calculate friction in the given machine at zero load.
4. Apply the load starting with smaller magnitude.
5. Apply the effort for each corresponding load.
6. Record the observations of load and effort in observation table. Take at least five readings.
7. Measure the radius or number of cogs of larger and smaller pulley.
8. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction for given Weston's differential pulley block.
9. Plot graphs viz. load against effort and load against efficiency.

XI Precautions to be followed

1. Effort must be applied gradually.

XII Actual procedure followed

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……..……...……
……

XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIIIV Precautions followed (To be written by students)

……...……

……...……

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XV Observations and Calculations

1. T1 = …… No.

2. T2 = …… No.

3. *T3* = …… No.

4. *T4* = …… No.

$$\text{Velocity Ratio} = \frac{2D}{D-d} \; or \; \frac{2T_1}{T_1 - T_2}$$

=

Observation Table

Sr. No.	Load W (N)	Effort P (N)	M.A.	Velocity Ratio	Efficiency η (%)	Ideal Effort Pi (N)	Effort Lost in Friction P_f(N)
1							
2							
3							
4							
5							

Sample Calculations:

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{W}}{\text{P}} =$$

$$\text{Efficiency}(\eta) = \frac{\text{M.A.}}{\text{V.R.}} \times 100\% =$$

$$P_i = \frac{\text{W}}{\text{V.R.}} =$$

$$P_f = P - P_i =$$

Law of machine is $P = mW + C$

Where,

m = Slope = $\frac{P_2 - P_1}{W_2 - W_1}$ =

C = Y intercept (i.e. Machine Friction) = ...N

XVI Results

1. The law of machine is *P*= (.....)*W*+(.....)*N*
2. The average efficiency of machine is =……. %

XVII Interpretation of results(Give meaning of the above obtained results)

1. Machine is ……
2. Friction loss is (i.e.Y- intercept = ……) reduced by …… the machine.
3. The graph between load and effort is straight line which indicates…….
4. The graph between load and efficiency is curve which indicates…….

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Give reason. Different sizes of pulley are used.
2. Explain effect in working in machine if position of pulleys is interchanged.
3. Write use of snatch block in working of machine.
4. Calculate maximum mechanical advantage and maximum efficiency of machine.
5. Give reason. Effort is required for zero load.
6. State the two situations in field where differential pulley block is used.
7. Give reason. Chain is not slipping from the pulley when the load is lifted.
8. Discuss velocity ratio of differential pulley block is greater than simple axle wheel.
9. State the given machine is reversible or not. Give reason.

Space to Write Answers

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

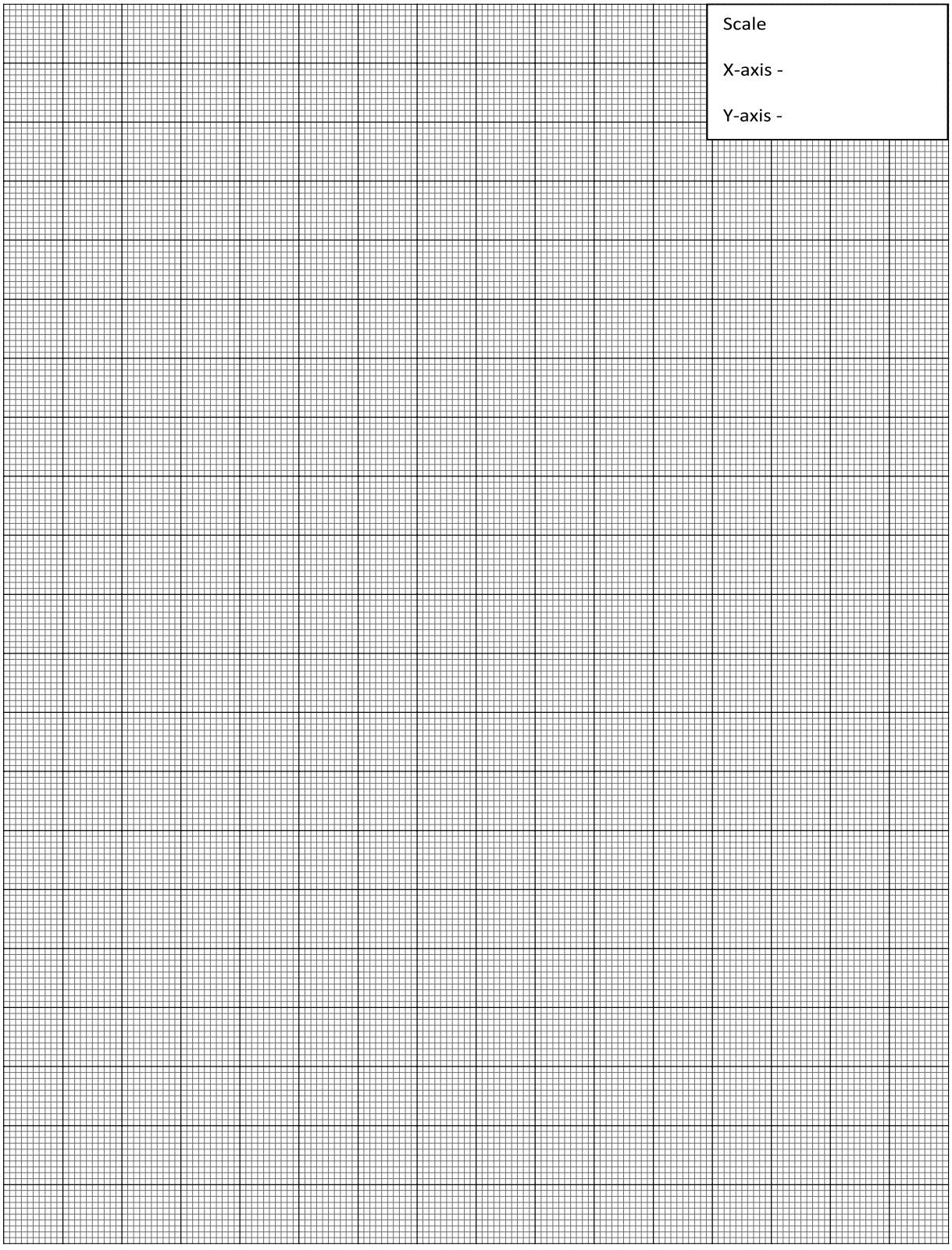
XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Determination of V.R. of machine.	10%
3	Applying load and determine effort to machine.	20%
4	Identify the type of machine i.e. Reversible or self locking.	10%
5	Calculation of parameters concerned.	10%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……
2. ……
3. ……
4. ……
5. ……

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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Scale
X-axis -
Y-axis -

Practical No. 06-B: Worm Gear Pulley Block

I Practical Significance

Many times there is a need to lift the loads and depending upon the type of load, intensity of load and other site conditions different lifting machines are used. Worm Gear pulley block is used to lift heavy loads with constraint of space. After performing this experiment a Diploma Engineer will be able to decide the suitability of worm gear pulley block based on the given lifting situation.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge PO
3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

II Relevant Course Outcomes (from course details)

Select the relevant simple lifting machine for a given purpose.

IV Practical Outcome

Use worm gear pulley block to lift very large heavy load.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices and precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Worm Gear Pulley Block: In a gear pulley block, an axle is coaxially attached to an effort wheelhavingT_1 number teeth. A pinion having teeth T_2 and a ratchet and clutch are attached coaxially on the axle. A pawl presses against this ratchet and clutch with the help of a spring. The pinion is geared with a spur wheel having teeth T_3. On the same axle as spur wheel a load drum having teeth T_4 is keyed on its circumference. An endless rope or chain is

wound over effort wheel with which the effort is applied. The motion is transmitted from effort wheel to load drum through pinion and spur wheel. A separate rope is wound around half the perimeter of load drum. One end of it is fixed to the frame and other end holds the load. When the load is hoisted, the ratchet passes under the pawl. On the removal of effort, the pawl prevents the load from falling down. Hence, it is self-locking arrangement.

In single rotation of effort wheel, effort moves through a distance proportional to T_1. At the same time, the spur wheel and the load drum rotate by (T_2/T_1) of a rotation. In single rotation of load drum, the load is lifted through distance proportional to T_4. So far a single rotation of effort wheel, the load is lifted by a distance $(T_2/T_3) \times T_4$. Hence,

$$\text{Velocity Ratio} = \frac{\text{Distance moved by the effort}}{\text{Distance moved by the load}} = \frac{T_1}{\left(\frac{T_2}{T_3}\right)T_4} = \frac{T_1 T_3}{T_2 T_4}$$

Where,

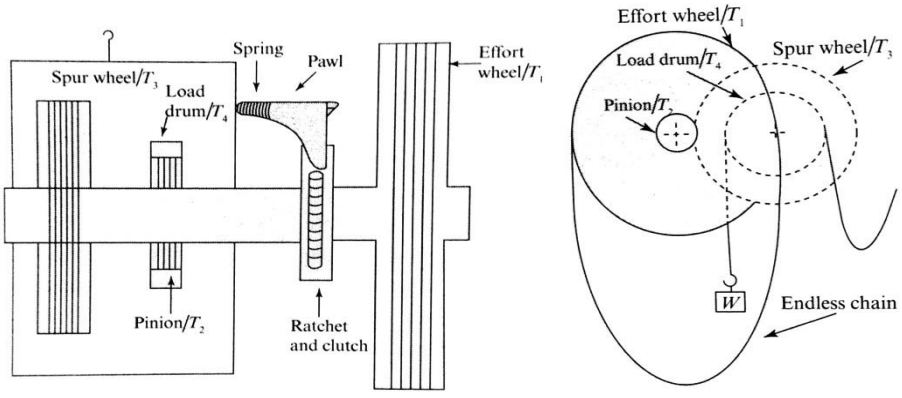
T_1= No. of teeth or cogs on effort wheel.

T_2= No. of teeth or cogs on pinion wheel.

T_3= No. of teeth or cogs on spur wheel.

T_4= No. of teeth or cogs on load drum.

VIII Experimental Set-up



Gear arrangementworking of gear pulley block

Figure: Worm Gear Pulley Block

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Worm Gear Pulley Block.	Worm gear pulley block consists of a metallic (preferably steel) cogged wheel of about 20 cm along with a protruded load drum of 10 cm diameter to suspend the weights of 10 kg, 20 kg and 50 kg weights.	01 for Group of 4 to 5 students	

X Procedure

1. Observe the machine carefully and identify the various components of machine.
2. Set the machine and check the reversibility of it.
3. Calculate friction in the given machine at zero load.
4. Apply the load starting with smaller magnitude.
5. Apply the effort for each corresponding load.
6. Record the observations of load and effort in observation table. Take at least five readings.
7. Measure the radius or number of cogs of larger and smaller pulley.
8. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction for given Weston's differential pulley block.
9. Plot graphs load against effort and load against efficiency.

XI Precautions to be followed

1. Effort must be applied gradually.

XII Actual procedure followed (To be written by students)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIIIV Precautions followed (To be written by students)

……...……

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XV Observations and Calculations

1. T1 = …… No.

2. T2 = …… No.

3. *T3* = …… No.

4. *T4* = …… No.

$$VR = \frac{T_1 T_3}{T_2 T_4} =$$

Observation Table:

Sr. No.	Load W (N)	Effort P (N)	M.A.	Velocity Ratio	Efficiency η(%)	Ideal Effort Pi (N)	Effort Lost in Friction P_f(N)
1							
2							
3							
4							
5							

Sample Calculations:

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{\text{W}}{\text{P}} =$$

$$\text{Efficiency}(\eta) = \frac{\text{M.A.}}{\text{V.R.}} \times 100\% =$$

$$P_i = \frac{\text{W}}{\text{V.R.}} =$$

$$P_f = P - P_i =$$

Law of machine is $P = mW + C$

Where,

m = Slope = $\frac{P_2 - P_1}{W_2 - W_1}$ =

C = Y intercept (i.e. Machine Friction) = ...N

XVI Results

1. The law of machine is P= (.....)W+(.....)N
2. The average efficiency of machine is =……. %

XVII Interpretation of results

a) Machine is ……

b) Friction loss is (i.e.Y- intercept = ……) reduced by …… the machine.

c) The graph between load and effort is straight line which indicates…….

d) The graph between load and efficiency is curve which indicates…….

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

……...……
……...……
……..

XIX Practical Related Questions

Note*: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Give reason. Worm is geared with worm gear.
2. Differentiate between differential and worm gear pulley block.
3. Write use of worm in working of machine.
4. State the two situations in field where worm gear pulley block is used.
5. Give reason. Chain is not slipping from the pulley when the load is being lifted.
6. State velocity ratio of gear pulley block with single threaded worm and with double threaded worm.
7. State the given machine is reversible or not. Give reason.
8. State the capacity of worm gear pulley block.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

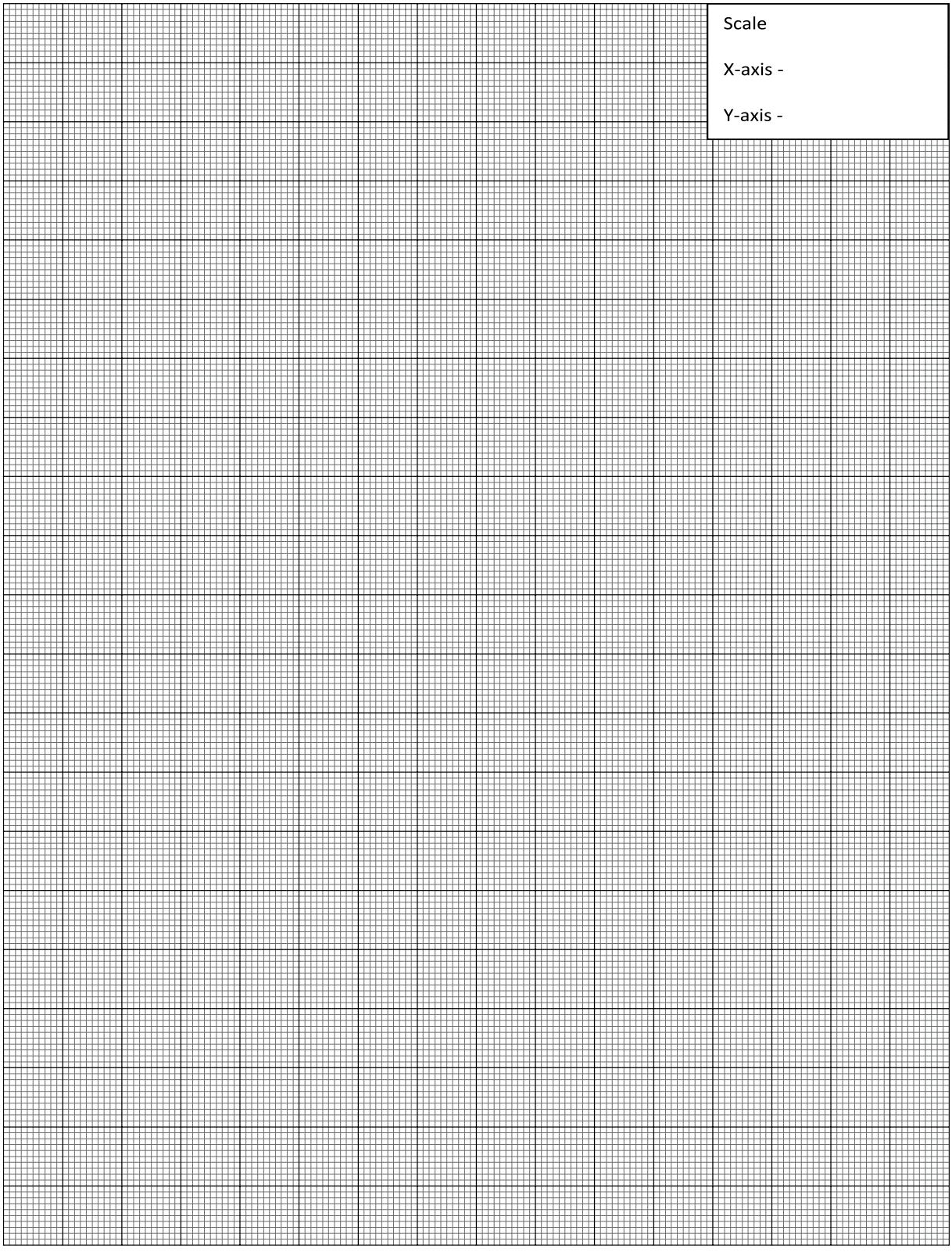
Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Determination of V.R. of machine.	10%
3	Applying load and determine effort of machine.	20%
4	Identify the type of machine i.e. Reversible or self locking.	10%
5	Calculation of parameters concerned.	10%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. …….
4. …….
5. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -


Scale
X-axis -
Y-axis -

Practical No. 07& 08:Determine Unknown Force by Using Force Table

I Practical Significance

Many times there is a need determine the resultant force. Depending upon the type of force system resultant can be determined by applying law of polygon of forces. After performing this experiment Diploma Engineer will able to find the resultant of concurrent force system.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Determine unknown force of different engineering system.

IV Practical Outcome

Use force table apparatus to determine unknown force with its magnitude and direction.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices.

b. Demonstrate working as a leader/a team member.

c. Maintain tools and equipment.

VII Minimum Theoretical Background

Resultant force is the combined effect of the generalized force system .polygon law of forces is basically the extension of the triangular law of forces. If a material body is subjected to more three coplanar, non-collinear, concurrent forces, polygon law is used to find the resultant force. Starting from a common point, we have to plot the forces in proper magnitude and direction, in a successive manner and in order. In this way, we obtain the successive arms of a polygon through the successive triangulation process. If the force

system keeps the body in equilibrium, a closed polygon will be formed and the resultant R will be zero if not so one side of the polygon will remain open. This side, when joined properly, gives the magnitude of the resultant R. the direction of resultant R will be in the order reverse to that of the constituent forces. Thus, the polygon law states that: If three or more coplanar ,non-collinear, concurrent forces constitute the force system and can be represented in magnitude and direction by the sides of a polygon, taken in order, then one side will remain open .this side of the polygon ,if joined properly and in reverse order, will give the resultant of the force system . If the material body remains in equilibrium under the action of such type of force system, then a closed polygon is obtained.

VIII Experimental Set-up

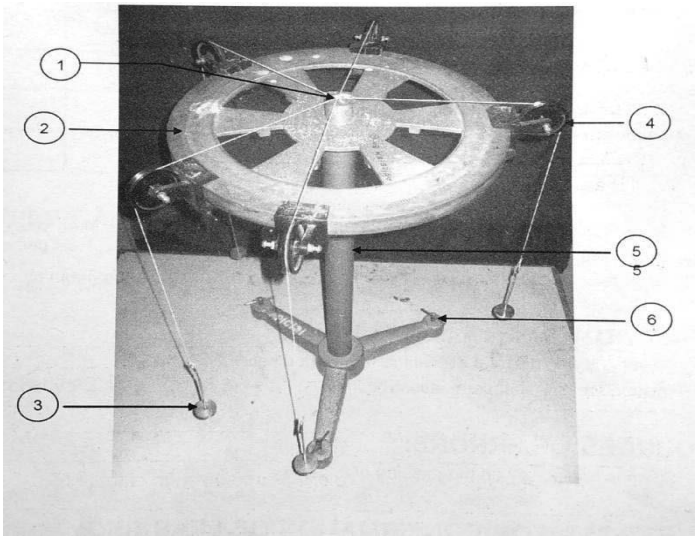


Figure: Force Table

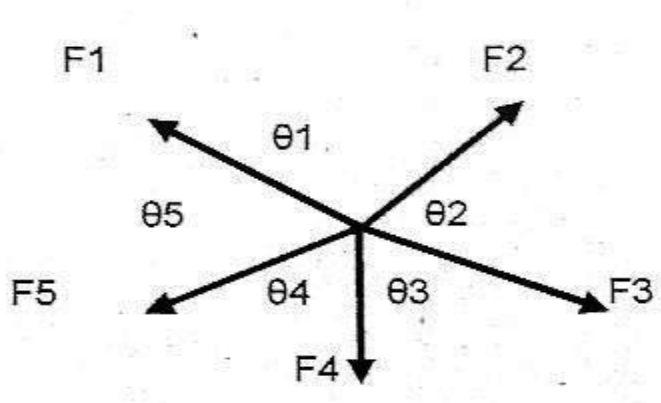
1.		4.	
2.		5.	
3.		6.	

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Universal Force Table	It Consists of a circular 40 cm dia. Aluminum disc, graduated into 360 degrees. with all accessories.	01 for Group of 4 to 5 students	

X Procedure

1. Place the universal force table on firm platform
2. Make the circular disc in horizontal position with the help of foot screws
3. Check the horizontal position of circular disc by spirit level
4. Clamp the five detachable pulleys to the circular disc at five different positions
5. Keep the ring at center of disc and pass the five strings each over the five pulleys.
6. Hang five hangers to these ends of strings passing over the pulleys
7. Put slotted weights to each hangers so as to make pivot and ring concentric with each other
8. Note the sum of slotted weights in each hanger and weight of hanger as five forces F1,F2,F3,F4 and F5
9. Measure the angles included between the two adjacent pulleys and note them as θ1, θ2, θ3, θ4, θ5.
9. Record these observation in observation table
10. Repeat step 7 by changing any one or two pulleys position and take three sets of observations.
11. Draw force polygon for each reading by choosing suitable scale on graph paper



XI Precautions to be followed

1. Pivot and ring must be concentric with each other.
2. Included angle must be measured carefully.

XII Actual procedure followed(Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

……...……

……...……

XV Observations and Calculations(Use blank sheet provided if space not sufficient)

……...……

……...……

Observation Table

	Forces (N) (Weight in hanger+ Weight of hanger)					Included angles between two forces in "degrees"					
Sr. No.	F1	F2	F3	F4	F5 From graph	θ1	θ2	θ3	θ4	θ5	θ5 From graph
1											
2											
3											
4											
5											

XVI Results

The force polygon is closed/not closed.

XVII Interpretation of results (Give meaning of the above obtained results)

Relation between resultant and equilibrant.

XVIII Conclusions and Recommendations (if any)

1. If the force polygon is closed……..

2. If the force polygon is not closed…….

XIX Practical Related Questions

Note: *Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. What is the magnitude of resultant force in case of concurrent forces in equilibrium?

2. State the graphical conditions of equilibrium for concurrent force system.

3. A system of coplanar concurrent forces consisting five forces is keeping the vertical pole stable. Ifthe four forces acting as pull are of magnitude 1kN, 2kN, 3kN and 4kN.Determine the fifth force inmagnitude and direction of the system graphically if every two adjacent forces have same includedangles.

4. If the force polygon is not a closed figure, what does it indicates?

5. If five concurrent forces having equal magnitude are in equilibrium, find the angle Betweenthem.

6. If two coplanar concurrent forces are acting at a point. State which law you will prefer to Calculateresultant between them.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
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2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Calculation of force.	10%
3	Measurement of angle.	10%
4	Proper reading.	10%
5	Calculation of parameters concerned.	10%
6	Drawing force polygon.	10%
7	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1 … ……..

2. ……..

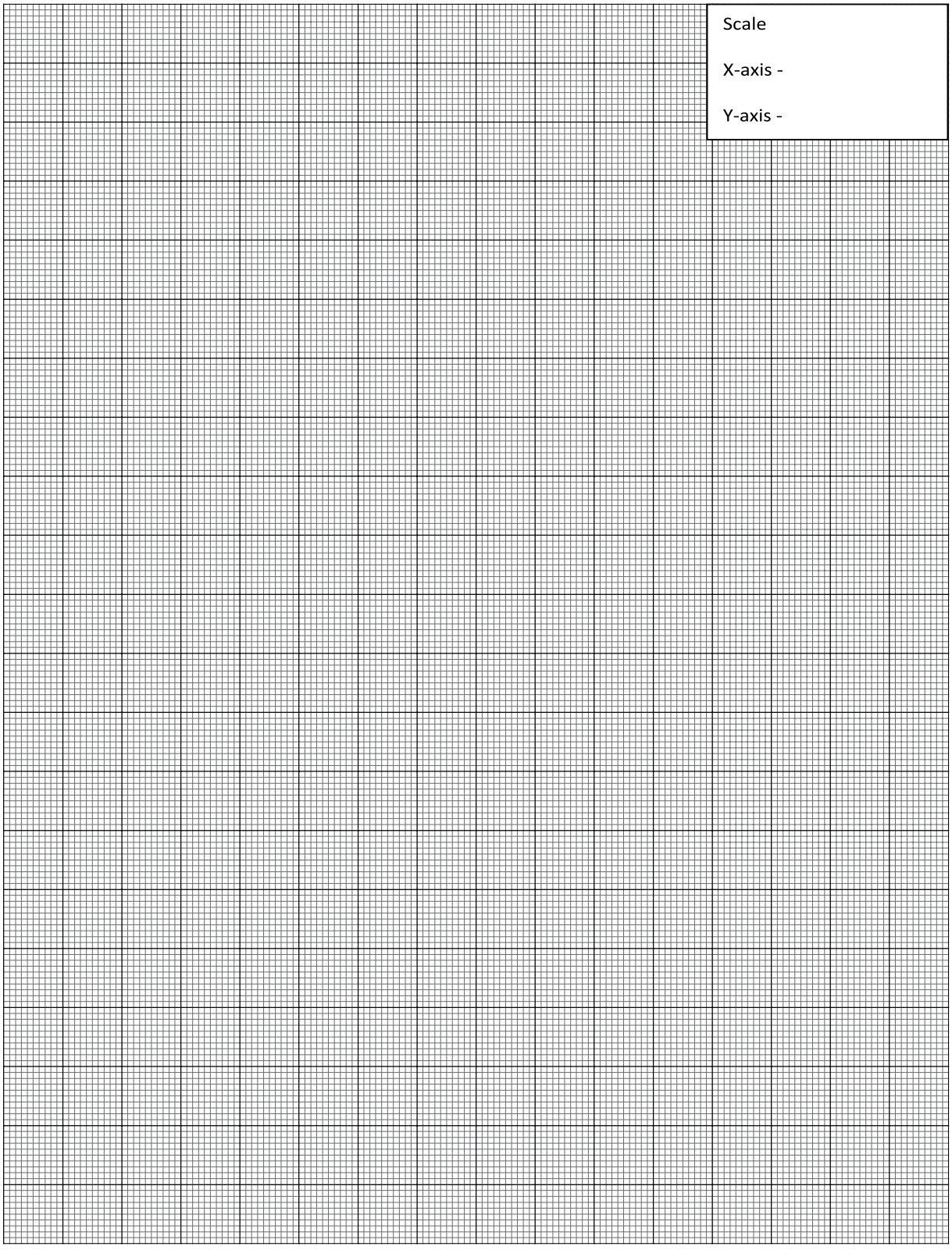
3. …….

4. ……..

5. ……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -


Scale
X-axis -
Y-axis -

Practical No. 09: Determine Resultant of Concurrent Force System by Graphical Method

I Practical Significance

Graphic statics is that branch of engineering science, which deals with solution of problems in 'statics' by graphical methods. Problems in statics include resultant of various force systems, beam reaction, forces in frames, trusses etc. Graphical method of solving a problem incorporates use of geometrical figures like points, straight lines, parallelograms, polygons etc. The results obtained by this method may tally with that obtained by analytical method, if sufficient care is taken in the graphical work. Diploma Engineer can able to solve the problems by graphical method. This method is generally used if the force system is complicated. It is suitable and quick in the analysis of frames, trusses, beams etc.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Determine resultant force of different engineering system.

IV Practical Outcome

Use graphical method to determine resultant force with its magnitude, direction and position.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/a team member.
c. Maintain drawing tools.

VII Minimum Theoretical Background

a. Bow's Notation:

It is the process of designating a force by naming the spaces created due to line of action of forces in given force system .The spaces are identified by the capital alphabets like A, B, C, etc. as shown below

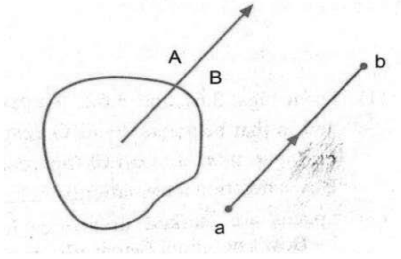
b. Space Diagram:

It is the diagram obtained after drawing given force system with suitable scale and designating the spaces created by Bow's notation

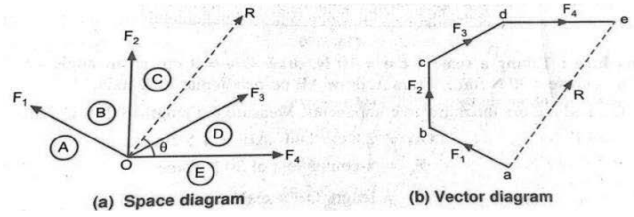
c. Vector Diagram:

It is the polygon constructed by plotting the forces of the given system of forces in magnitude and direction with suitable scale in sequence.

VIII Experimental Set-up



Bows Notation



IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Drawing sheet with drawing instruments	Pencil, Eraser, Straight Edge, Sets Square, Mini Drafter, etc.	1 set for each student	

X Procedure

1. Draw space Diagram of given force system by choosing suitable scale. Give Bow's notation.
2. Construct Vector diagram by selecting suitable scale for forces by drawing lines parallel to line of action of Space Diagram in sequence.
3. If the vector diagram is closed figure then resultant of the force system is zero, if not follow next steps.
4. Determine the resultant force in magnitude, which is represented by closing side of vector diagram.

5. Show the direction of resultant force, which is from beginning of first vector force to the end of last vector force in vector diagram.
6. Show the position of resultant force in space diagram by drawing line parallel to the closing side of vector diagram and passing through common point of application of all the forces.
7. Measure the angle (θ) made by the resultant force with horizontal in the space diagram.

XI Precautions to be followed

While drawing the diagrams accuracy should be maintained.

XII Actual procedure followed(Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

……...……
……...……

XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Resultant force = (Length of closing side) X (Scale multiplying factor)

XVI Results

1. Magnitude of the resultant force = ……..kN
2. Direction of the resultant force with horizontal (θ) = …….
3. Position of the resultant force ….....

XVII Interpretation of results(Give meaning of the above obtained results)

1. Compare the above result analytically.

XVIII Conclusions and Recommendations(Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note:*Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Define Bow's notation and state its use.
2. Explain a) Space diagram b) Vector diagram.
3. State graphical conditions of equilibrium for all force system.
4. State Law of Polygon of forces.
5. Define force as a vector.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

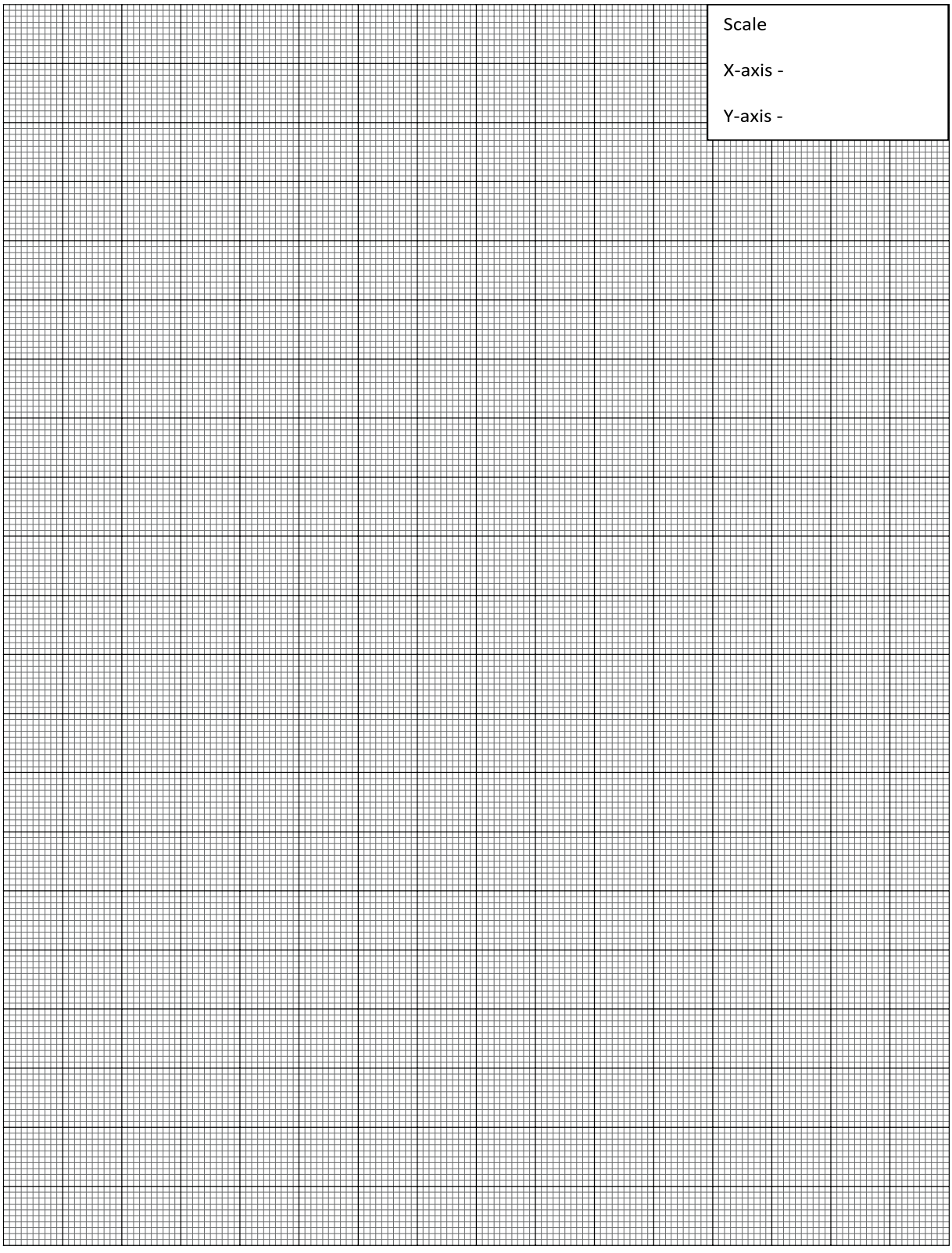
XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Proper use of drawing instruments.	5%
2	Calculation of force.	10%
3	Measurement of angle.	10%
4	Proper reading.	10%
5	Calculation of parameters concerned.	10%
6	Drawing force polygon.	10%
7	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. …….
4. ……..
5. ……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -


Scale
X-axis -
Y-axis -

Practical No.10: Determine Resultant of Parallel Force System by Graphical Method

I Practical Significance

Graphic statics is that branch of engineering science which deals with solution of problems in 'statics' by graphical methods. Problems in statics include resultant of various force systems, beam reaction, forces in frames, trusses etc. Graphical method of solving a problem incorporates use of geometrical figures like points, straight lines, parallelograms, polygons etc. The results obtained by this method may tally with that obtained by analytical method, if sufficient care is taken in the graphical work. Diploma engineer can able to solve the problems by graphical method. This method is generally used if the force system is complicated. It is suitable and quick in the analysis of frames, trusses, beams etc.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Determine resultant force of different engineering system.

IV Practical Outcome

Use graphical method to determine resultant force with its magnitude, direction and position.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant affective domain related

a. Follow safety practices & precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain drawing tools.

VII Minimum Theoretical Background

a. Bow's Notation:

It is the process of designating a force by naming the spaces created due to line of action of forces in given force system .the spaces are identified by the capital alphabets like A,B,C,etc. as shown below.

b. Space Diagram:

It is the diagram obtained after drawing given force system with suitable scale and designating the spaces created by Bow's notation.

c. Vector Diagram:

It is the polygon constructed by plotting the forces of the given system of forces in magnitude and direction with suitable scale in sequence.

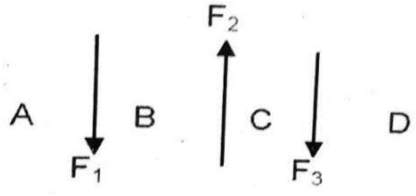
d. Polar Diagram:

It is the diagram obtained by joining beginning and end point of all forces of vector diagram to any arbitrary point 'O' called pole.

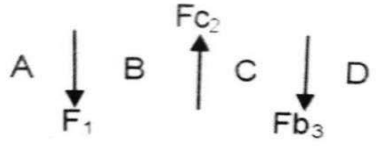
e. Funicular Polygon:

It is the figure obtained by drawing lines parallel to rays oa, ob, oc, od etc. of polar diagram in respective spaces A, B, C, D etc. in space diagram.

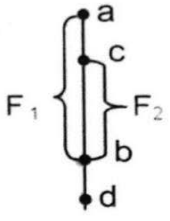
VIII Experimental Set-up



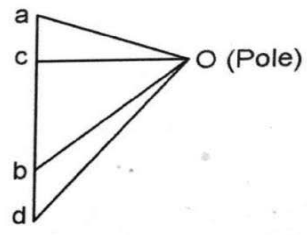
Bow's Notation



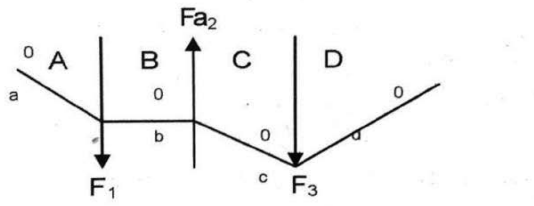
Space Diagram



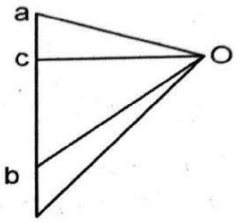
Vector Diagram



Vector Diagram and Polar Diagram



Space Diagram and Funicular Polygon



Vector Diagram and Polar Diagram

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Drawing sheet with drawing instruments	Pencil,Eraser,straightEdge,Sets Square, Mini Drafter,etc.	1 set for each student.	

X Procedure

1. Draw space Diagram of given force system by choosing suitable scale for distance. Also giveBow's notation.
2. Construct Vector diagram by selecting suitable scale for forces by drawing lines parallel to line of action of Space Diagram in sequence.
3. If the vector diagram is closed figure then resultant of the force system is zero, if not follow next steps.
4. Determine the resultant force in magnitude, which is represented by closing side of vector diagram .use following equation.
5. Show the direction of resultant force, which is from beginning of first vector force to the end point of last vector force in vector diagram.
6. Select any arbitrary point called pole in vector diagram and join beginning and end point of all forces to the pole to obtain polar diagram.
7. Draw lines parallel to rays of polar diagram in their respective spaces (i.e. ray oa in space A, ray ob in space B and so on) and in continuation with each other. This diagram obtained is called Funicular polygon.
8. Extend first and last rays drawn in funicular polygon to meet at single point. This is the point through which line of action of resultant force will pass.
9. Locate resultant force in space diagram by drawing line parallel to closing side (resultant) of vectordiagram passing through the point as obtained in step 4.
10. Measure the angle made by resultant with horizontal.
11. Measure the perpendicular of resultant force from any known point in space diagram.

XI Precautions to be followed

While drawing the diagrams accuracy should be maintained.

XII Actual procedure followed(Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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……
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XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Perpendicular distance= (Length of perpendicular) X (Scale multiplying factor)

XVI Results

1. Magnitude of the resultant force ……..
2. Direction of the resultant force …….
3. Position of the resultant force ….....

XVII Interpretation of results(Give meaning of the above obtained results)

Compare the above result analytically.

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note:*Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Define Funicular polygon.
2. Where funicular polygon is used?
3. State for which system of forces it is necessary to construct funicular polygon in graphic statics.
4. State graphical conditions of equilibrium for non-concurrent force system.

Space to Write Answers

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XX References / Suggestions for further Reading

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2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

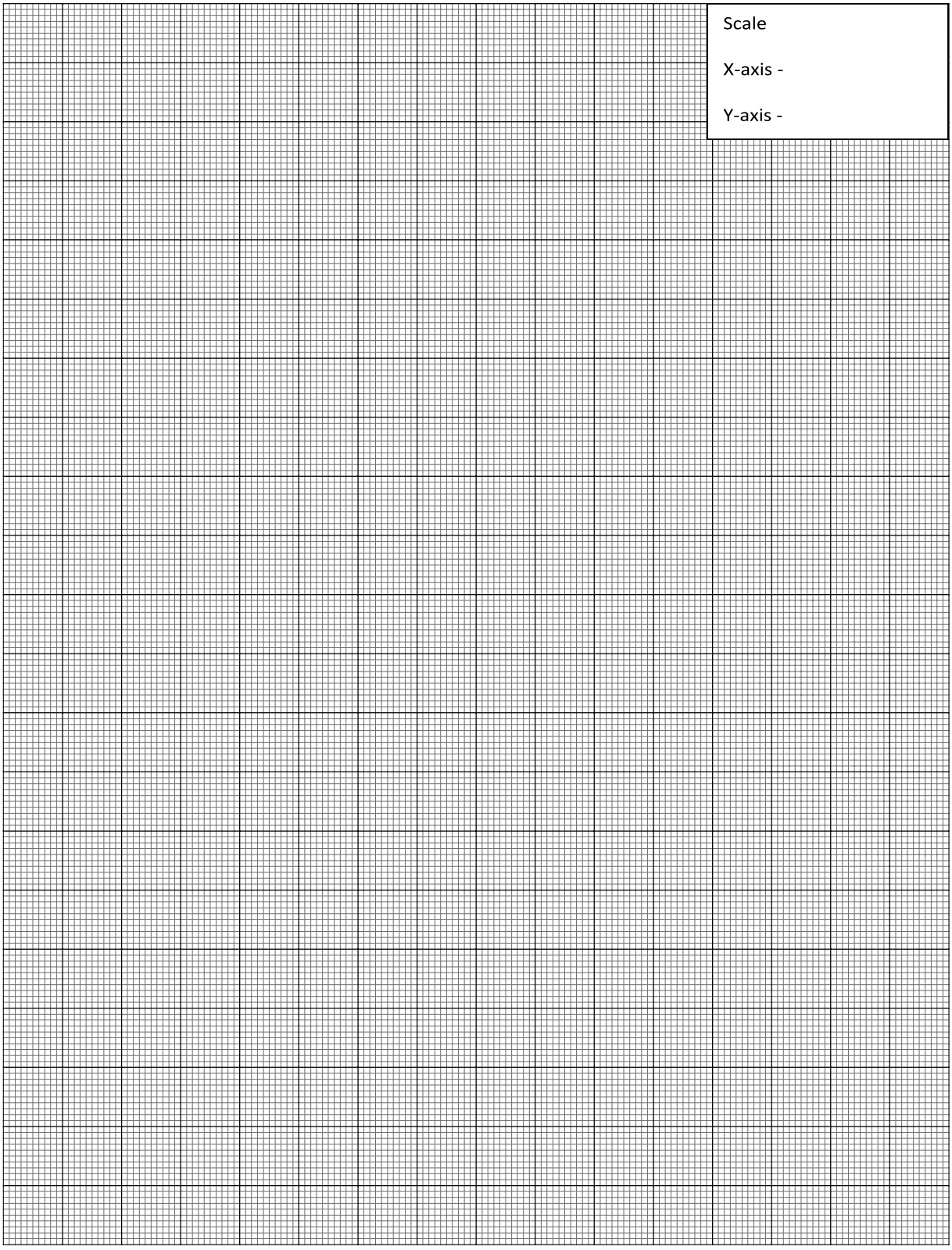
XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Proper use of drawing instruments.	5%
2	Giving Bow's notation and drawing Space diagram.	10%
3	Drawing Vector diagram.	10%
4	Drawing Funicular polygon.	10%
5	Calculation of magnitude and direction of resultant force.	10%
6	Locating position of Resultant force.	10%
7	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……
2. ……
3. ……
4. ……..
5. ……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	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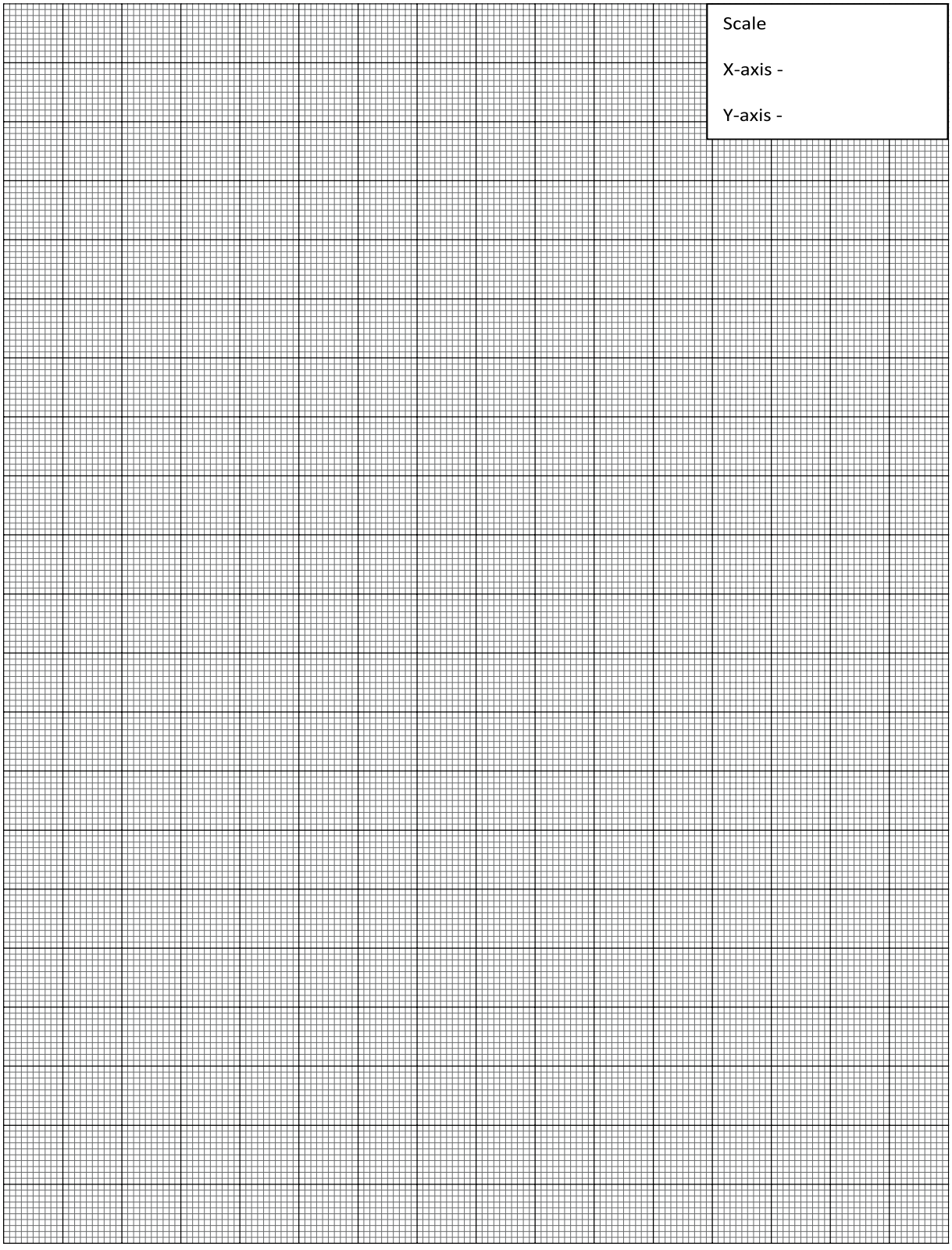
Y-axis -


Scale
X-axis -
Y-axis -

Practical No. 11: Determine Unknown Force by Using Law of Moment

I Practical Significance

When an object is balanced on a pivot the turning effect of the forces on one side of the pivot must balance the turning effect of the forces on the other side of the pivot - if they didn't, it would not balance.

In the picture (Figure 1(a) two girls are sitting on a see saw. They have moved until it is balanced. They are the same weight and so as to balance the seesaw they must sit the same distance from the pivot.

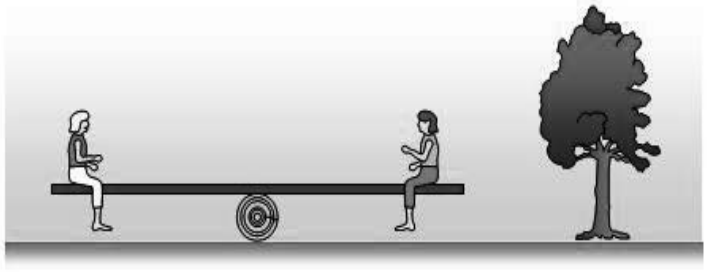


Figure 1(a)

In the picture (Figure 1(b) one of the girls gets off and a man sits on instead. They move until the see saw is balanced. The girl is much lighter than the man and so she has to sit further away from the pivot then he does so that she can balance his extra weight.

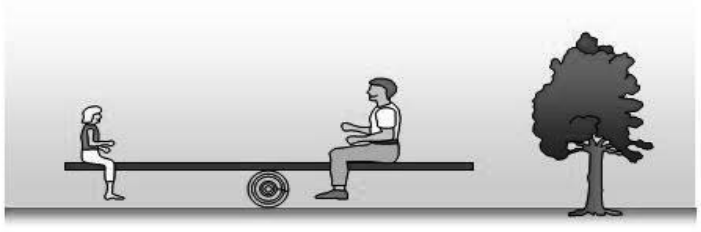


Figure 1(b)

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge

PO 2- Discipline knowledge

PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Determine unknown force of different engineering systems.

IV Practical Outcome

Use law of moment apparatus to determine unknown force.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill

b. Error estimation skill

c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.

b. Demonstrate working as a leader/a team member.

c. Maintain tools and equipment.

VII Minimum Theoretical Background

Law of Moments: When an object is balanced (in equilibrium) the sum of theclockwise moments is equal to the sum of the anticlockwise moments.
Force 1 x its distance from pivot = Force 2 x distance from the pivot.

$$F_1 d_1 = F_2 d_2$$

VIII Experimental Set-up

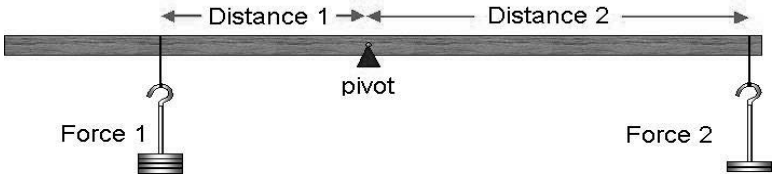
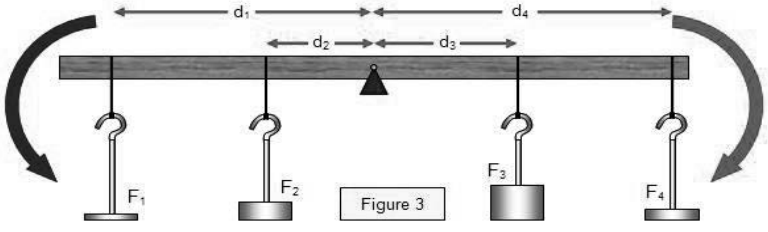


Figure 2: Law of Moment Apparatus

The following diagram (Figure 3) shows the effect of having more than one force on each side of the pivot



IX Resources required

S. No.	Particulars	Specification	Quantity	Remark
1	Meter rule	With small hole drilled at 50 cm mark.	01 for Group of 4 to 5 students	
2	Smooth optical pin	At least 5 cm long.	One	
3	50 g, 100 g masses	-----	3 No each	
4	Split cork	-----	One	

X Procedure

1.Place unequal weights on each side of the pivot.
2.Move the weights until the meter rule balances.
3.When this occurs take note of the anti-clockwise and clockwise moments.
4.Repeat several times by changing the distances on each side.
5.Repeat step (4) by changing one or two position and take two more sets of observations.

XI Precautions to be followed

1. Weights should be placed properly at required distance.
2. Meter rule should be perfectly horizontal.
3. Pivot should be perfectly at the center.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIIIV Precautions followed (To be written by students)

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XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Observation Table (As per Fig. No. 02)

Sr. No.	Force F_1 (N)	Force F_2(N)	Distance d_1 (cm)	Distance d_2 (cm)	Anti-clockwise Moment F_1xd_1 (N-cm)	Clockwise Moment F_2xd_2 (N-cm)
1						
2						
3						
4						
5						

XVI Results

Anticlockwise moment and clockwise moments are: …..……

(Equal / Nearly equal / Not equal)

XVII Interpretation of results(Give meaning of the above obtained results)

Unknown forces are such that anticlockwise and clockwise moments are nearly same.

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note:*Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State law of moments and its use.
2. State the two field situations where law of moment is used.
3. State how the load is shifted from one point to another point using couple.
4. Explain clockwise moment and anti-clockwise moment.
5. Write the significance of perpendicular distance while calculating moment.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the meter scale.	5%
2	Application of different weights at different locations.	15%
3	Observation of weights and distances.	10%
4	Measuring of weights and distances.	10%
5	Calculation of clockwise and anticlockwise moments.	15%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……
4. ……..
5. ……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

PracticalNo. 12: Determine Unknown Force by Using Lami'sTheorem

I Practical Significance

Several practical systems of equilibrium involving three forces require the analysis of thirdequilibriant force to keep the two concurrent forces in equilibrium. A cable carrying intermediate load suspenders, a roller climbing an obstacle, a sphere resting on two inclined surfaces etc. are few examples which can be analyzed using Lami's theorem. After performing this experiment students are able to solve different problems on coplanar concurrent force system in equilibrium consisting three forces.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Check the stability of various force systems.

IV Practical Outcome

Apply Lami's theorem to determine unknown force.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices and precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

Lami's theorem states that, if three concurrent forces act on a body keeping it in Equilibrium, then each force is proportional to the sine of the angle between the other two forces.

Let P, Q, R be the three concurrent forces in equilibrium as shown in figure below.

If an object is in equilibrium under the action of these three forces, the resultant of two forces must be equal and opposite to the third force. Thus, the line of action of the third force must pass through the point of intersection of the lines of action of the other two

forces. In other words, the system of three coplanar forces in equilibrium, must obey Lami's theorem.

By using simple weights, pulleys & strings placed around a circular table, several forces can be applied to an object located in the centre of the table in such a way that the forces exactly cancel each other, leaving the objects in equilibrium (the object will appear to be at rest). Force table is used to study the components at the force vector.

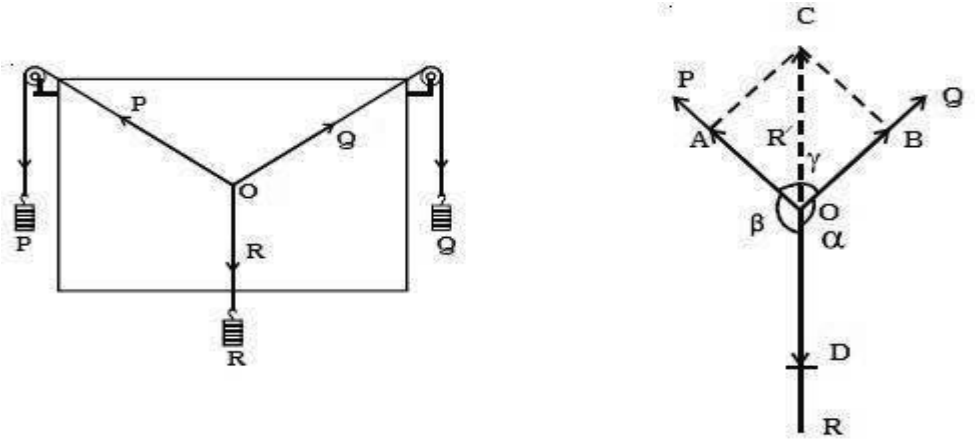

Figure 1

VIII Experimental Set-up

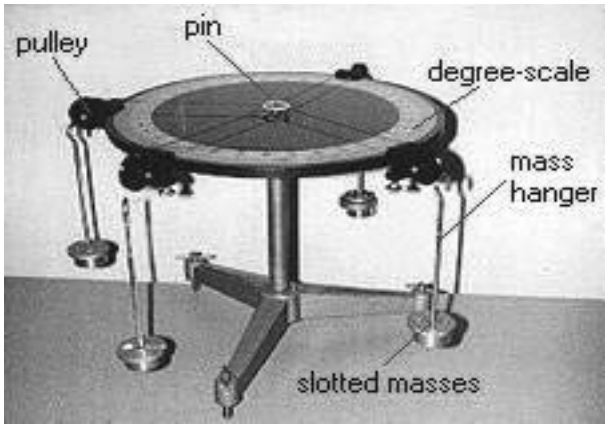

Figure 2: Force Table

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Force table	Circular graduated disc supported on rod and the assembly supported on three adjustable screws.	01 for Group of 4 to 5 students	
2	Circular ring of metal tied to the three strings.	-----	One ring Three strings.	
3	Load Hangers	50 gms and 100 gms	3 Nos each	
4	Slotted weights	50 gms and 100 gms	Three sets of 5 weights each	
5	Spirit level	10 cm long	One	

X Procedure

1. Place the Universal Force Table on firm platform.
2. Make the circular disc in horizontal position with the help of boot screws.
3. Check the horizontal position of circular disc by spirit level.
4. Clamp the three detachable pulleys to the circular disc at three different positions.
5. Keep the ring at the centre of disc and pass the other ends of each string over the three pulleys.
6. Hang three hangers to these ends of strings passing over the pulleys.
7. Put some slotted weights in two hangers and then add weight to third hanger so as to make pivot and
   Ringconcentric with each other, thus finding the third force.
8. Note the sum of slotted weights in each hanger and weight of hanger as three forces P, Q, and R.
9. Measure the angles included between the two adjacent pulleys and note them as α, β, γ as per figure 1.
10. Record these observations in table.
11. Repeat step (7) by changing one or two pulleys position and take two more sets of observations.

XI Precautions to be followed

1. Hangers should sit in the pulleys properly.
2. Force table should be perfectly horizontal.
3. Pivot and ring should be perfectly concentric with each other.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed (To be written by students)

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XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Observation Table

Sr. No.	Force (N)			Angle (Degree)			Ratio		
	P	Q	R	α	β	γ	P/sin α	Q/sin β	R/sin γ
1									
2									
3									
4									
5									

Sample Calculations:

1. P/sin α =
2. Q/sin β =
3. R/sin γ =

XVI Results

1. Ratios P/sin α, Q/sin β and R/sin γ are …..……..
   (Equal / Nearly equal / Not equal)
2. The force polygon is …….figure.

XVII Interpretation of results(Give meaning of the above obtained results)

If the ratio of force to the sin of opposite angle remains constant then the third observed equilibriant force is correct.

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note:*Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State conditions of Lami;s theorem.
2. State limitations of Lami;s theorem.
3. Give reason. P/sin α, Q/sin β and R/sin γ are equal.
4. State the two situations in field where Lami's theorem is used.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXISuggestedAssessment Scheme

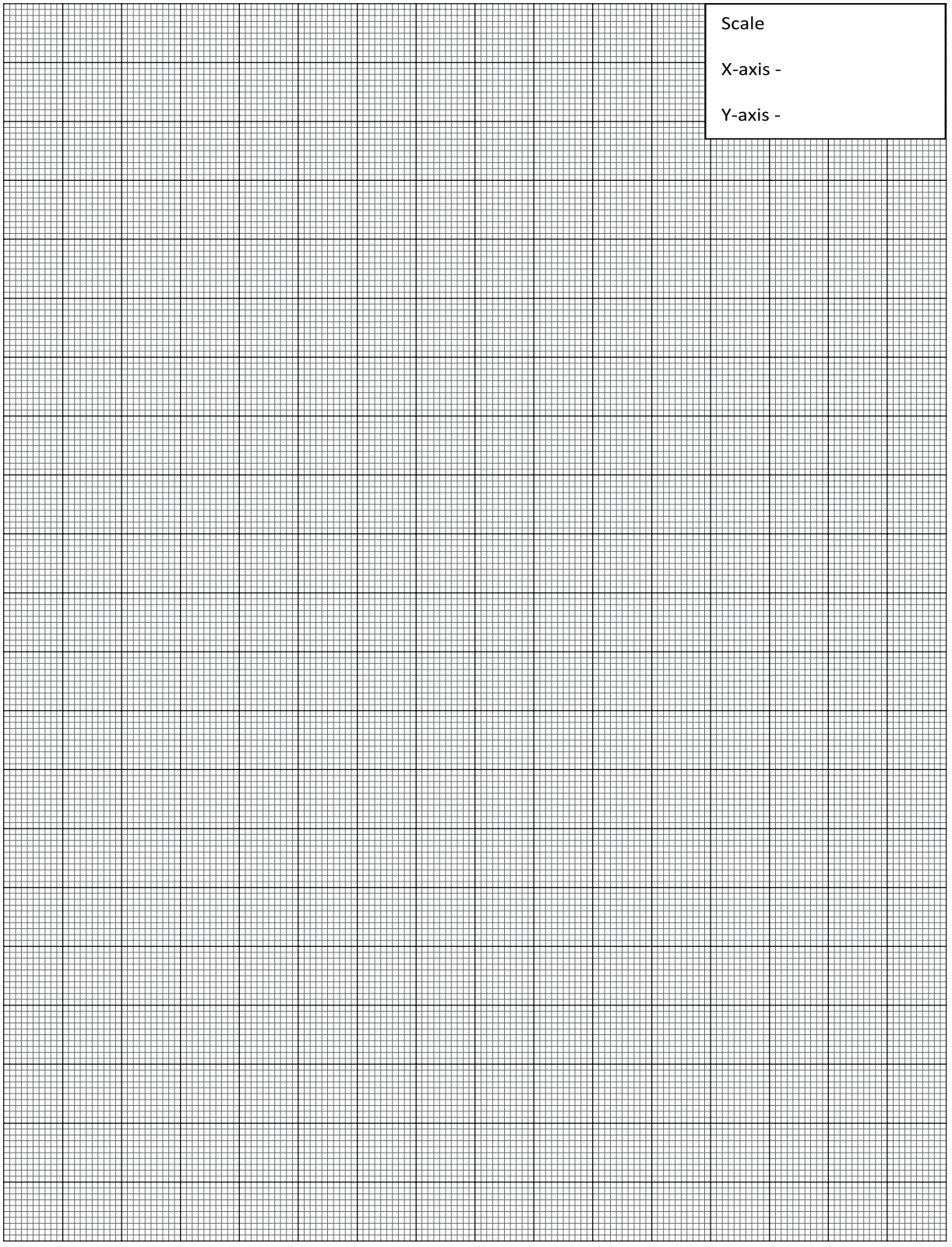
Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the force table.	5%
2	Application of different weights at different locations.	15%
3	Observation of weights in hangers and included angles.	5%
4	Measuring of weights in hangers and included angles.	15%
5	Calculation of third equilibrant force.	15%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. …….
2. …….
3. …….
4. …….
5. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -


Scale
X-axis -
Y-axis -

Practical No.13*:* Determine Support Reactions Of Simply Supported Beam

I Practical Significance

Determination of support reactions for loads coming on structural component such asbeam forms an integral part of structural analysis. Beams are used to support slabs, walls and other live loads and transfer loads coming on them to the supporting columns. After performing this experiment a Diploma Engineer will be able to compare the support reactions determined practically and analytically.

II Relevant Program Outcomes (POs) (from programme structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3-Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Check the stability of various force systems.

IV Practical Outcome

Determine support reactions of simply supported beam.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

1.Measurement skill

2.Error estimation skill

3.Observation skill

VI Relevant Affective domain related

a. Follow safety practices.

b. Demonstrate working as a leader/a team member.

c. Maintain tools and equipment.

VII Minimum Theoretical Background

Beam Apparatus: In a beam apparatus, a horizontal wooden beam of size 40mm x40mm x 1000mm with grooves at every 50mm along its length is attached with a wooden scale showing distances in centimeters. This beam is mounted in simply supported condition on two force measuring circular dials at its two ends, which can measure force upto 10 kg.

As the beam is loaded with different loads on hangers at different locations on the beam, the dials will show the reaction of the simply supported beam at the respective supports.

Beam is a structural member usually horizontal and straight provided to carry loads that are vertical or inclined to its axis. A simply supported beam is one whose ends are resting freely on the supports that provide only vertical reactions. Simply supported beam becomes unstable if it is subjected to oblique or inclined loads. When simply supported beam is subjected to only vertical loads, its FBD forms a system of parallel forces in equilibrium. Conditions of equilibrium $\Sigma Fy = 0$ and $\Sigma M = 0$ can be applied to determine the support reactions analytically.

VIII Experimental Set-up

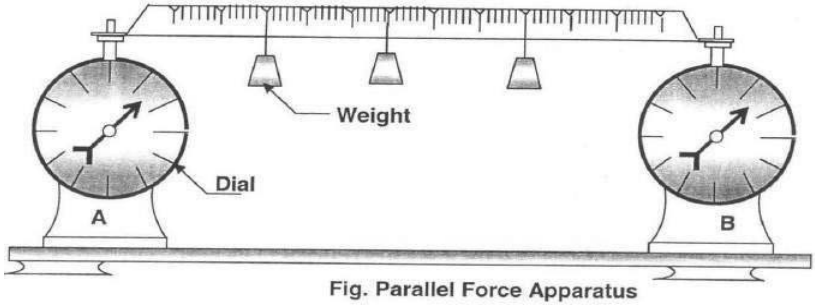


Fig. Parallel Force Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Beam apparatus	1000mm long beam with Scale fitted along length.	01 for Group of 4 to 5 students	
2	Force measuring Dials	Least count:100gm Max: 10kg	Two Nos.	
3	Measuring weights	500gms 1000gms	3 Nos. 3 Nos.	
4	Load Hangers	Hollow rectangular hangers to fit in grooves on the beam	3 Nos.	

X Procedure

1. Place the beam of length L on simple supports. Note that below both the simple supports there is a spring arrangement. On loading, the spring compresses due to the reaction force and this compressive force is indicated on the dial.
2. Arrange the load hangers arbitrarily on the beam and set the left and right dial pointers to zero. This will nullify the effect due to self-weight of the beam and the hangers.
3. Suspend the loads from the hangers. Note the load values W1, W2, and so on and their corresponding distances X1, X2 and so on from the left support.
4. Note the left and right support dial readings.
5. Repeat the above steps 1 to 4 by changing the weights in the hangers and also the hanger position for two more sets of observations.
6. Compare the experimental values with analytical values obtained by applying Conditions of Equilibrium

XI Precautions to be followed

1. Hangers should sit in the grooves properly.
2. Dials to be set to zero before loading the beam.

XII Actual procedure followed ((Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed (To be written by students)

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XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Observation Table

Sr. No.	Load W_1(N)	Load W_2(N)	Distance X_1(mm)	Distance X_2(mm)	Observed Reactions		Analytical Reactions	
					R_A (N)	R_B (N)	R_A (N)	R_B (N)
1								
2								
3								
4								
5								

Sample Calculations:

XVI Results

1. Observed Reaction R_A and Analytical Reaction R_A are: ……..
   (Equal / Nearly equal / Not equal)
2. Observed Reaction R_B and Analytical Reaction R_B are: ……..
   (Equal / Nearly equal / Not equal)

XVII Interpretation of results(Give meaning of the above obtained results)

The support reactions obtained experimentally are nearly equal to the analytical values.

The difference is within the limits of experimental error.

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note:*Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Give reason. $W_1 + W_2 = R_A + R_B$.
2. Write use of calculating support reactions of a beam.
3. State the two situations in field where simply supported beams are used.

4. State the analytical and graphical conditions of equilibrium used for calculating unknown force in parallel force system.
5. State the magnitude of R_A and R_B if simply supported beam carrying udl '*w*' over entire span.

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

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Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the force table.	5%
2	Application of different weights at different locations.	15%
3	Observation of weights in hangers and included angles.	5%
4	Measuring of weights in hangers and included angles.	15%
5	Calculation of third equilibrant force.	15%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. …….
2. …….
3. …….
4. …….
5. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.14: Determine Coefficient Of Friction for Motion On Horizontal Plane

I Practical Significance

Whenever two surfaces touch, they exert forces on each other. Friction is the force thatresists the relative motion of one surface in contact with another. We are able to walk on any surface due to this friction between our feet and the surface below. Similarly any vehicle moving on a surface is also due to friction between the tyre and the surface. If the moving vehicle has to be stopped the again the friction plays a role to bring the vehicle to halt. Hence life would be difficult without friction.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3- Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Apply the principles of friction in various conditions for useful purposes.

IV Practical Outcome

Determine force of friction and coefficient of friction for the given condition.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill

b. Error estimation skill

c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices.

b. Demonstrate working as a leader/a team member.

c. Maintain tools and equipment.

VII Minimum Theoretical Background

Friction force is developed whenever there is a motion or tendency of motion of one body with respect to the other body involving rubbing of the surfaces of contact. Friction is therefore a resistance force to sliding between two bodies produced at the common surfaces of contact. It is the least force required to make a body start sliding over a surface.

Friction occurs because no surface is perfectly smooth, however flat it may appear. On every surface there are 'microscopic hills and valleys (i.e. irregularities) and due to this the surfaces get interlocked making it difficult for one surface to slide over the other. During static state the friction force developed at the contact surface depends on the magnitude of the disturbing force. When the body is on the verge of motion the contact surface offers maximum frictional force called as 'Limiting Frictional Force'.

In 1781 the French Physicist Charles de Coulomb found that the limiting frictional force did not depend on the area of contact but depends on the materialsinvolved and the pressure (normal reaction) between them. Thus frictional force $F \alpha N$

The contact surfaces of the block and the incline are faced with sheets of materials between which the coefficient of friction is desired.

VIII Experimental Set-up

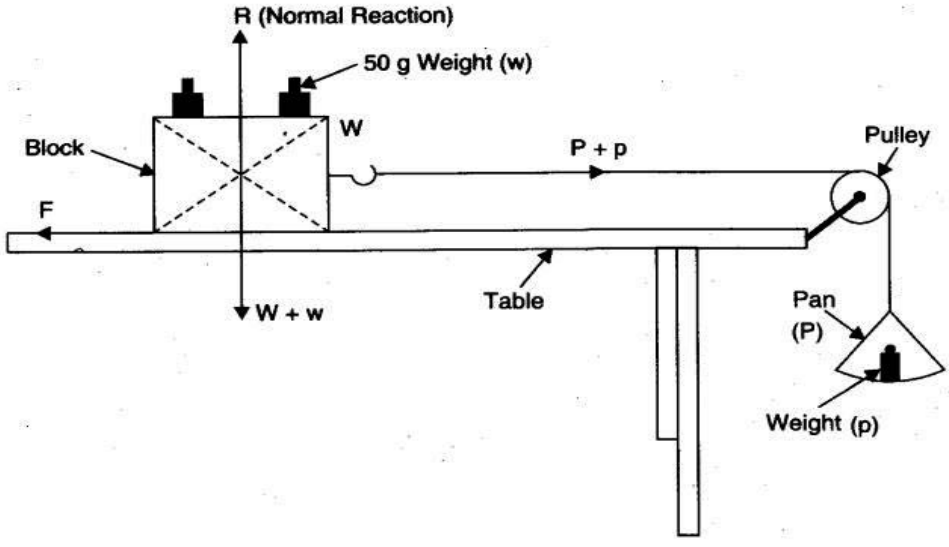

Fig. Study for force of sliding friction.

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Adjustable Inclined Plane	Wooden make with protractor fitted to it for measurement of angle of inclination. A frictionless pulley fitted at its free end.	One for Group of 4 to 5 students	
2	Block	Hollow wooden block with bottom fitted with different material sheets such as aluminum, brass, copper, plywood etc	One each	
3	Standard Weights	Measuring 100, 500 and 1000gms a fractional weight box	Two each One	
4	Inextensible String with Pan	1m long tied to the block at one end and pan at the other	One for each block	
5	Spirit Level	150mm long portable	One	

X Procedure

1. Set the apparatus perfectly horizontal.
1. Weigh the block then add some weight to it and record its mass.

3.Wipe the surfaces of the plank and block with a moist paper towel. Make sure both arefree of dirt and grit.

4. Clamp the pulley at the end of the plank and place the plank at the edge of a lab table. Place the block on the far end of the plank and attach a length of string to it. Drape the string over the pulley and hang the mass hanger from its end. The string should be short enough so that the block can slide the length of the plank before the mass hanger hits the floor.
5. Determine how much weight must be added to the hanger so that the system (block, string and hanger with mass) moves at constant speed.
6. Add a little mass to the hanger. Give the block a slight push to start it moving. If the block accelerates (speeds up), take a little mass off and try again. If the block decelerates (slows down), add a little more mass and try again. (Note: If the blockaccelerates from the weight of the mass hanger alone, put 20 or so grams on top of the block and treat that mass as part of the block.)If the block moves the length of the plank at roughly the same speed, you have found the necessary mass.

7. Record the total hanging mass and its weight (P).
8. Record the total mass of and on the block and its weight (W).
9. Repeat the above process, adding 100 grams on top of the block for each new trial, for a total of three trials.
10. Repeat the process with different set of surfaces in contact.

XI Precautions to be followed

1. The reading must be noted down carefully.
2. The load and effort should move slowly.
3. Effort must be applied gradually.
4. There should be no knot in the string.
5. Only light weights must be used during the conduct of experiment.

XII Actual procedure followed(Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

……

……

XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Observation Table

Sr. No.	Surfaces in contact	Load W (N)	Effort P (N)	Force of Friction F=P (N)	Normal Reaction R=W (N)	Coefficient of Friction μ =F/R	Average μ
1							
2							
3							
1							
2							
3							

Draw FBD

Sample Calculations:

By using conditions of equilibrium. ($\Sigma F_y=0$ and $\Sigma Fy=0$), determine coefficient of friction (μ)

1. F=
2. R=
3. μ= F / R =

XVI Results

1. The average value of the coefficient of static friction for surface in contact

   a) ……. …..and……..…. (μ) =……

2. …… …..….and……..…… (μ) =……

XVII Interpretation of results(Give meaning of the above obtained results)

1. Force of friction (F) increases / decreases with increase in load (W).
2. Coefficient of friction for a pair of surfaces in contact……..
   and…… is more / less than that for …….....…..and……...

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note:*Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. Write any four field applications of friction on horizontal surface.
2. Does the coefficient of friction change with load? How does it vary?
3. Weather the coefficient of friction will remain same for motion in reverse direction? Give reason.
4. What will be the situation if there is no friction?
5. Calculate coefficient of friction by plotting graph between load pulled and effort required.
6. Determine the effort required to pull the load of 100kN on same pair of surfaces.

Space to Write Answers

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Engineering Mechanics	Khurmi R.S. Khurmi N.	S. Chand & Co (p) Ltd. New Delhi 2016 ISBN: 978-93-854-0194-7
2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling and setting of the apparatus.	5%
2	Proper determination and applying of effort.	15%
3	Observation of motion.	10%
4	Calculation of parameters concerned.	10%
5	Determination of coefficient of friction.	15%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1……

2…….

3……..

4…….

5…….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.15: Determine Coefficient Of Friction for Motion On Inclined Plane

I Practical Significance

Whenever two surfaces touch, they exert forces on each other. Friction is the force thatresists the relative motion of one surface in contact with another. We are able to walk on any surface due to this friction between our feet and the surface below. Similarly any vehicle moving on a surface is also due to friction between the tyre and the surface. If the moving vehicle has to be stopped the friction plays a role to bring the vehicle to rest. Hence life would be difficult without friction.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3-Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Apply the principles of friction in various conditions for useful purposes.

IV Practical Outcome

Determine force of friction and coefficient of friction for the given condition.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement Skill

b. Error estimation Skill

c. Plotting graphs

VI Relevant Affective domain related

a. Follow safety practices.

b. Demonstrate working as a leader/a team member.

c. Maintain tools and equipment.

VII Minimum Theoretical Background

Friction force is developed whenever there is a motion or tendency of motion of one body with respect to the other body involving rubbing of the surfaces of contact. Friction is

therefore a resistance force to sliding between two bodies produced at the common surfaces of contact.

Friction occurs because no surface is perfectly smooth, however flat it may appear. On every surface there are 'microscopic hills and valleys (i.e. irregularities) and due to this the surfaces get interlocked making it difficult for one surface to slide over the other. During static state the friction force developed at the contact surface depends on the magnitude of the disturbing force. When the body is on the verge of motion the contact surface offers maximum frictional force called as 'Limiting Frictional Force'.

In 1781 the French Physicist Charles de Coulomb found that the limiting frictional force did not depend on the area of contact but depends on the materials involved and the pressure (normal reaction) between them.

The contact surfaces of the block and the inclined plane are faced with sheets of materials between which the coefficient of friction is desired.

At a fixed angle of inclination θ, the suspended mass is increased until the block is at the verge of upward i.e. in the state of impending motion.

VIII Experimental Set-up

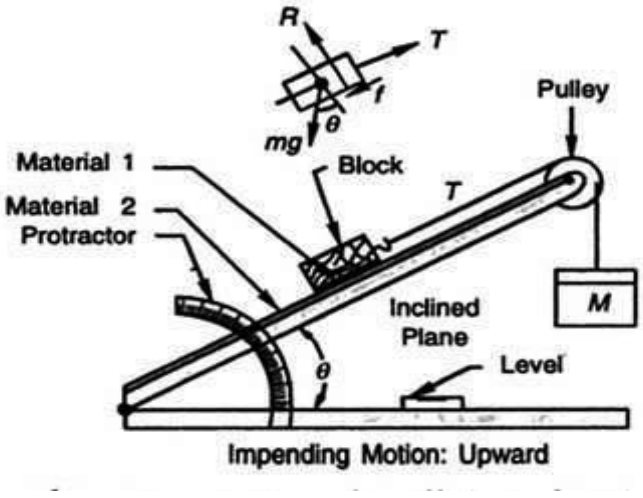

Figure: Motion on Inclined Plane

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Adjustable inclined plane	Wooden make with protractor fitted to it for measurement of angle of inclination. A frictionless pulley fitted at its free end.	One for Group of 4 to 5 students	
2	Block	Hollow wooden block with bottom fitted with different material sheets such as aluminum, brass, copper, plywood etc	One each	
3	standard weights	Measuring 100, 500 and 1000gms a fractional weight box	Two each One	
4	Inextensible string with pan	1m long tied to the block at one end and pan at the other	One for each block	

X Procedure

1. Set the apparatus at any desired angle.
2. Weigh the block then add some weight to it and record its mass.
3. Wipe the surfaces of the plank and block with a moist paper towel. Make sure both are free of dirt and grit.
4. Clamp the pulley at the end of the plank and place the plank at the edge of a lab table. Place the block on the far end of the plank and attach a length of string to it. Drape the string over the pulley and hang the mass hanger from its end. The string should be short enough so that the block can slide the length of the plank before the mass hanger hits the floor.
5. Determine what weight must be added to the hanger so that the system (block, string and hanger with mass) moves at constant speed:
6. Add a little mass to the hanger. Give the block a slight push to start it moving. If the block accelerates (speeds up), take a little mass off and try again. If the block decelerates (slows down), add a little more mass and try again. (Note: If the block accelerates from the weight of the mass hanger alone, put 20 or so grams on top of the block and treat that mass as part of the block.)
7. If the block moves the length of the plank at roughly the same speed, you have found the necessary mass.
8. Record the total hanging mass and its weight (P).
9. Record the total mass of and on the block and its weight (W).
10. Repeat the above process, adding 100 grams on top of the block for each new trial, for a total of six trials.

XI Precautions to be followed

1. The reading must be noted down carefully.
2. The load and effort should move slowly.
3. Effort must be applied gradually.
4. There should be no knot in the string.
5. Only light weights must be used during the conduct of experiment.
6. The hanger should not move fast enough to bang the floor below.

XII Actual procedure followed(Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Observation Table

Sr. No.	Surfaces in contact	Inclination of plane	Load W (N)	Effort P (N)	Sin θ	Cos θ	Coefficient of Friction μ	Average μ
1								
2								
3								
1								
2								
3								

Draw FBD

a) Body just sliding down the inclined plane.

b) Body just sliding up the inclined plane.

Sample Calculations:

By using conditions of equilibrium. ($\Sigma F_y=0$ and $\Sigma Fy=0$),determine coefficient of friction (μ)

a) Body just sliding down the inclined plane.

$\mu = W\ Sin\theta - P / WCos\theta$

=

b) Body just sliding up the inclined plane.

$\mu = -P - W\ Sin\theta / WCos\theta$

=

XVI Results

1. The average value of the coefficient of static friction for surface in contact …… ….and……. is ……..

XVII Interpretation of results(Give meaning of the above obtained results)

Friction depends on the nature of surfaces in contact and independent on area of contact.

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note:*Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. State law of friction.
2. Define angle of friction
3. Write relation between μ and α.
4. Write laws of static friction.
5. Give reason. In rainy season the moving vehicles skid on the road.
6. Write any two advantages of reduction in friction.
7. Write any two advantages of increase in friction.

Space to Write Answers

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XX References / Suggestions for further Reading

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2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI SuggestedAssessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling and setting of the apparatus.	5%
2	Proper determination and applying of effort.	15%
3	Observation of motion.	10%
4	Calculation of parameters concerned.	10%
5	Determination of coefficient of friction.	15%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1……..

2……..

3…….

4…….

5……..

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 16: Determine Centroid of Geometrical Plane Figures

I Practical Significance

The centroid of an area is the point at which all the area could be concentrated without changing its first moment about any axis. When an area has only one axis of symmetry only one coordinate of the centroid can be found by inspection.
If we can calculate the centroids of geometric plane figures we can locate the centroid of any area by breaking it down into simple geometric shapes. If some parts require integration, you must do that first and then use composite methods.

II Relevant Program Outcomes (POs) (from programme Structure)

PO 1- Basic knowledge
PO 2- Discipline knowledge
PO 3-Experiments and practice

PSO 2 – Equipment and Instruments: Maintain machine, equipment and instruments related to Mechanical Engineering.

III Relevant Course Outcomes (from course details)

Find the centroid and centre of gravity of various components in engineering systems.

IV Practical Outcome

Determine centroid of geometrical plane figures.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill

b. Error estimation skill

c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices and precautions.

b. Demonstrate working as a leader/a team member.

c. Maintain tools and equipment.

VII Minimum Theoretical Background

Centroid is the geometric centre of a plane lamina. The centroid or geometric center ofa plane figure is the arithmetic mean (“average”) position of all the points in the shape. In other words it is the point at which a cutout of the shape could be perfectly balanced on the tipof a pin.

In particular, the geometric centroid of an object lies in the intersection of allitshyper planes of symmetry. The centroid of many figures (regular polygon, regularpolyhedron, cylinder, rectangle, rhombus, circle, sphere, ellipse, ellipsoid, super ellipse, super ellipsoid, etc.) can be determined by this principle alone.

Thus the centroid of a parallelogram is the meeting point of its two diagonals. This is not true for other quadrilaterals.

VIII Experimental Set-up

Figure 1. Centroid with the help of Centre of gravity (centre of mass)

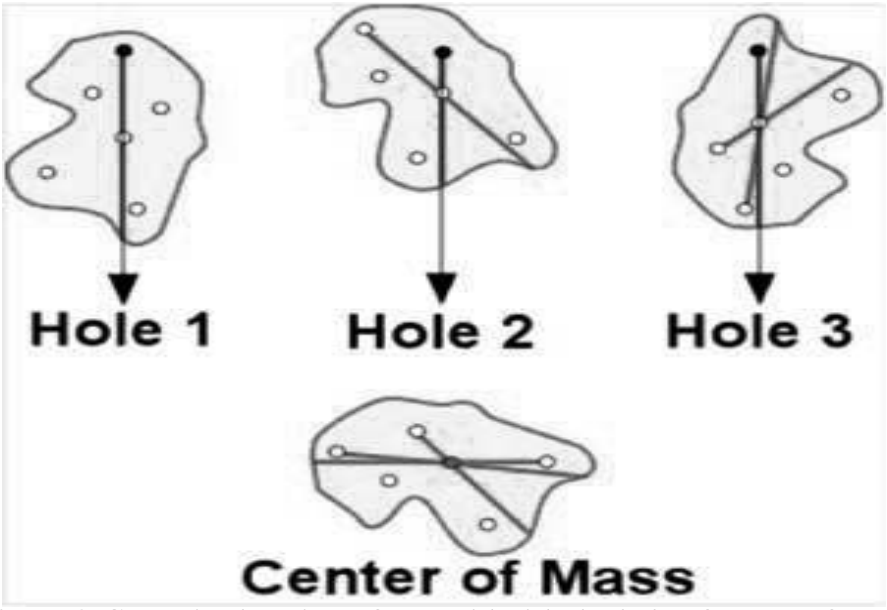

Figure 2. Step wise location of centroid with the help of centre of mass

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Sheet of paper/ Hardboard/plywood or equivalent	-----	01 for each shape	
2	Scissor/Cutter	-----	01 for batch of 3 to 4 students	
3	Plumb bob with string	-----	01 for batch of 3 to 4 students	
4	Marker pen	-----	01 for batch of 3 to 4 students	

X Procedure

Centroid of any shape with plumb line.

1. Draw any shape on a sheet of hard board/plywood or equivalent material.
2. Hang that shape on a peg through the desired hole.
3. Hang a plumb bob in front.
4. Mark plumb line with marker.
5. Repeat with other holes.
6. Mark the point of intersection of line.
7. This point of intersection of line is centriod of plane lamina.

XI Precautions to be followed

1. Lines should be connected to each other accurately.
2. Drawing errors should be reduced to minimum so as to get correct results.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIX Precautions followed (To be written by students)

……

……

XV Observations and Calculations(Use blank sheet provided if space not sufficient)

Observation Table

Sr. No.	Shape	Dimensions (mm)			X-Coordinate (mm)	Y-Coordinate (mm)
1	Square					
2	Rectangle					
3	Triangle					
4	Circle					
5	Semicircle					
6	Trapezium					

XVI Results

1. Centroid of Square =
2. Centroid of Rectangle =
3. Centroid of Triangle =
4. Centroid of Circle =
5. Centroid of Semi-circle =
6. Centroid of Trapezium =

XVII Interpretation of results(Give meaning of the above obtained results)

Centroids of plane figures calculated by using formulae are nearly equal to measured value of centroid with plumb line.

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

Note:*Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.*

1. What is the centroid of a circle of diameter 100mm.
2. Locate the centroid of a right angle triangle having base 100mm and height 150mm.
3. Differentiate between centroid and centre of gravity.
4. Indicate the positions of centre of gravity of solid hemi sphere.
5. Indicate the positions of centre of gravity of solid cone.

Space to Write Answers

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XX References / Suggestions for further Reading

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2	Engineering Mechanics	Bhattacharyya Basudeb	Oxford University press New Delhi 2014 ISBN-13:978-0-19-809632-0

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of different geometrical shapes.	5%
2	Keeping the plumb line vertical.	10%
3	Marking of line on plane lamina.	10%
4	Determination of centroid of geometrical shapes.	10%
5	Analytical calculations of centroid	20%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result.	10%
3	Conclusions and recommendations	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..……..
2. ……..……....
3. …….
4. …….
5. …….

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101W
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048
20	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22049

Fifth Semester:

1	Network Management & Administration	17061
2	Solid Modeling	17063
3	CNC Machines	17064
4	Behavioral Science(Hand Book)	17075
5	Behavioral Science (Assignment Book)	17075
6	Windows Programming using VC++	17076
7	Estimation and Costing	17501
8	Public Health Engineering	17503
9	Concrete Technology	17504
10	Design of Steel Structures	17505
11	Switchgear and Protection	17508
12	Microprocessor & Application	17509
13	A.C. Machines	17511
14	Operating System	17512
15	Java Programming	17515
16	System Programming	17517
17	Communication Technology	17519
18	Hydraulic & Pneumatics	17522
19	Advanced Automobile Engines	17523
20	Basic Electrical & Electronics	17524
21	Measurement and Control	17528
22	Power Engineering	17529
23	Metrology & Quality Control	17530
24	Computer Hardware & Networking	17533
25	Microcontroller	17534
26	Digital Communication	17535
27	Control System & PLC	17536
28	Audio Video Engineering	17537
29	Control System	17538
30	Industrial Electronics and applications	17541
31	Heat Transfer Operations	17560
32	Chemical Process Instrumentation & control	17561

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

HEAD OFFICE

Secretary,
Maharashtra State Board of Technical Education
49, Kherwadi, Bandra (East), Mumbai - 400 051
Maharashtra (INDIA)
Tel: (022)26471255 (5 -lines)
Fax: 022 - 26473980
Email: -secretary@msbte.com
Web -www.msbte.org.in

REGIONAL OFFICES:

MUMBAI

Deputy Secretary (T),
Mumbai Sub-region,
2nd Floor, Govt. Polytechnic Building,
49, Kherwadi, Bandra (East)
Mumbai - 400 051
Phone: 022-26473253 / 54
Fax: 022-26478795
Email: rbtemumbai@msbte.com

PUNE

Deputy Secretary (T),
M.S. Board of Technical Education,
Regional Office,
412-E, Bahirat Patil Chowk,
Shivaji Nagar, Pune
Phone: 020-25656994 / 25660319
Fax: 020-25656994
Email: rbtepn@msbte.com

NAGPUR

Deputy Secretary (T),
M.S. Board of Technical Education
Regional Office,
Mangalwari Bazar, Sadar, Nagpur - 440 001
Phone: 0712-2564836 / 2562223
Fax: 0712-2560350
Email: rbteng@msbte.com

AURANGABAD

Deputy Secretary (T),
M.S. Board of Technical Education,
Regional Office,
Osmanpura, Aurangabad -431 001.
Phone: 0240-2334025 / 2331273
Fax: 0240-2349669
Email: rbteau@msbte.com