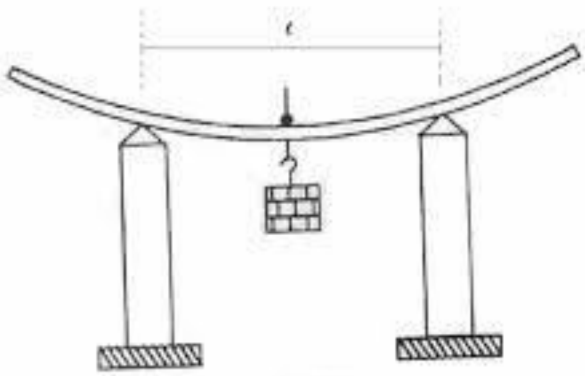
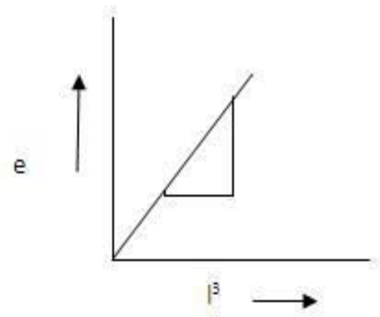
DIAGRAM



YOUNG'S MODULUS - NON-UNIFORM BENDING

Graph between depression and length



1. YOUNG'S MODULUS – NON UNIFORM BENDING PIN AND MICROSCOPE

Expt No:01

AIM

To find the Young's modulus of the given material bar by non uniform bending using pin and microscope method.

APPARATUS

Pin and Microscope arrangement, Scale ,Vernier calipers, Screw gauge, Weight hanger, Material bar or rod.

THEORY

Young's modulus is named after Thomas Young,19th century ,British scientist. In solid mechanics, Young's modulus is defines as the ratio of the longitudinal stress over longitudinal strain, in the range of elasticity the Hook's law holds (stress is directly proportional to strain). It is a measure of stiffness of elastic material.
If a wire of length L and area of cross-section 'a' be stretched by a force F and if a change (increase) of length 'l' is produced, then

$$Young's\ modulus = \frac{Normal\ stress}{Longitudinal\ strain} = \frac{F/a}{l/L}$$

Non Uniform Bending Using Pin and Microscope

Here the given beam(meter scale) is supoorted symmetrically on two knife edges and loaded at its centre. The maximum depression is produced at its centre. Since the load is applied only one point of the beam, the bending is not uniform through out the beam and the bending of the beam is called non- uniform bending.
In non-uniform bending (central loading), the Young's modulus of the material of the bar is given by

$$Y = \frac{mgl^3}{48Ie}$$

I is the moment of inertia of the bar.
For a rectangular bar**,**

$$I = \frac{bd^3}{12}$$

Substituting (4) in (3)
In non uniform bending, the young's modulus of the material of the bar is given by,

OBSERVATIONS

Value of 1 M.S.D = 1/20
Number of divisions on the vernier, n = 50
Least count of microscope = 1 m.s.d/n = 1/1000 = 0.001 cm

No	Distance of the knife edges , l (cm)	Load M(kg)	Telescope reading			depression for load 4m, e (cm)	Mean e (cm)	$\frac{l^3}{e}$ (cm^3)	Mean $\frac{l^3}{e}$ (cm^3)
			Loading (cm)	unloading (cm)	mean (cm)				
1		Wo Wo+m Wo+2m Wo+3m Wo+4m Wo+5m Wo+6m Wo+7m			Xo X1 X2 X3 X4 X5 X6 X7	X4-X0 X5-X1 X6-X2 X7-X3			
2									
3									
4									

CALCULATIONS

Thickness of the material bar "d" = ……………………….. mm.
Breadth of the material bar "b" = ……………………………cm.
Mean value of l^3/e = ………………………….m.
Load applied for depression "e" = ………………………… m.

Young's modulus of the material bar , $Y = \frac{mgl^3}{4bd^3e}$ = …………………………N/m^2.

$$Y = \frac{mgl^3}{4bd^3e}$$

m - Mass loaded for depression.

g - Acceleration due to gravity.

l - Length between knife edges.

b - Breadth of the bar using vernier calipers.

d - Thickness of the bar using screw gauge.

e - Depression of the bar.

PROCEDURE

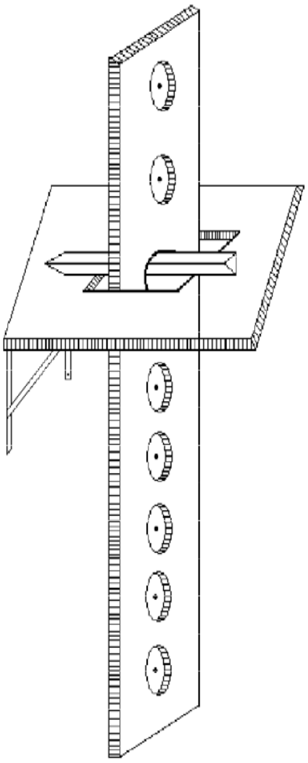
1. Select the environment and material for doing experiment.
2. Choose mass, length , breadth and thickness of the material bar using sliders on the right side of the simulator .
3. Fix the distance between knife edges.
4. Focussing the microscope and adjusting the tip of the pin coincides with the point of intersection of the cross wires using left and top knobs on microscope respectively.
5. Readings are noted using the microscope reading for 0g. Zoomed part of microscope scale is available by clicking the centre part of the apparatus in the simulator. Total reading of microsope is MSR+VSR*LC. MSR is the value of main scale reading of the microsope which is coinciding exacle with the zero of vernier scale. One of the division in the vernier scale coincides exactly with the main scale is the value of VSR. LC is the least count.
6. Weights are added one by one say 50g, then pin moves downwards while viewing through microscope. Again adjust the pin such that it coincides exactly with the cross wire.
7. The readings are tabulated and Y is determined using equation (2).

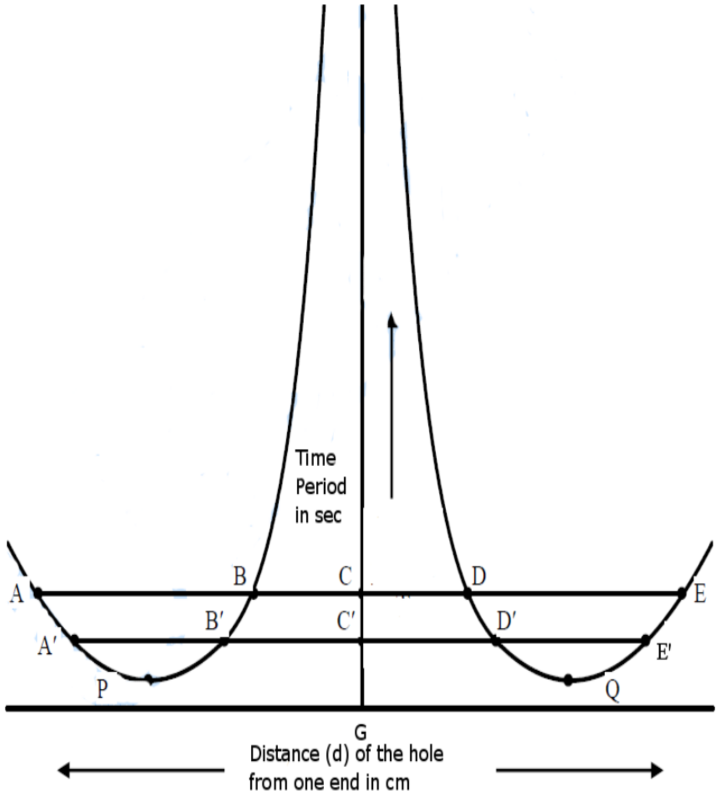
From graph $\frac{l^3}{e}$ can be calculated.

RESULT

Young's modulus of the given material using non uniform bending method =..................................Nm^{-2}.

DIAGRAM





OBSERVATIONS:

To draw graph :

No.of holes from A	Distance of knife edge from A: (cm)	Time for 10 oscillations (s)			Time period T (s)
		1	2	Mean (s)	

2. MEASUREMENT OF ACCELERATION DUE TO GRAVITY (G) BY A COMPOUND PENDULUM

Expt No 02

AIM

To determine the acceleration due to gravity (g) by means of a compound pendulum.

APPARATUS

(i) A bar pendulum, (ii) a knife–edge with a platform, (iii) a sprit level, (iv) a precision stop watch, (v) a meter scale and (vi) a telescope.

FORMULA

Acceleration of gravity, $g= 4\pi^2(2k_G/T_{min}^2)$

PROCEDURE

(i) Suspend the bar using the knife edge of the hook through a hole nearest to one end of the bar. With the bar at rest, focus a telescope so that the vertical cross-wire of the telescope is coincident with the vertical mark on the bar.

(ii) Allow the bar to oscillate in a vertical plane with small amplitude (within 4^0 of arc).

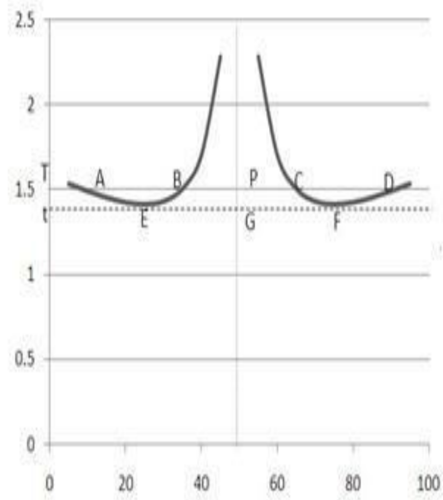
(iii) Note the time for 20 oscillations by a precision stop-watch by observing the transits of the vertical line on the bar through the telescope. Make this observation three times and find the mean time t for 20 oscillations. Determine the time period T.

(iv) Measure the distance d of the axis of the suspension, i.e. the hole from one of the edges of the bar by a meter scale.

(v) Repeat operation (i) to (iv) for the other holes till C.G of the bar is approached where the time period becomes very large.

To find the value of 'g' :

SI.No	Length of equivalent simple pendulum(cm)			Time period, T (s)	g (cm/s^2)
	AC (cm)	BD (cm)	Mean l		



CALCULATION

To find the radius of gyration and the acceleration of gravity (step 3 above):

Radius of gyration about the centre of mass k_G = EF/2 = ...
.
Acceleration of gravity, g= $4\pi^2(2k_G/T_{min}^2)$ = ...

To find the radius of gyration (step 4 above):

SI.No	h=AD/2	h' =BC/2	$k_G=(hh')^{1/2}$

RESULTS:

Average acceleration of gravity, $g = 4\pi^2(l/T^2)$ = ... m/s^2

1) Average radius of gyration of the pendulum about its centre of mass, k_G = ... m
2) Mass of the pendulum M = ... Kg
3) Moment of inertia of the pendulum about its centre of mass, $I_G = Mk_G^2$ = ... Kgm^2

DIAGRAM

Fig.6.4 Spectrometer – Angle of Prism

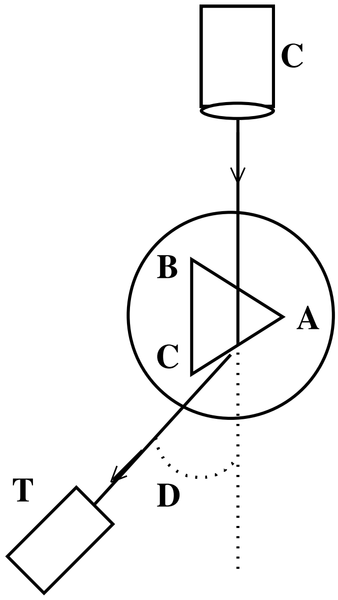
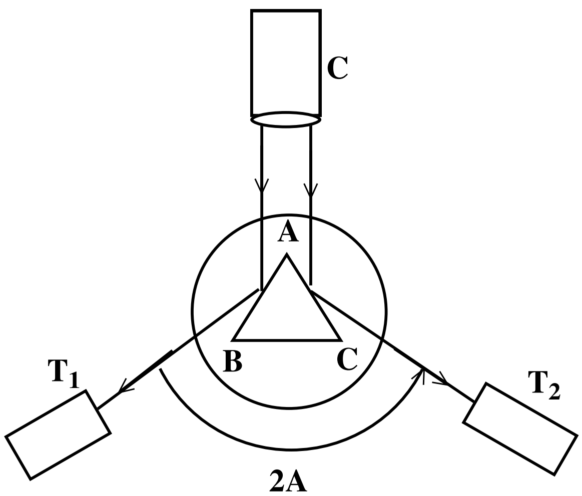


Fig.6.5 Angle of Minimum Deviation



3. DETERMINATION OF DISPERSIVE POWER OF A PRISM USING SPECTROMETER

Expt No.03

AIM

To determine the dispersive power of a given prism for any two prominent lines of the mercury spectrum.

APPARATUS

A spectrometer, mercury vapour lamp, prism, spirit level, reading lens etc.

FORMULAE

1. Refractive index of the prism for any particular colour

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left[\frac{A}{2}\right]}$$

where A = Angle of the prism in (deg)

D = Angle of minimum deviation for each colour in (deg)

2. The dispersive power of the prism is

$$\omega = \frac{\mu_1 - \mu_2}{\left(\frac{\mu_1 + \mu_2}{2}\right) - 1}$$

where μ_1 and μ_2 are the refractive indices of the given prism for any two colours.

PROCEDURE

Part I : To determine the angle of the prism (A)

1. The initial adjustments of the spectrometer like, adjustment of the telescope for the distant object, adjustment of eye piece for distinct vision of cross –wires, levelling the prism table using spirit level, and adjustment of collimator for parallel rays are made as usual.
2. Now the slit of the collimator is illuminated by the mercury vapour lamp.
3. The given prism is mounted vertically at the centre of the prism table, with its refracting edge facing the collimator as shown in figure (6.4) (i.e.) the base of the prism must face the telescope. Now the parallel ray of light emerging from the collimator is incident on both the refracting surfaces of the prism.
4. The telescope is released and rotated to catch the image of the slit as reflected by one refracting face of the prism.

OBSERVATIONS

$$LC = \frac{\text{Value of one MSD}}{\text{No. of div on VS}} = \frac{30'}{30} = 1'$$

Table 6.7: To determine the angle of prism (A)

LC = 1’ TR = MSR + (VSC ×LC)

Position of the reflected ray	Vernier –A			Vernier-B		
	MSR degree	VSC div	T.R degree	MSR degree	VSC div	T.R degree
Left side			(R_1)			(R_3)
Right Side			(R_2)			(R_4)
	2A =(R_1–R_2) = $\therefore A = \frac{R_1 - R_2}{2}$ A=			2A =(R_3–R_4) = $\therefore A = \frac{R_3 - R_4}{2}$ ∴A=		

∴Mean A =

5. The telescope is fixed with the help of main screw and the tangential screw is adjusted until the vertical cross-wire coincides with the fixed edge of the image of the slit. The main scale and vernier scale readings are taken for both the verniers.
6. Similarly the readings corresponding to the reflected image of the slit on the other face are also taken. The difference between the two sets of the readings gives twice the angle of the prism (2A). Hence the angle of the prism A is determined.

Part 2 : To determine the angle of the minimum deviation (D) and Dispersive power of the material of the prism

1. The prism table is turned such that the beam of light from the collimator is incident on one polished face of the prism and emerges out from the other refracting face. The refracted rays (constituting a line spectrum) are received in the telescope Fig. 6.5.
2. Looking through the telescope the prism table is rotated such that the entire spectrum moves towards the direct ray, and at one particular position it retraces its path. This position is the minimum deviation position.
3. Minimum deviation of one particular line, say violet line is obtained. The readings of both the verniers are taken.
4. In this manner, the prism must be independently set for minimum deviation of red line of the spectrum and readings of the both the verniers are taken.
5. Next the prism is removed and the direct reading of the slit is taken.
6. The difference between the direct reading and the refracted ray reading corresponding to the minimum deviation of violet and red colours gives the angle of minimum deviation (D) of the two colours.
7. Thus, the refractive index for each colour is calculated, using the general formula.

$$\mu = \frac{\sin \frac{(A+D)}{2}}{\sin A/2}$$

and Dispersive power of the prism.

$$\omega = \frac{\mu_1 - \mu_2}{\left(\frac{\mu_1 + \mu_2}{2}\right) - 1}$$

To determine the angle of the minimum deviation (D) and Dispersive power of the material of the prism:

Direct ray reading (R_1) : Vernier A : Vernier B:

LC = 1’ TR = MSR + (VSC ×LC)

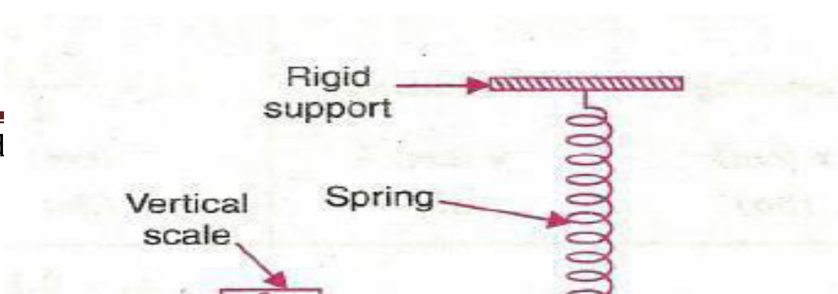
Line	Refracted ray readings when the prism is in minimum deviation position(R_2)						Angle of minimum deviation (D) (= $R_1 \sim R_2$)		Mean D
	Vernier –A			Vernier -B			Vernier –A degree	Vernier-B degree	
	MSR degree	VSC div	TR degree	MSR Degree	VSC div	T.R degree			
Violet									
Red									

Mean (D) :

Result

The dispersive power of the material of the prism is -------------

DIAGRAM



OBSERVATION

Least count of vertical scale = 0.1 cm.

Table for load and extension

Serial No.	Load (g)	Reading of the scale while		Extension x (cm)
		Loading	Unloading	
1				
2				
3				
4				
5				

4. DETERMINATION OF SPRING CONSTANT OF THE GIVEN SPRING

Expt No:04

AIM

To find the force constant of a helical spring by plotting graph between load and extension.

APPARATUS

Spring, a rigid support, slotted weights, a vertical wooden scale, a fine pointer, a hook.

THEORY

When a load *F* suspended from lower free end of a spring hanging from a rigid support, it increases its length by amount *x*,

then $F \; a \; x$

or $F = k\,x$,

where *k i*s constant of proportionality.
It is called the force constant or the spring constant of the spring.

PROCEDURE

1. Suspend the spring from a rigid support. Attach a pointer and a hook from . free end.
2. Hang a 20 g hanger from the hook.
3. Set the vertical wooden scale such that the tip of the pointer comes over the scale.
4. Note the reading of the position of the tip of the pointer on the scale. Record the reading in loading column against zero load. .

CALCULATIONS

From graph,

k =……………… gwt per cm.

Gently add a 20 g slotted weight to the hanger. The pointer tip moves down. Wait for few minutes till the pointer tip comes to rest. Repeat step 4.

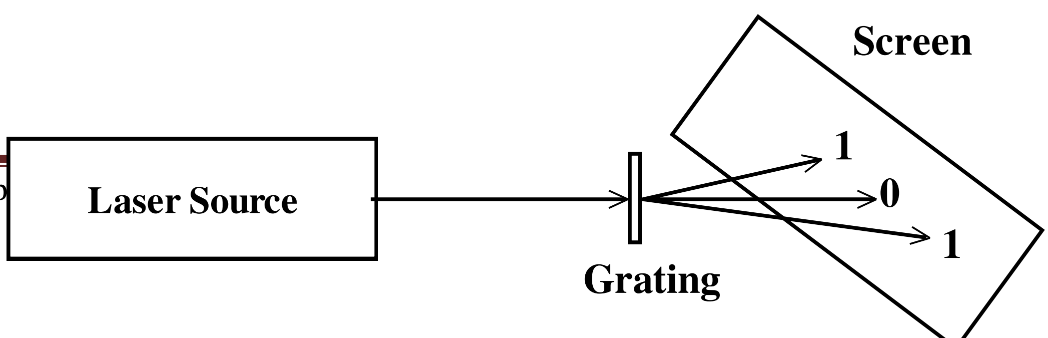
6. Repeat steps 5 and 6 till five slotted weights have been added.
7. Now remove one slotted weight. The pointer tip moves up. Repeat step 6. Record the reading in unloading column.

8. Repeat step 8 till only hanger is left.
Record your observations as given below.

RESULT

The force constant of the given spring is ………… g wt per cm.

DIAGRAM



Experimental Setup for Laser Grating

5. DETERMINATION OF LASER PARAMETERS – DIVERGENCE AND WAVELENGTH FOR A GIVEN LASER SOURCE USING LASER GRATING

Expt No:05

AIM

To determine the divergence and wavelength of the given laser source using standard grating.

APPARATUS

Laser source, grating, a screen etc.,

PRINCIPLE

When a composite beam of laser light is incident normally on a plane diffraction grating, the different components are diffracted in different directions. The m^{th} order maxima of the wavelength λ, will be formed in a direction θ if $d \sin \theta = m\lambda$, where d is the distance between two lines in the grating.

FORMULA

1. The angle of divergence is given by

$$\Phi = \frac{(a_2 - a_1)}{2(d_2 - d_1)}$$

where a_1 = Diameter of the laser spot at distance d_1 from the laser source

a_2 = Diameter of the laser spot at distance d_2 from the laser source

2. The wavelength of the laser light is given by

$$\lambda = \frac{\sin \theta_m}{Nm} \quad \text{m}$$

where m = Order of diffraction

θ_n = Angle of diffraction corresponding to the order m

N = number of lines per metre length of the grating

θ = $\tan^{-1}$ (x/D)

x = Distance from the central spot to the diffracted spot (m)

D = Distance between grating and screen(m)

OBSERVATION

Determination of wave length of Laser Light:

Distance between grating and screen (D) = ----------- m

Number of lines per metre length of the grating = N = --------------

S.No	Order of Diffraction (m)	Distance of Different orders from the Central Spot (x) m	Mean (x) m	Angle of diffraction θ = tan $^{-1}$[x /	$\lambda = \frac{\sin \theta_m}{Nm}$

		Left	Right		D]	Å

CALCULATION

The angle of divergence

a_1 = Diameter of the laser spot at distance d_1 from the laser source =

a_2 = Diameter of the laser spot at distance d_2 from the laser source =

$$\Phi = \frac{(a_2 - a_1)}{2(d_2 - d_1)}$$

The wavelength of the laser light

m = Order of diffraction =

θ_n = Angle of diffraction corresponding to the order m =

N = number of lines per metre length of the grating =

θ = $\tan^{-1}(x/D)$ =

x = Distance from the central spot to the diffracted spot (m) =

D = Distance between grating and screen(m) =

$$\lambda = \frac{\sin\theta_m}{Nm} \quad \text{m}$$

PROCEDURE

Part 1: Determination of angle of divergence

1. Laser source is kept horizontally.
2. A screen is placed at a distance d_1 from the source and the diameter of the spot (a_1) is measured.
3. The screen is moved to a distance d_2 from the source and at this distance, the diameter of the spot (a_2) is measured.

Part 2: Determination of wavelength

1. A plane transmission grating is placed normal to the laser beam.
2. This is done by adjusting the grating in such a way that the reflected laser beam coincides with beam coming out of the laser source.
3. The laser is switched on. The source is exposed to grating and it is diffracted by it.
4. The other sides of the grating on the screen, the diffracted images (spots) are seen.
5. The distances of different orders from the central spot are measured.
6. The distance from the grating to the screen (D) is measured.
7. θ is calculated by the formula $\theta = \tan^{-1} (x/d)$.
8. Substituting the value of θ, N and m in the above formula, the wavelength of the given monochromatic beam can be calculated.

RESULT

1. The angle of divergence is = -----------.
2. The wavelength of the given monochromatic source is = ----------- Å