



*DRONACHARYA GROUP OF INSTITUTIONS,
GREATER NOIDA*

Mechanical Engineering Department

LABORATORY MANUAL

Engineering Mechanics (ME-201)

INDEX

S.No	Topic	Date of Submission	Remarks
1	Polygon law of Co-planer forces (concurrent)		
2	Friction experiment(s) on inclined plane and/or on screw-jack.		
3	Experiment on Trusses.		
4	Moment of inertia of fly wheel.		
5	Screw fiction by using screw jack		
6	Worm & worm-wheel experiment for load lifting		

EXPERIMENT NO-1

OBJECTIVE-

To verify the principle of forces in beam of Parallel Forces Apparatus.

APPARATUS REQUIRED-

- Parallel forces Apparatus 10 kg dial type,
- Conical weights
- Aluminum rectangular stirrups.

THEORY-

If a system of coplanar forces acting on a rigid body keep it in equilibrium then the algebraic sum of their moments about any point in their plane is zero.

PROCEDURE-

- Note the zero error in the compression balances. When the beam is supported at its ends.
- Suspend two different weights from the sliding hook against any division marked on the beam.
- Note the reaction on the beam given by the readings of compression balances and take into account the zero error from each reading.
- Find the sum of anti-clockwise moment about its reading.
- Find the % age error between clockwise and anti-clockwise moment.
- Suspend three or four weights at different graduated divisions of the beam and find % age error between clockwise and anti-clockwise moment as before.

OBSERVATION TABLE-

Zero error in compression balances No. 1 = -----

Zero error in compression balances No. 2 = -----

S.No.	Wt. W_1	Reaction R_1	Distance Of W_1 (X_1)	Distance of R_1 (y_1)

Take in this manner about seven readings.

RESULTS AND DISCUSSION-

PRECAUTIONS-

- Zero error of the compression balances must be taken into account.
- Weight should not be put on the beam with a jerk.
- Slightly press the beam in to remove any frictional resistance at the support before taking readings.

EXPERIMENT NO-2

OBJECTIVE-

To verify the Parallelogram law of forces.
(Triangle, Parallelogram, Polygon & Lamis Theorem)

APPARATUS REQUIRED-

- Iron nickelled slotted Weight box
- Paper sheet
- Four frictionless pulleys
- Thread
- Drawing pins
- Mirror strip
- Gravesend's apparatus
- Set squares
- Pencil
- Pans

THEORY-

Law of parallelogram of forces states that "if two force, acting simultaneously on a particle, be represented in magnitude and direction by the two adjacent sides of a parallelogram, then their resultant may be represented in magnitude and direction by the diagonal of the parallelogram, which passes through their point of intersection."

Mathematically, resultant force, $R = \sqrt{P^2 + Q^2 + 2PQ \cos\theta}$ where, P and Q are the force, where whose resultant is required to be found out and θ is the angle between the forces P and Q.

PROCEDURE-

- Set the board in vertical plane and fix the paper sheet with drawing pins.
- Pass a thread over two pulleys.
- Take a second thread and tie the middle of this thread to the middle of first thread.
- Pass the ends of the second thread over the other set of two pulleys.
- Take a third thread and tie its one end to the point of first two threads.
- Attach pans to the free ends of the thread as shown in (Fig. 2.1).
- Place the weight in the pans in such a manner that the knot comes approximately in the center of the paper.
- Take the mirror strip and place it under the threads turn by turn and mark the points by keeping the eye, the thread and its image in the same line without disturbing the system.
- Mark the lines of forces and write down the magnitude of forces.
- Remove the paper from the board and produce the lines to meet at a point O.
- Select a suitable scale and draw the vector diagram (Fig. 2.2) by moving in one direction (i.e. clockwise or anticlockwise). Draw ab parallel to AB and cut it equal to force p, draw bc parallel to BC and cut it equal to force Q, draw cd parallel to CD and cut it equal to force R, draw de parallel to DE and cut it equal to force S. Vector ae will be the resultant force T1 taken in opposite direction and should be equal to force T which proves the law of polygon of force. If forces. If ae is not equal to then percentage error is found as follows.

Percentage error =
$$\frac{T-T_1}{T} \times 100$$

OBSERVATION TABLE- Scale-----

S. No.	Force (Total weight of part)					Calculated Resultant T_1	Percentage Error $=\frac{T-T_1}{T} \times 100$ 100
	P	Q	R	S	T		

RESULTS AND DISCUSSION-

PRECAUTIONS-

- Pans/ weights should not touch the board.
- There should be only one central knot on the thread which should be small..
- Make sure that all pans are at rest when the lines of action of force are marked.
- All the pulleys should be free from friction.
- While calculating the total force in each the weight of the pan should be added to the weight put into the pan.

EXPERIMENT NO-3

OBJECTIVE-

To measure the co-efficient of friction of different surfaces.

APPARATUS REQUIRED-

- Inclined plane.
- Sliding boxes with different surfaces.
- String.
- Scale pan.

THEORY-

The co- efficient of friction can be found by three different ways on the inclined plane.

Method -1

- The inclined plane is kept horizontal and the sliding box is given a horizontal pull P. In the limiting case, when the box just slides,

$$P = \mu w \text{ or } \mu = p/w.$$

Method -2

- The inclined plane is kept in an inclined position and the sliding box is pulled upwards along the inclined plane by a force p. When the box just slides,

$$R = W \cos\theta$$

$$P = W \sin\theta + \mu W \cos\theta$$

Or

$$\mu = (P - W \sin\theta) / W \cos\theta$$

Method -3

- The sliding box is kept in the horizontal plane, and is the plane is raised gradually until the box just slides. If θ is the angle when the box just slides,

$$W \cos\theta = W \sin\theta$$

Or

$$\mu = \tan\theta$$

PROCEDURE-

- Take the inclined board with a glass surface.
- Keep it horizontal initially and put the slider with steel base on it. Increase the inclination of the inclined board gradually till the slider just begins to slide on it.
- Note the angle in this position. This is angle friction let it be θ_1 .
- Now place some weights in the slider and repeat and experiment as before. Let the angle of inclination in this case be θ_2 .
- Repeat the experiment as before with different weight in the slider each time. Note the corresponding angle of inclination of inclined Board and their mean. Let it be θ . This is the then the coefficient of friction is (μ) given by $\mu = \tan \theta$.

- The experiment may be repeated with other different surface, to find the coefficient of friction between them.

OBSERVATION TABLE-

S. No-	Wt. of Box. (a)	Wt. in the box (b)	Total Weight $W=(a+b)$	Wt. of Pan (c)	Wt. in The pan (d)	Total Wt $P=(c+d)$	μ	Mean μ

RESULTS AND DISCUSSION-

PRECAUTIONS-

- Clean the two surfaces so no grease or sand sticking to the surfaces.
- Increase the angle very slowly.
- Particular region of the inclined board may be used.
- The block should just begin to move, it should not move abruptly.

EXPERIMENT NO-4

OBJECTIVE-

To calculate the force in the member of simple roof truss.

APPARATUS-

- A roof truss model having one end hinged and the other roller supported
- Spring balance to measure forces
- Weights
- Scale

THEORY-

A truss is a triangulation arrangement of straight members, all connected by frictionless pins. The loads act on the joint. The members are under tension or compression. Therefore, they are known as TIE or STRUT respectively.

The trusses may be of two kinds viz.

- (a) Perfect truss (b) imperfect truss

An imperfect truss may be (i) redundant (ii) deficient

A truss is known as perfect or imperfect according to the law obeyed by them as given below

- $m = (2j - \lambda)$ for perfect truss
- $m > (2j - \lambda)$ truss is redundant
- $m < (2j - \lambda)$ truss is deficient

Where m = number of member, j = number of joints, and λ = number of external reaction.

Practically $\lambda = 3$ because, one support is kept hinged while the other as simply supported.

- $m = 2j - 3$ for perfect truss
- $m > 2j - 3$ for redundant truss
- $m < 2j - 3$ for deficient truss

Perfect Truss-

A perfect truss may be simply supported or of cantilever type. The theoretical analysis of forces in magnitude and is done by the following methods.

- Method of joints in which equilibrium conditions are $\sum F_x = 0, \sum F_y = 0,$
- Method of section in which equilibrium conditions are $\sum M = 0$
- Graphical method (Maxwell's method)

TEST SET-UP:

A roof truss apparatus is hinged at one end and roller supported on the end. There are two arms (rafter) named AB and AC. Both are pin-jointed at A. Since the hinged end B cannot move, therefore arm AB is called 'fixed arm'; while the arm AC is known as 'variable arm' because the roller end C can move away.

Both arms AB and AC are equipped with spring mounted arrangement. The spring used is of spring stiffness $k = \text{kg/cm}$. Hence if some force is to be calculated in the arm; the recorded deflection x on the graduated scale should be multiplied by spring stiffness. Thus

$$F = K \times x$$

The value of k may be different for different set-up. For the set-up under question, its value is $k = 2.34 \text{ kg/cm}$. The ends B and C are connected to a balance which is used to determine the force induced in BC string.

PROCEDURE:

The stepwise procedure to conduct this experiment is given as follows.

- First of all, an external load W is the joint of fixed arm AB and variable arm AC. Consequently the arms AB and AC undergo deformation which can be noted from graduated scale and calculated by using Eq.
- Under the effect of W the roller C moves rightwards. Hence the string BC extends in length. Which indicates that BC has undergone tension. The tensile force is noted from the corresponding spring balance.
- The applied load W is now changed to W_1 and the corresponding forces in AB and BC spring balances are measured each time.
- above experiment is repeated 4 & 5 time by changing the applied load to W_2 , W_3 and so on, and reading in AB and BC member are recorded each time.

OBSERVATIONS-

The following data are obtained by conducting a real experiment.

Spring stiffness for fixed arm =-----kg/cm

Spring stiffness for variable arm =-----kg/cm

S.No.	Load W		Deformation in		Observed force F	
	In kg	In N	Fixed arm (cm)	Variable arm (m)	In fixed arm (N)	In variable arm (N)
1.						
2.						

Observed force for fixed arm = Deformation in fixed x (spring stiffness)

Observed force for variable arm = Deformation in variable arm x (spring stiffness)

Theoretical calculation of forces forces for other Configuration of the Truss.

Similarly the forces for other truss configuration can also be calculated.

S.No.	Height h (cm)	Arm AB (cm)	Arm AC (cm)	Theoretical	
				Force in fixed Arm (N)	Variable arm (N)
1.					
2.					

3.					
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RESULT –

The experimentally observed values and theoretical calculated magnitudes of force in AB and AC members are different values of W. These can be found in terms of percentage error by

$$\% \text{ Error} = \frac{\text{Force determined experimentally} - \text{Force calculated theoretically}}{\text{Force calculated theoretically}}$$

Set of reading	% Error for force in AB	% Error for force in AC
• For 1st reading		
• For 2 nd reading		

Sources of error and precautions –

Following care should especially be taken.

- Length of member of the truss must be measured carefully.
- Deformation in string should be observed carefully.

EXPERIMENT NO-5

OBJECTIVE-

To determine the moment of inertia of a flywheel about its own axis of rotation.

APPARATUS REQUIRED-

- Knife-edge.
- Connecting
- Rod/pulley
- Weighing scale
- Ruler.

Moment of Inertia-

If m is any mass distances from a given line be r then $\sum mr^2$ is defined as the moment of inertia of the given line. Radius of Gyration. If this quantity is equal to Mk^2 . Where M is the total mass of the body then k is called the **radius of gyration** of the body about the given line. It is also called the swing-radius. It is assumed that the students are acquainted with the theorems on moment of inertia.

THEORY-

When a weight is suspended to the free end of a cotton string, which is wrapped round tin: shaft and the other end of which is tied to the shaft and it is allowed to fall to touch the ground then P.E. energy possessed by the falling weight has partly been used to give moment to the fly wheel and partly used in overcoming frictional resistance present in the bearings.

- Initial potential energy (P.E) = $W \times h$ when h is the height of the weight from the level ground.
- Initial kinetic energy (K.E) = 0. Final P.E = 0
- Final (K.E) = $\frac{1}{2} (w/g) v^2 + \frac{1}{2} I (w^2/g)$ where $\frac{1}{2} (w/g) v^2$ is the K.E. of the falling wt. And $\frac{1}{2} I (w^2/g)$ is the K.E. of the fly wheel and shaft combined and w is the final angular velocity of the wheel or of the shaft.
 1. Work done due to frictional resistance = $f \times h$ where F is the force of force of friction acting tangentially to the shaft. From law of conservation of energy we can write $w \times h = \frac{1}{2} (w/g) v^2 + \frac{1}{2} I (w^2/g) + F \times h$

$$\Rightarrow 2g (W - F) \times h$$

$$\Rightarrow I = (W - F) \times 2gh - Wv^2 / w^2$$

But v (final velocity) r is given by the formula $(u+v)/2 = h/t$ where t is the time taken for the weight to fall a distance h so that h/t is average velocity.

$W = v/r$ where r is the radius of the shaft.

$$\Rightarrow I = (W - F) \times 2gh - w (2h/t)^2 / (2h/t^2) \text{ gm cm}^2$$

PROCEDURE-

- Wrap the cotton string round the shaft and suspend a small weight (W) to the free end of the string. Go tri increasing this weight till the shaft just begins to rotate. This weight is the value of F , the frictional resistance.
- Mark the position of the string where it just “leaves the shaft when the weight (W) is held” at rest. Mark another position of the string where where it just leaves the shaft when the weight (W) has touched the earth-after it is allowed to fall. The distance between these two positions is the value of h .
- (Note this method is used when the vibrometer is not provided with the fly wheel).

- Place a weight (W) more than F and hold the. Pen in, this weight is placed. Release weight (w) and start the stopwatch simultaneously. Stop the watch as soon as the telling weight has touched the level ground. This gives the time (t).
- Measure the diameter of the shaft with the help of vernier caliper at four places. Take their mean and find the radius (r) of the shaft.
- Repeat the experiment for different values of 'W. take in this way about seven readings.
- Apply the formula proved in theory to calculate the value of I as W, F, t, h and r have been determined.

OBSERVATION-

- Diameter of the shaft = 1-----cm, 2----- cm, 3-----cm, 4-----cm.
- Mean diameter =-----cm.
- Radius of the shaft (r) =-----cm.
- Fractional resistance (F) = 1 -----kg, 2-----kg, 3-----kg, 4-----kg
- Mean F = -----kg.
- Distance between the marked position on the string (h) = -----cm.

S.No.	Falling Weight (W)	Time Taken (t)	$I = \frac{(W-F) \times 2gh - W (2h/t)^2}{(2h/t^2)}$
1.			
2.			
3.			

RESULTS AND DISCUSSION-

Mean (I) =-----gm cm².

PRECAUTIONS-

- Note the time accurately to the fraction of a second.
- Note the value of F when the motion just begins and wheel does not move with any acceleration.
- Oil the bearing to reduce friction.
- Overlapping of the string should be avoided.
- Note the time thrice for the same weight (W).

EXPERIMENT NO-6

OBJECTIVE-

To determine the mechanical advantage and efficiency of a square thread screw jack.

APPARATUS REQUIRED-

- Screw Jack Apparatus.
- Slotted & Conical Weight.
- Nylon string.
- Meter Rod & Pan.

THEORY-

This machine is used for lifting load with the application of a smaller effort. It may have different shapes but the principle is same I, e, it works on the principle of a screw. The screw head carries the load w . The nut is fixed and the screw is rotated by means of a lever. The effort p is applied at the screw is rotated by means of a lever. The effort p is applied at the end of the lever.

Now if the screw head revolves through n number of revolution the screw head will move by a distance $p \times n$, where p is the effort p will move a distance $n \times 2R$, where $2r$ is the circle head over which p is coming.

There fore

$$V = \frac{\text{Distance moved by the effort } p}{\text{Distance moved by the load } W}$$
$$= \frac{n \times 2 \pi R}{n \times P} = \frac{2 \pi R}{P}$$

PROCEDURE-

- Wrap on string round the circumference of the screw head and take it over a small pulley. Effort p_1 is tied to the free end of this string.
- wrap another string around the circumference of the screw head in the same direction in which the above string is wound and take it over the other small pulley.
- place a load w on the screw head.
- suspend p_1 and p_2 to the free ends of both the strings coming over the two small pulleys. This load p_1 and p_2 should be increased gradually suitable to give adjust upward motion to the screw head.
- note down w and p to determine the M.A. I . e w/p . in this case $p_1 + p_2$ will be the value of p .
- p_1 and p_2 should be noted down carefully.
- teke in this way about 10 reading by increasing w and finding out the corresponding value of p ($p_1 = p_2$).
- Measure the circumference of the screw head.
- Measure the pitch i. E. the distance between the two consecutive threads.

OBSERVATION TABLE-

- Circumference of the screw head = $2 \pi R = \text{-----}$
- Pitch = -----

S.No.	Load Lifted Upward (W)	Effort (p1)	Effort (p2)	Total Effort (p1+p2)	M.A. = w/p	Velocity ratio V	Percentage Efficiency
1.							
2.							
3.							

PRECAUTIONS-

- Lubricate the apparatus.
- There should be no overlapping of the strings.
- W should move slowly and in upward direction.

EXPERIMENT NO-7

OBJECTIVE-

To determine the mechanical advantage, velocity ratio and efficiency of a worm and worm wheel.

APPARATUS REQUIRED-

- Worm and worm wheel Apparatus.
- Conical Weight

THEORY-

- As the pulley of the worm moves through n revolutions, n teeth of the wheel pass completely through the worm. If there are N teeth in pulley of the worm to rotate completely the worm moves through N revolution the load is raised up by the a distance equal to the length of the circumference of the pulley of the worm wheel.

So that velocity ratio is

$$\frac{N \times \text{circumference of pulley of worm}}{\text{Circumference of pulley of worm wheel}}$$

PROCEDURE-

- Wrap the string round the pulley of the worm the free end of which is to be tied to the effort.
- Wrap another string to carry the load the pulley the worm wheel in such a manner that as the effort is applied the is lifted up.
- Suspend a small weight (w) through the free string, which should just move the load upward.
- Note w and p . so that mechanical advantage is given by W/P .
- Increase the load (w) gradually and increase the effort (p) correspondingly and take in this way about seven readings.
- Measure the circumference of the pulley of the worm and also that of the worm wheel.
- The percentage efficiency is given by
$$\frac{W \times 100}{PV}$$
- Plot a graph between w and p and w and.

OBSERVATION -

Circumference of pulley of the worm ($2 \Pi R_1$)= _____ cm.

Circumference of pulley of the worm wheel ($2 \Pi R_2$)= _____ cm.

No of teeth in the worm wheel (N)= _____

Velocity ratio =
$$\frac{N \times 2 \Pi R_1}{2 \Pi R_2}$$

OBSERVATION TABLE-

RESULTS AND DISCUSSION-

Dronacharya Group Of Institutions

INSTRUCTIONS FOR STUDENTS

1.1. General Information

Laboratory experiments are integral part of the course. It is said that “**You see you forget; you read you remember; you do you understand**”. That makes the practical as an integral part of learning process.

Some of the purpose of conducting experiments can be enumerated as below:

- To get familiarized with the basic components, measuring instruments, workbench and basic machines.
- Observing basic phenomena and characteristics of machine.
- Reporting and analyzing the observations.
- Verify observations, basic rules and understanding physical concepts.
- Hands-on experience on machines.
- Observing safety and developing group-working culture.

To make laboratory experiments safe and effective, each student must obey the following rules.

1.2. Safety

- **Dress:**
Boys: Loose clothes not allowed. Shirt should be tucked-in properly, shoes with the rubber sole, no slippers.
Girls: Skirts with large flares not permitted, shoes with the rubber sole, no slippers.
- Make sure that all the power sources are off, when you are connecting the circuit.
- Keep safe distance from machines.
- Follow the instructions given by the faculty or course instructor.
- Failure to obey safety rules may result in the disciplinary action.

1.3. Attendance

All students are required to attend and contribute adequately while performing experiments in the group. Performance will be judged based on experiments conducted, quality & punctual submission of the lab report for each experiment.

Faculty will take attendance. Failure to be present for an experiment will result in losing entire mark for the corresponding lab. However, genuine cases may be considered to repeat the experiment.

Students must not attend a different lab group/section from the one assigned at the beginning of the class (unless otherwise approved by the instructor).

If a student misses a lab session due to unavoidable circumstances, can provide a legitimate proof as soon as possible, he/she may then be allowed by the lab instructor, to make-it-up with a different section.

1.4. Preparation and performance

- Before leaving the laboratory, each student must ask the lab instructor for the experiment number to be conducted on the next lab turn, so that the students come prepared after reading and reviewing the reallocated experiment. Faculty might check your preparedness and understanding of the experiment and failure to satisfactory reply may de-bar you from conducting the experiments.
- Record your observations and calculations in the Lab Manual's observation tables. Do not hesitate to clear any of your doubts concerning the experiments.
- Leave the work place clean after you have finished with your experiments. Dismantle the circuit and put all the wires and equipment back at its original place.

1.5. General working discipline in the Lab

Students are advised to strictly follow the instructions given below while working in the Workshop Practice Lab:

1. Attendance in the laboratory is mandatory. For any absence, students have to fill up the format available in the lab to indicate reasons for absence.
2. Students will not be allowed after 10 minutes from the scheduled time.
3. No student will leave the Lab without permission.
4. Students should bring their Lab Manual and are understood to have gone through the manual thoroughly.
5. Any confusion may be clarified from the faculty before starting the experiments.
6. Students must maintain discipline and silence in the lab.
7. Students are to remain within their allotted experimental area.
8. Be attentive all the time.

1.6. Lab Reports

- Each student is required to write reports for the experiments conducted.
- Reports are due one week after the completion of the experiment.
- All reports must be neatly written.
- The Lab report must contain the following:
 1. Duly completed Title pages.
 2. Each report to include Objective, Material required, Tools required, Operations involved, Procedure and Precautions.
 3. Summary section can be included explaining what you have learned doing the experiments and subsequent calculations.(Note: Summary space is not provided on the report page, thus students are requested to write it in the footer space.)
 4. Questions given under the lab report to be answered by student in the space provide in the Lab Manual.
 5. Individual comments/Notes must be written for the further improvement of the lab manual, on the space provided at the end of the manual, however extra pages could be attached if required.

QUESTIONS FOR VIVA-VOICE:

1. CHARPY & IZOD TEST

1.1) In what way the values of impact energy will be influenced if the impact tests are conducted on two specimen, one having smooth surface and the other having scratches on the surface?

Ans. Surface scratches are the sources of stress concentration. A specimen having scratches will develop more stress due to stress concentration, and therefore will show a poor impact energy than the energy of smooth surface specimen

1.2) What is the necessity of making a notch in impact test specimen?

Ans. Notch is made for the purpose of raising the stress to a peak value to elastic stress concentration. Also the yield stress is raised due to elastic and plastic. The two effects combine together and break the specimen due to brittle fracture more readily than in an unnotched specimen

1.3) Why is the hammer placed at 30 kg m energy, initially.

Ans. It is the maximum value of potential energy that can be a stored in machine set-up, before conduct of experiment.

1.4) Which material can sustain more impact: a ductile material or a brittle material?

Ans. A ductile material.

1.5) Compare the Charpy test with Izod test from various view points.

Ans. It is given below.

Consideration	Charpy Test	Izod Test
1. Placement of specimen	Easier on machine as specimen is centrally located	Needs adjustment in location of specimen
2. Temperature suitability	Better for low temperature tests	Suitable for room and high temperature tests
3. Type of beam	Simply supported	Cantilever

1.6) Explain 'notch sensitivity'?

Ans. It is the tendency of some ductile materials to behave in a brittle manner in presence of a notch. It is caused due to stress concentration and lowers the

properties of materials.

1.7) if the sharpness of v-notch is more in one specimen than the other, what will be its effect on the test result?

Ans. With increase in the sharpness of v-notch, there is an increase in stress concentration also. Therefore, the energy of rupture will decrease.

2. BRINELL HARDNESS TESTING

2.1) What is the limitation of brinell harness test and why?

Ans. This test can be accurately used to test materials up to about 400 BHN. Above this hardness, the accuracy of test is jeopardized because the spherical steel ball itself deforms.

2.2) Discuss the test requirements, salient observations, and limitations of Brinell hardness test.

Ans. **Salient Information:** Test requirements, noticeable observations, and limitations of Brinell hardness test can be enumerated as below:

1. The steel ball indenter may be used to test the specimen of cast iron, unhardened steel and light alloys.
2. Standard diameters of the ball are 2.5 mm, 5 mm, 10 mm.
3. Deformation of the ball during application of indenting load is neglected in calculating Brinell hardness number.

2.3) How much is the approximate BHN for (a) Cutting tool steel, (b) Carborundum, (c) Plastics (d) Aluminum, and (e) Graphite.

Ans. These are about (a) 700 to 900 (b) 2000 (c) 5 to 30 (d) 80 (e) less than 5.

2.4) How much is the hardness number of diamond on different hardness scales?

Ans. It is 10 on Mohs scale, 2600 on Brinell and Vicker scales.

2.5) What is the unit of BHN?

Ans. BHN is expressed in kgf/mm^2 . Thus a value of $\text{BHN} = 115$ means 115 kgf/mm^2 .

3. Universal Testing Machine

3.1) Which steel have you tested? What is its carbon content?

Ans. The tested specimen is made of mild steel. Its carbon content may be anything between 0.10 percent to 0.30%.

3.2) What general information are obtained from tensile test regarding the properties of a material?

Ans. From conducting of tensile test; we obtain its Young's modulus, proportional

limit, yield point stress, ultimate stress percentage elongation etc.

3.3) Which stress have you calculated: nominal stress or true stress?

Ans. We have calculated the nominal stress because it has been calculated on the basis of original cross-sectional area A_0 . This is also called engineers or conventional stress. A true stress will be obtained if the calculation is done on basis of instantaneous cross-sectional area A_i corresponding to loading P_i .

3.4) What is the effect of improper gripping of specimen on test results?

Ans. Due to improper gripping, slip will occur between the specimen and the gripping jaws. Consequently, the rise in load and elongation will be incorrectly recorded. Improper gripping may also mean non-aligned gripping of the specimen. In this case, the specimen will not be subjected to pure tensile load. In this case, the specimen will not be subjected to pure tensile load. It may be tensile load accompanied with bending moment. Hence the result will be incorrect.

3.5) How is the pointer on load dial set to zero-value?

Ans. It is set by 'zero-adjusting knob' provided generally on the right side of Machine.

4. PARALLEL FORCES

4.1) Define equilibrium?

Ans. It is the state balance of forces, reactions and moment of a system.

4.2) What is equilibrant?

Ans. It is a force whose magnitude and line of action are the same as that of the resultant of a force system, but its sense is opposite.

4.3) Parallel forces are scalar or vector quantity?

Ans. parallel forces are vector quantity.

4.4) How will you define moment of a force?

Ans. A force can be utilized to serve different purposes. While it can be used to produce translator motion, it may also be used to produce rotary motion. The measure of this turning effect is know as 'moment of a force'.

4.5) Explain the Varignon's theorem?

Ans. Varignon's theorem is a theorem of moment, and states that " the sum of moment of many coplanar, concurrent forces in a system about any axis will be

equal to the moment of the resultant of above forces taken about the same axis".
 Alternatively, "the moment of a force about an axis is equal to the sum of
 Moment of its component about the same axis". This theorem is applied to
 Concurrent forces.

5. PARALLELOGRAM OF FORCES

5.1) How will you define a force?

Ans. It is such an identity which changes or tends to change the position of a body at rest or in uniform motion. It can produce pull, push, bending and twist in a body. A force can be defined by specifying its (i) magnitude, (ii) line of action.

5.2) The resultant of two forces P and Q acting at an angle θ is equal?

Ans. Resultant (R) = $\sqrt{P^2 + Q^2 + 2PQ \cos\theta}$

5.3) If the resultant of two forces P and Q acting at an angle (α) with P, then

Ans.

$$\tan \alpha = \frac{Q \sin \theta}{P + Q \cos \theta}$$

5.4) Discuss the Scope and applications of engineering Mechanics.

Ans. The scope of studies of engineering is very vast. It extends to cover the topics like.

- Equilibrium of particles and rigid bodies.
- Analysis of trusses and frames
- Centroids of line, area and volume, and C.G.
- Mechanical vibrations.
- Impulse momentum method.
- Virtual work done

6. COEFFICIENT OF FRICTION

6.1) What is friction?

Ans. It is the surface property of materials by virtue of which the motion between two surfaces is prevented.

6.2) What is frictional fore? What are different types of friction?

Ans. A force called as frictional force resists Ans. Tendency of motion of a body on the other. Friction may be of following types.

(a) Static or dry or solid friction- this is of two types viz.

(i) Sliding friction and (ii) rolling friction

(b) Dynamic or kinetic friction

6.3) What is coulomb's law?

Ans. The law that states the law of dry friction is known as Coulomb's law.

6.4) What do you mean by impending condition of friction?

Ans. Impending condition of friction means the 'limiting condition'.

6.5) Narrate the experimentally observed values of μ for different surfaces you have tested during your semester studies.

Ans. These values are listed below approximately.

- For wood, $\mu = 0.35$
- For leather, $\mu = 0.34$
- For copper, $\mu = 0.35$

7. ROOF TRUSS

7.1) What is a truss?

Ans. Truss is a structure of triangulation geometry which is made of straight members, connected by frictionless pins (joint), and the load acts on joint only. The members develop axial force only of either tensile nature or compression.

7.2) Distinguish between a planer truss and what is a spatial truss, and quote their examples?

Ans. A planer truss is a 2- dimension truss, while the spatial truss is a 3- dimensional truss. Steel bridges generally found over rivers are the example of spatial truss, whereas the truss generally supporting the slant roofs of industrial buildings are the examples of planer truss.

7.3) What do you mean by 'Tie' and 'Strut'?

Ans. Truss members, which are under tension, are called tie. Those members which are under compression are called strut.

7.4) What do you mean by statically determinate truss?

Ans. A truss is statically determinate if the equations of static equilibrium alone are sufficient to determine the axial forces in the member without the need of considering their deformation.

7.5) Define spring stiffness.

Ans. Spring stiffness (s) is defined, as the load (p) required for unit deflection (δ) of the spring. Thus

$$S = P/\delta$$

8. MOMENT OF INERTIA

8.1) Define mass moment of inertia?

Ans. Mass moment of inertia (I_m) of a body is its ability to resist motion to it. It is expressed by

$$I_m = mk^2$$

Where, m is the mass of the body and k is radius of gyration.

8.2) What is a flywheel? What is its use?

Ans. A flywheel is a circular disc that rotates with the shaft on which it is mounted. A flywheel is used on the crankshaft of IC engines to keep the fluctuation of speed within desired limits/range.

8.3) Write the value of mass m.o.I. of a thin disc about its centroidal axes xx and yy.

Ans. $I_{mxx} = I_{myy} = mr^2 / 4$, where r is radius of the disc.

8.4) Enlist the factors that influence the determination of I of the flywheel of this experiment?

Ans. various factors that influence the value of I are as follows.

- Mass of the flywheel = m
- Distance fallen through by mass = h
- Number of rotation made by the flywheel till the mass detaches = n_1
- Number of rotation made by the flywheel after the mass detaches = n_2

8.5) What is the unit of mass moment of inertia?

Ans. Unit of I_m is (mass) x (length)² i.e. kg-m².

9. SCREW JACK

9.1) Why is it called as simple screw jack?

Ans. This is called as 'simple screw jack' because it is different from 'differential screw jack'. In a differential screw jack, there are two lead screws having threads cut in opposite directions while in simple screw jack, there is only one lead screw.

9.2) In respect of screw jack, define (a) velocity ratio, (b) lead and (c) pitch.

Ans. (a) in this machine the **velocity ratio** is given by

$$VR = \frac{2\pi l}{L}$$

Where, Velocity ratio l = length of the handle, L = lead = np , p = pitch, n = number of start of screw

(b) **Lead (L)**. It is the distance moved by the screw in one rotation

(c) **Pitch (P)**. It is the distance between two consecutive threads.

9.3) Explain the following terms.

(a) **Mechanical advantage** (b) **Velocity ratio**

Ans. These are given below.

(a) **Mechanical advantage**. It is the ratio of the load lifted to the effort applied, mechanical advantage (M.A.) = W/P .

(b) **Velocity ratio**. It is the ratio of the distance moved by the effort to the corresponding distance moved by the load. If the distance moved by the effort = D , and the distance moved by the load = d , then (V.R.) = D/d

9.4) How you determine the efficiency of a machine?

Ans. Efficiency of the machine is defined as

$$\eta = \frac{\text{Output of the machine}}{\text{Input to the machine}} = \frac{\text{M.A}}{\text{V.R}}$$

10. WORM AND WORM WHEEL

10.1) The velocity ratio of a simple wheel and axle with D and d as the diameter of effort wheel and load axle is?

Ans. D/d

10.2) The velocity ratio of a differential wheel and axle with D as the diameter effort wheel and d_1 and d_2 as the diameters of larger and smaller axles respectively is?

Ans. $2D/d_1 - d_2$

10.3) In a wormed geared pulley block, if we double the number of teeth on the worm wheel, its velocity ratio is?

Ans. Doubled

10.4) the velocity ratio of a single purchase crab winch can be increased?

Ans. Increasing the length of the handle.