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KARAIKUDI – 630 003

DIRECTORATE OF DISTANCE EDUCATION

M.Sc. PHYSICS

III - SEMESTER

34534

ADVANCED ELECTRONICS AND PHYSICS LABORTORY – III

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SYLLABI-BOOK MAPPING TABLE

ADVANCED ELECTRONICS AND PHYSICS LABORTORY – III

STUDY OF COUNTERS

NOTES

AIM

To construct a decade counter and to study its working by displaying the counts in a seven segment display.

APPARATUS AND COMPONENTS

IC 7400, IC 7490, IC 7447, seven segment display, 5V power supply, multimeter etc.

PROCEDURE

A BCD counter has ten states 0000 to 1001 (i.e. 0 to 9 in decimal). It is also called as mod-10 counter or decade counter.

IC 7490 is a BCD counter. IC 7490 consists of four J-K flip-flops (A, B, C and D) separated into two independent circuits. The input signal applied to terminal 14 gets divided by 2 by the first flip-flop A whose output is available at 12. The flip-flops B, C and D are connected as mod-5 counter. The outputs B, C and D are available at pins 9, 8 and 11 respectively. The output of the first stage (pin 12) is connected to the clock input of the second stage (pin 1) respectively. The IC can be configured to count from 0 to 9 (decade counting) or from 0 to 15 (binary counting). The BCD outputs of IC 7490 are denoted by A, B, C and D from the pins 12, 9, 8 and 11 respectively.

First the pulser circuit is constructed using IC 7400 and a switch. Its working in verified by throwing the switch from START position to CLEAR position and back to START position. A single clock pulse is produced at the output (pin 3 of IC 7400) which can be verified using multimeter. (Note: This verification is necessary because if the pulser does not work properly the entire will not work). Next the output of the pulser is connected to the clock input (pin 14 of IC 7490) of the counter. Pulses are applied in sequence using the switch and the BCD outputs of 7490 are checked using of multimeter. The BCD outputs of 7490 are connected to the seven segment display.

Pin 3 of 7447 is use for lamp Test. When it is touched to GND, all the seven segments are turned ON. After this verification pin 3 is floated (No connection). Then the individual clock pulses are applied from the pulser circuit and the counts displayed in the seven segment display are noted.

NOTES

Table 1: Model

CLK	Q_3	Q_2	Q_1	Q_0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	0	0	0	0

Table 2: Experimental verification

CLK	Q_3	Q_2	Q_1	Q_0

RESULT

The decade counter is constructed to count the pulses 0 to 9. The counts are decoded and displayed in seven segment display.

MONOSTABLE MULTIVIBRATOR USING OP-AMP

AIM

To construct a monostable multivibrator using operational amplifier and measure the experimental, theoretical time periods.

APPARATUS AND COMPONENTS

IC 741 (Op-amp), IN 4001 diode, resistors, capacitors, cathode ray oscilloscope (CRO), audio frequency oscillator (AFO), dual regulated power supply, connecting wires etc.

FORMULA

(i) Theoretical time period

$$T_P = 2.303\, R_f C \log [1+R1/R2]$$

(ii) Experimental time period

$$T_P = \text{Number of division x time per sec}$$

PROCEDURE

Monostable multivibrator has one stable state. It produces a single pulse when triggered properly. The pulse width is proportional to the resistor R and capacitor C used. The circuit for the monostable multivibrator is shown in figure 2. The main difference between the monostable and astable multivibrator is that a silicon diode is connected across the capacitor. Thus the multivibrator can deliver one rectangular output pulse for the input trigger pulse. Here pin 2 is inverting input, pin 3 is non-inverting input and pin 7 is +Vcc are connected together to +Vcc through the resistor R. The pin 1 and 5 offset setup the pins is the connection. The output is taken across pin 6.

Now the power supply is switched on, the output reaches to +Vsat. Because now the silicon diode is forward biased through the R and the voltage drop across the silicon diode is 0.6 volts. The drop Voltage is fed back to the non-inverting input. And the feedback factor β is decided by R1 and R2. This applied voltage is higher than the value 0.6V to the inverting input and the output will continue remains at +Vsat. This is the stable state of the monostable multivibrator.

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Figure 1. Circuit diagram of monostable multivibrator constructed using OP-Amp.

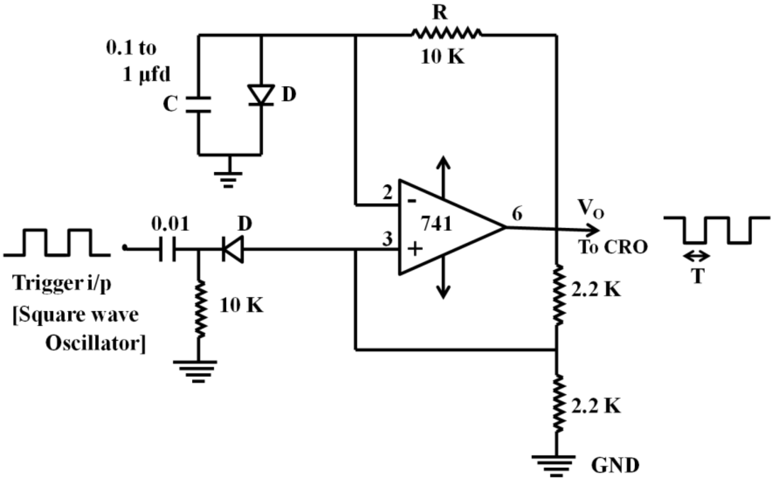

Table 1: Monostable multivibrator

S. No.	Resistance (R) (Ω)	Capacitance (C) (µ F D)	Time Period (T) (No. of divisions) × 1 ms	Measured Frequency (Hertz)	Calculated Frequency

RESULT

A monostable multivibrator is constructed using op-amp (IC 741) and the experimental values of frequencies are calculated and then the waveforms are traced.

ASTABLE MULTIVIBRATOR USING OP-AMP AND IC 555

AIM

To construct astable multivibrator using op-amp and IC 555 timer and calculate its experimental, theoretical time period and frequencies.

APPARATUS AND COMPONENTS

IC 741 (op-amp), IC 555, variable resistors, variable capacitors, dual regulated power supply, connecting wires etc.

FORMULA

1. Astable multivibrator using IC 741 (Op-amp)
   The period of the square wave is
   $T = 2t_1=2t_2=2RC \ln [(1 +\beta)/(1 -\beta)]$
   By making $R_1=R_2$, so that $\beta = (1/2)$
   The frequency of the square is $f=(1/T)$
   The period of the square wave
   $T = 2RC \ln 3 = 2 RC (1.1) = 2.2 RC$

2. Astable multivibrator using IC 555 timer
   Time taken by the capacitor to charge
   $t_1= 0.693(R_A+R_B)C$
   Time taken by the capacitor to discharge $t_2= 0.693 R_B$
   The period of the square wave is
   $T= t_1 + t_2$
   $T = 0.693 (R_A + R_B) C$
   Frequency of the square wave is
   $f=1/T=t_1=0.693 (R_A + 2R_B)C$

PROCEDURE

Astable multivibrator using Op-Amp

The astable multivibrator circuit is constructed using Op-amp is shown in Figure. The non-inverting input of op-amp is connected to ground through resistances R1 and R2 connected to ground. One end of the capacitor is connected to inverting input of Op-amp and the other end is connected to ground. The pin 4 and pin 7 of Op-amp are connected to +Ve and -Ve of 12V power supply. The output is taken

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from pin 6 and connected to cathode ray oscilloscope. Now the power supply is switched on the Oscillations will seen on the CRO screen.

Figure 1.Circuit diagram of Astable multivibrator constructed using Op-Amp

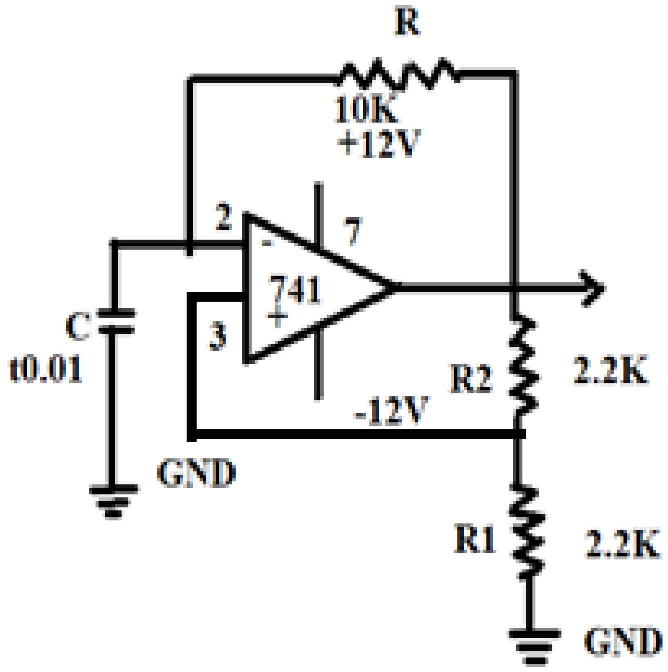

TABLE 1: Astable multivibrator using op-amp

S. No.	Resistance (R) (Ω)	Capacitance (C) (μ F D)	No. of divisions)	Experimental pulse width	Experimental Frequency (Hertz)

ASTABLE MULTIVIBRATOR USING IC 555 TIMER:

The circuit is constructed using IC 555 timer is shown in figure. The threshold input (pin6) and trigger input (pin 2) are connected together. One end the capacitor is connected to ground and other end is connected to +Vcc through RA and RB . The voltage appears across the capacitor acts as input to threshold-trigger inputs. The junction of RA and RB connected to discharge input (pin 7) of the timer. The output is taken from pin 3 and connected to cathode ray oscilloscope (CRO) screen. Now measure the ON time 't1'and OFF time' t2' separately and note the readings carefully in the tabular column.

The time period T= t1+ t2 is calculated and hence the frequency of oscillation is found. The experiment is repeated for different values of R and C. The observed readings are tabulated. The frequency of Oscillations and their duty cycles are calculated in each case.

Figure 2. Circuit diagram of Astable multivibrator constructed using IC 555 timer

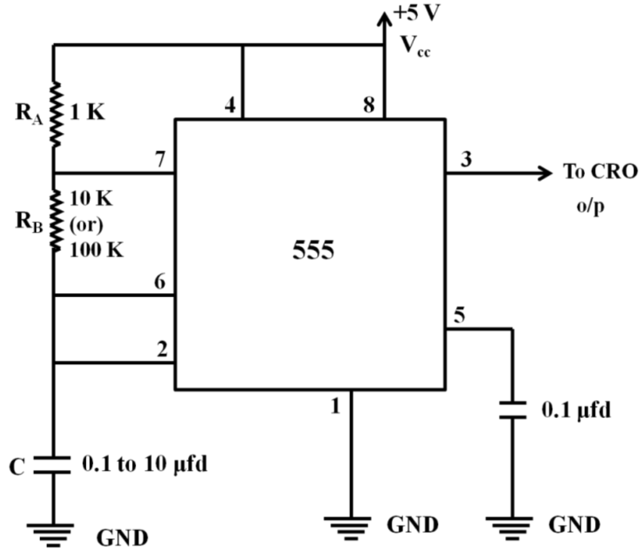

TABLE 2: Astable multivibrator using IC 555 timer

S. No.	Time (1 ms)	Measured frequency (Hertz)	Experimental Frequency (Hertz)

NOTES

RESULT

Astable multivibrator is constructed using IC 741 and IC 555 timer. The output frequencies are noted for different capacitance values in IC 555 timer and the least square fitting is also studied.

SCHMITT TRIGGER USING OP-AMP

AIM

To study the characteristics of Schmitt trigger circuit using Op-amp.

APPARATUS AND COMPONENTS

IC 741 (Op-amp), resistors (10 KΩ, 100 kΩ), bread board, Cathode ray oscilloscope (CRO), dual power supply, connecting wires, etc.

FORMULA

Frequency = 1/ width × (time/div) Hz

THEORY

Schmitt trigger is useful in squaring of slowly varying input waveforms. Vin is applied to inverting terminal of Op-amp. Feedback voltage is applied to the non-inverting terminal. LTP is the point at which output changes from high level to low level. This is highly useful in triangular waveform generation, wave shape pulse generator, Analog to Digital converters etc.

PROCEDURE

The circuit diagram of IC 741 is shown in figure 1. The Schmitt trigger circuit is constructed using OP-AMP is shown in figure 2. A sinusoidal voltage Vin of KHz frequency is applied from the audio frequency oscillator through pin 2. The input of the Schmitt trigger is varied up to 10 volts and the corresponding output voltage remaining constant up to some value of input. It suddenly changes input voltage at which output changes state in the upper threshold voltage Vo. Pin 4 and 7 are connected to +Ve and -Ve terminal of 12 Volt power supply. Pin 3 is connected to the resistors R1 and R2 in series. Pin 6 is connected to the Cathode Ray Oscilloscope. Now the input is gradually decreases and the output voltages are measured. At a particular value, the input and output suddenly changes from low to high. The value of the input voltage gives the lower threshold voltage. The readings are entered in the tabulation.

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Figure 1. Pin diagram of IC 741

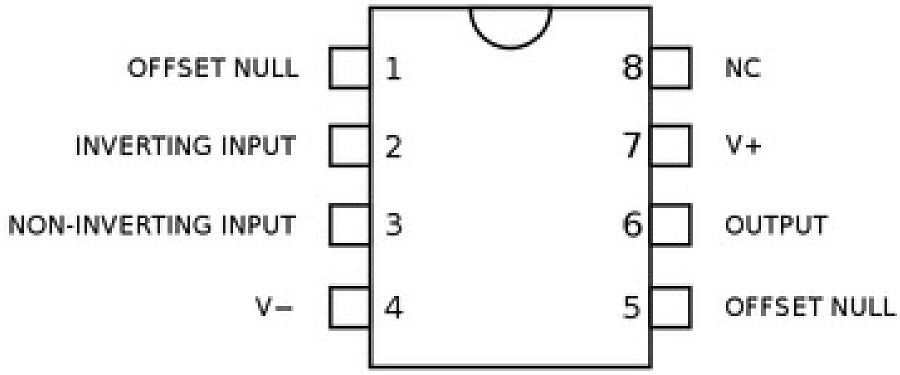

Figure 2. Circuit diagram of schmitt trigger constructed using OP-Amp

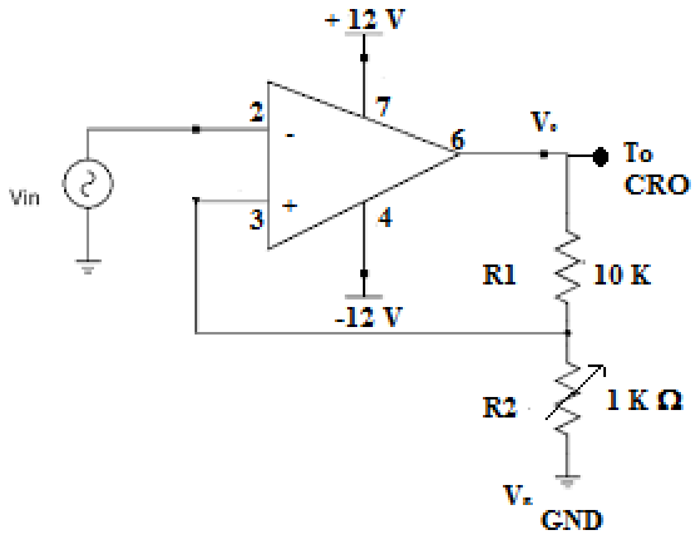

Table 1: Schmitt trigger

S.No.	Input frequency (Hertz)	(Time/Division) × width (1 ms)	Calculated Frequency (Hertz)

RESULT

The Schmitt trigger circuit is constructed using Op-Amp and then the waveform are traced and input, output frequencies are determined.

VOLTAGE COMPARATOR

NOTES

AIM

To construct a voltage comparator by using IC 741 and to study its characteristics.

APPARATUS AND COMPONENTS

IC 741, resistors (10kΩ), multimeter, bread board, connecting wires, etc.

THEORY

The voltage comparator using Op-amp compares one analogue voltage level with another analogue voltage level, or some preset reference voltage, Vref and produces an output signal based on this voltage comparison. In other words, the op-amp voltage comparator compares the magnitudes of two voltage inputs and determines which is the largest of the two. The voltage level for both the positive and negative output voltages will be about 1 V less than the power supply. Voltage comparators on the other hand, either use positive feedback or no feedback at all to switch its output between two saturated states.

PROCEDURE

In the voltage-comparator circuit, first a reference voltage is applied to the inverting input in the pin 2 of IC 741. Then the voltage to be compared with the reference voltage is applied to the non-inverting input through the pin 3. The output voltage from the pin 6 depends on the value of the input voltage relative to the reference voltage, as follows:

Input voltage	Output voltage
Less than reference voltage	Negative
Equal to reference voltage	Zero
Greater than reference voltage	Positive

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Table 1: Comparison of voltages

V_{ref}	
V_{in} (V)	V_{out} (V)

Figure 1. Circuit diagram of voltage comparator using IC 741

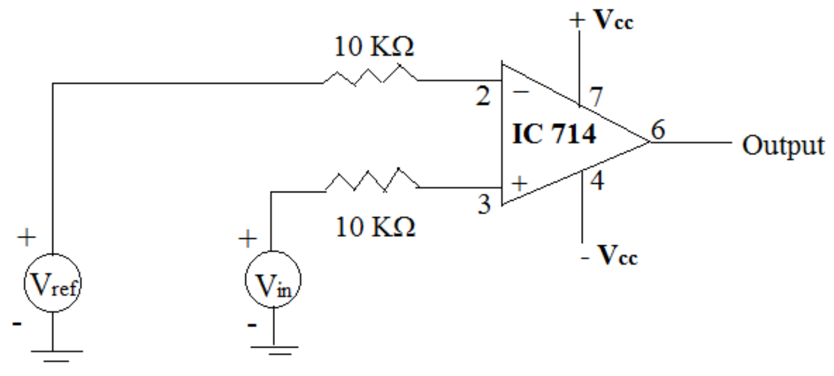
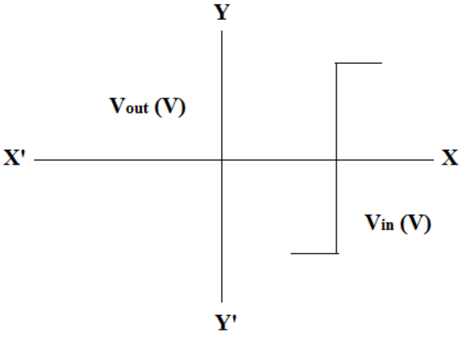


Figure 2. Model graph



RESULT

The voltage comparator is constructed using IC 741 and the results have been confirmed with the help of model graph.

DEMULTIPLEXER

AIM

To study the demultiplexer circuit using IC's and verify its truth table.

NOTES

APPARATUS AND COMPONENTS

IC-74155, bread board, connecting wires, power supply, etc.

PROCEDURE

Connect the circuit of IC 74155 as shown in figure. Connect the pin 16 to the power supply. Pin 1 and 2 are selected for A input. Pin 14 and 15 are selected for B input. The outputs for A input is taken from the pins 4,5,6 and 7. The outputs for B input is taken from the pins 9,10,11 and 12. Ground the pin 8.

Figure 1: Block diagram of demultiplexer

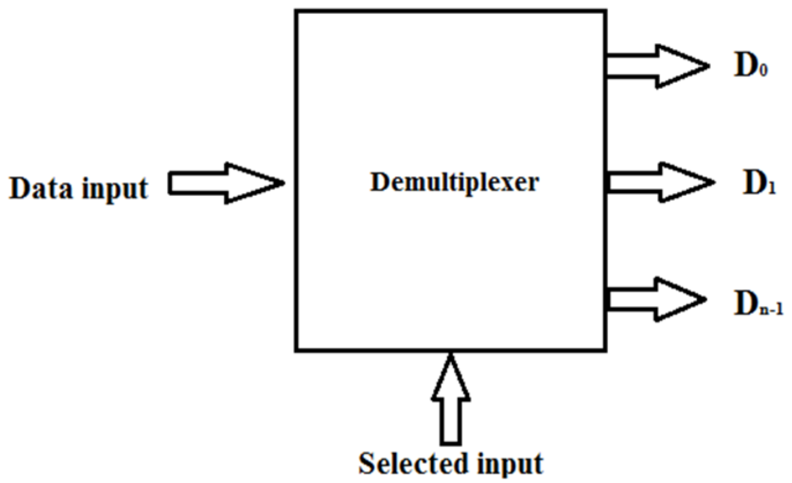


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Figure 2: Circuit diagram

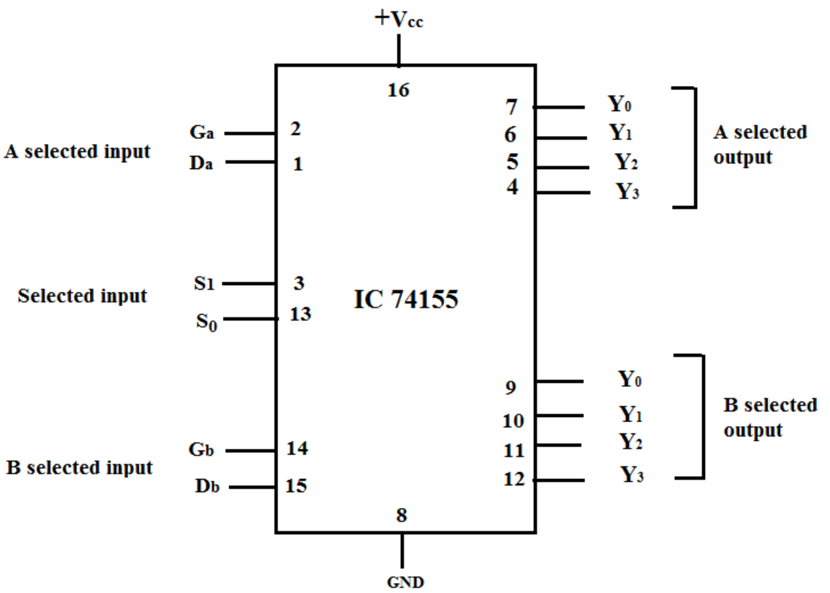

Table 1: Truth table for A values

Input				Output			
S_1	S_0	G_a	D_a	Y_0	Y_1	Y_2	Y_3
X	X	1	X	1	1	1	1
X	X	X	0	1	1	1	1
0	0	0	1	0	1	1	1
0	1	0	1	1	0	1	1
1	0	0	1	1	1	0	1
1	1	0	1	1	1	1	0

Table 1(A): Verification table for A values

Input				Output			
S_1	S_0	G_a	D_a	Y_0	Y_1	Y_2	Y_3

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Table 2: Truth table for B values

Input				Output			
S_1	S_0	G_b	D_b	Y_0	Y_1	Y_2	Y_3
X	X	1	X	1	1	1	1
X	X	X	0	1	1	1	1
0	0	0	0	0	1	1	1
0	1	0	0	1	0	1	1
1	0	0	0	1	1	0	1
1	1	0	0	1	1	1	0

Table 2(A): Verification table for B values

Input				Output			
S_1	S_0	G_b	D_b	Y_0	Y_1	Y_2	Y_3

RESULT

The demultiplexer circuit was constructed using IC 74155 and its truth tables were verified.

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LOGIC GATES USING IC'S

AIM

To study the truth tables of AND, OR, NOT, NAND and NOR by constructing the logic gates through IC's.

APPARATUS AND COMPONENTS

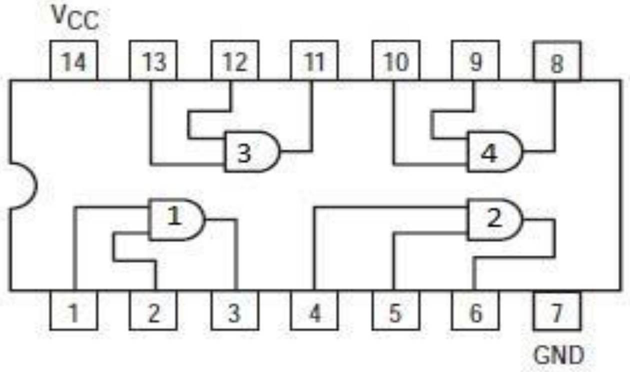
IC 7408 (AND Gate), IC 7432 (OR Gate), IC 7404 (INV Gate), IC 7402 (NOR Gate), IC 7400 (NAND Gate), bread board, 5V dc power supply, connecting wires, logic level indicator or voltmeter and IC pin socket (14 & 16 pin) etc.

PROCEDURE

AND Gate using IC 7408

AND gate produces an output as 1, when all its inputs are 1; otherwise the output is 0. This gate can have minimum 2 inputs but output is always one. Its output is 0 when any input is 0. Connect the circuit as shown in figure. The pin 14 is connected to +5V supply voltage and pin 7 is connected to ground. Set the switches S1 and S2 as needed to get the differential binary input combination as shown in truth table. Record the state of the output as a binary 0 (or) 1 for each input possibility using a voltmeter in the truth table.

Figure 1: Circuit diagram of AND gate constructed using IC 7408



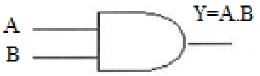


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Table 1: 7408 AND Gate Truth Table and its Observation

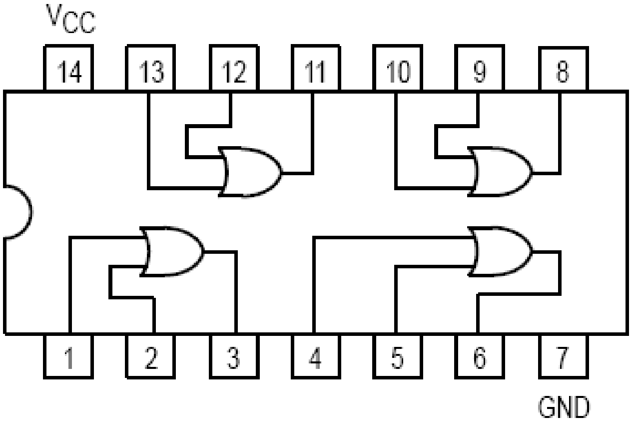
A	B	Y=A.B
0	0	0
0	1	0
1	0	0
1	1	1

A	B	Y=A.B

OR Gate using IC 7432

OR gate produces an output as 1, when any or all its inputs are 1; otherwise the output is 0. This gate can have minimum 2 inputs but output is always one. Its output is 0 when all input are 0. Connect the circuit as shown in figure. The pin 14 is connected to +5V supply voltage and pin 7 is connected to ground. Set the switches S1 and S2 as needed to get the differential binary input combination as shown in truth table. Record the state of the output as a binary 0 (or) 1 for each input possibility using a logic level indicator or voltmeter in the truth table.

Figure 2. Circuit diagram of OR gate constructed using IC 7432



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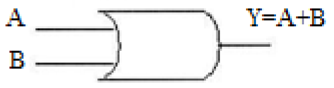

Table 2: 7432 OR Gate Truth Table and its observation

A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

A	B	Y=A+B

NOT Gate using IC 7404

NOT gate produces the complement of its input. This gate is also called an INVERTER. It always has one input and one output. Its output is 0 when input is 1 and output is 1 when input is 0. Connect the circuit as shown in figure. The pin 14 is connected to +5V supply voltage and pin 7 is connected to ground. Put switch S1 to ground. Measure the output using voltmeter. Put S1 to +5V of the supply, now measure the output voltage or observed using logic level indicator. Tabulate the reading and compare it with the truth table.

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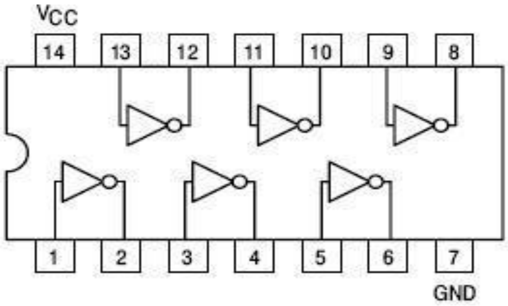
Figure 3. Circuit diagram of NOT gate constructed using IC 7404



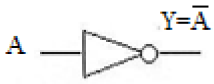


Table 3: 7404 NOT Gate Truth Table and its observation

A	**Y=$\overline{A}$**
0	1
1	0

A	**Y=$\overline{A}$**

NAND Gate using IC 7400

NAND gate is actually a series of AND gate with NOT gate. If we connect the output of an AND gate to the input of a NOT gate, this combination will work as NOT-AND or NAND gate. Its output is 1 when any or all inputs are 0, otherwise output is 1. Connect the circuit as shown in figure. The pin 14 is connected to +5V supply voltage and pin 7 is connected to ground. Set the switches S1 and S2 as needed to get the different binary input combination shown in truth table. Record the state of the output as binary 0 (or) 1 for each input possibility using a voltmeter in the truth table. Make the truth table and compare it with given table.

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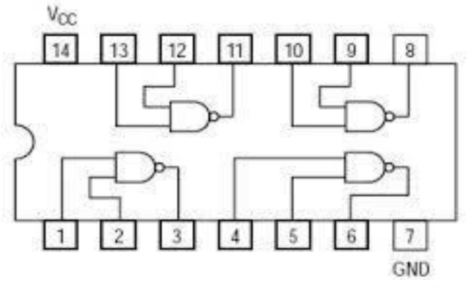
Figure 4. Circuit diagram of NAND gate constructed using IC 7400



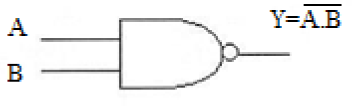


Table 4: 7400 NAND Gate Truth Table and its observation

A	B	Y=$\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

A	B	Y=$\overline{A.B}$

NOR Gate using IC 7402

NOR gate is actually a series of OR gate with NOT gate. If we connect the output of an OR gate to the input of a NOT gate, this combination will work as NOT-OR or NOR gate. Its output is 0 when any or all inputs are 1, otherwise output is 1. Connect the circuit as shown in figure. The pin 14 is connected to +5V supply voltage and pin 7 is connected to ground. Set the switches S1 and S2 as needed to get the differential binary input combination as shown in truth table.

Record the state of the output as a binary 0 (or) 1 for each input possibility using a logic level indicator or voltmeter in the truth table. Make the truth table and compare it with given table.

Figure 5. Circuit diagram of NAND gate constructed using IC 7402

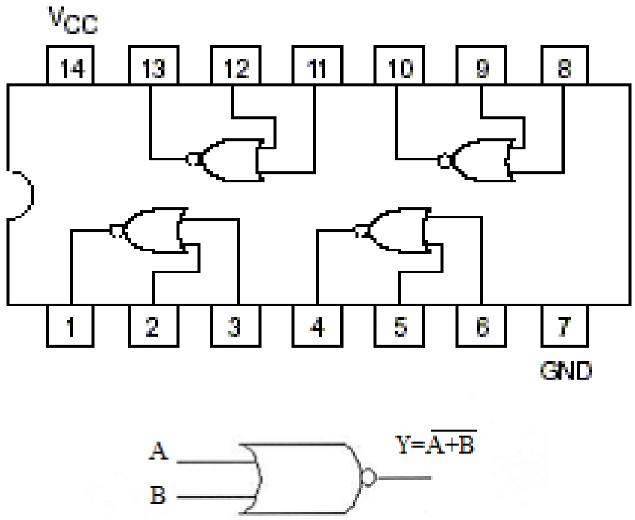


Table 5: 7402 NOR Gate Truth Table and its observation

A	**B**	**Y=$\overline{A+B}$**
0	0	1
0	1	0
1	0	0
1	1	0

A	**B**	**Y=$\overline{A+B}$**

RESULT

The logic gates are constructed using IC's and the truth table for all fundamental gates are verified.

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YOUNG'S MODULUS – CORNU'S METHOD

AIM

To determine Young's modulus of elasticity of the materials of the beam, subjecting it to uniform bending by Cornu's method.

APPARATUS AND COMPONENTS

Optically plane glass plate, knife edges, horizontal rigid support, convex lens, Sodium vapour lamp, 45° slot with glass plate, co-ordination microscope with longitudinal and transverse movement, weights etc.

DESCRIPTION

The rectangular plane glass plate AB is symmetrically placed on two knife edges, K1 and K2, held by horizontal rigid support, HS. Two equal weights W1 (say 200 g) are suspended from two ends C and D of the plate symmetrically from respective nearest knife edges. A convex lens L is placed at the middle of the plate. The light from sodium vapour lamp, after reflection from glass plate G inclined in the slot at 45° to the horizontal, falls normally on the lens L.

A thin air film of varying thickness is enclosed between curved surface of convex lens and uniformly bent glass plate. Due to interference, bright and dark elliptical fringes may be observed in the field of view of the properly focused microscope M. The microscope can be moved to and fro either along (longitudinal) or across (transverse) the plate AB by working on its screws separately. The microscope readings are noted using a pinch scale and a head scale. The head scale is also provided with a vernier to improve the reading to the fourth decimal point. This arrangement is provided both for longitudinal and transverse movements.

PROCEDURE

To start with two weights, W1=200g each, are suspended at the two ends C and D of the plate, at a distance from the nearest knife edge. The 45° inclined glass plate and the position of the microscope is adjusted to get maximum uniform intensity in the field of view. By focusing the microscope, a well-defined bright and dark elliptical fringes with dark center may be observed as show in figure. The eyepiece alone is adjusted to get clear view of the cross wires. From the figure the direction of the major axis (X) of the elliptical fringes is taken as longitudinal and the direction of the minor axis (Y) is taken as transverse.

First the vertical cross wire is made to coincide with the left edge of the first dark elliptical fringe. This fringe is counted as n. The head scale is rotated in the clock wise (or anticlock wise) direction so that the cross wire moves towards the left from the fringe pattern. As the cross wire moves across the fringes, the dark fringes are counted as n+1, n+2, etc. On reaching n+21, the head scale screw is adjusted slowly so that the vertical cross wire coincides with $(n+21)^{th}$ fringe. The pitch scale reading, head scale reading and the vernier coincidence are noted.

The head screw is now rotted in the opposite direction so that the cross wire moves towards the right. The cross wire is made to coincide with the $(n+18)^{th}$ in the same direction, the readings are taken for the (n+15), (n+12),….(n+3), and fringe n. The microscope is further rotated in the same direction and the vertical cross wire is made to coincide with the n^{th} fringe on the right side. Then readings corresponding to (n+3), (n+6),… (n+21) are taken each time making the cross wire to coincide with the respective fringe. The readings taken are tabulated as shown, Table 1.

The experiment is repeated by suspending a weight W_2 (equal to 300 g) on both ends of the glass plate and observations are noted in another table identical to table 1. The distance between the point of suspension of the weight and the nearest knife edge, a is measured. The breadth b and thickness d of the glass plate are measured using vernier calipers and screw gauge respectively. The experiment may be repeated by changing the distance, a of the point of suspension of weights.

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Figure 1. Schematic representation of Young's modulus

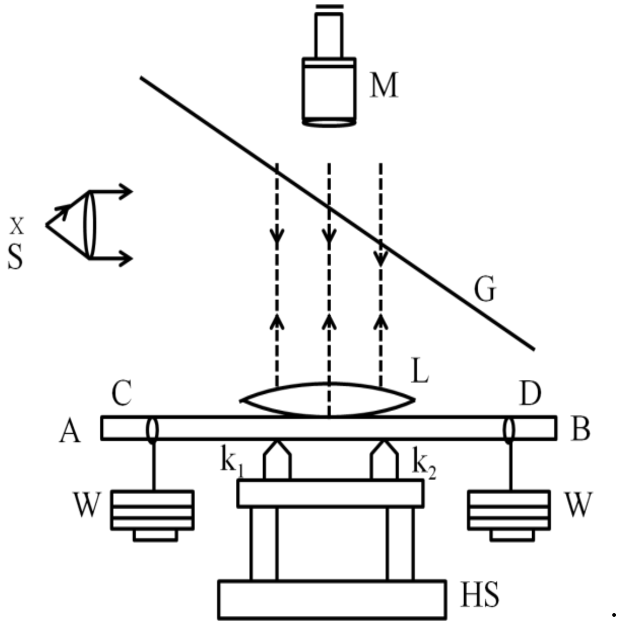
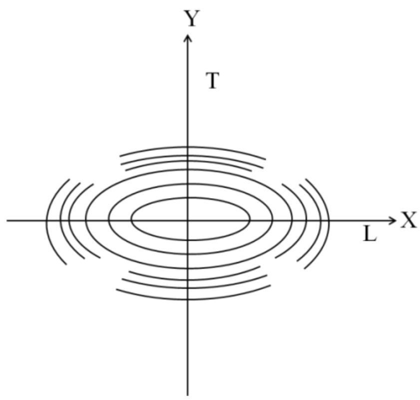


Figure 2.



THEORY

Cornu's method is based on the principle of formation of Newton's Rings and uniform bending of a rectangular beam. The radius of curvature of glass plate is given by (in longitudinal direction)

$$\mathbf{R_L = X^2_{n+m} - X^2_n / 4\, m\, \lambda}$$

where X_{n+m} and X_n are length of major axes of the $(n+m)^{th}$ and n^{th} order dark fringes respectively and λ is the wavelength of monochromatic light.

R_{L1} and R_{L2} are calculated for $W_1$and W_2 using above formula.

Then, Young's modulus of the material of the glass plate is given by:

$$E = 12\,(W_2-W_1)\,a\,g\,/\,bd^3\,[1/R_{L2} - 1/R_{L1}]$$

Table 1: Determination of RL1 for W1=200 gm

Order of ring	Microscope Readings		$X_n \times 10^{-2}$ m	$X_n^2 \times 10^{-4}$ m^{-2}	$(X^2_{n+m} - X^2_n)$ (m=12)
	Left (cm)	Right (cm)			
n n+3 n+6 n+9				x_1 x_2 x_3 x_4	
n+12 n+15 n+18 n+21				x_5 x_6 x_7 x_8	$x_5 - x_1$ $x_6 - x_2$ $x_7 - x_3$ $x_8 - x_4$

Mean $(X^2_{n+m} - X^2_n) = 10^{-4}\ m^2$

OBSERVATIONS

Distance between the point of suspension and nearest knife edge

a= m

Breadth of glass plate

b= m

Thickness of glass plate

d= m

Acceleration due to gravity

$g = 9.81\ ms^{-2}$

Wavelength of sodium light

$\lambda = 589.3 \times 10^{-9}$ m

RESULT

Young's modulus of the material of glass plate E= Nm^{-2}

NOTES

REFRACTIVE INDEX OF LIQUID BY LASER

NOTES

AIM:

To calculate the refractive index of the given liquids with the help of LASER.

APPARATUS AND COMPONENTS

Open rectangular container with thin transparent wall, LASER light source as pointer, an opaque stripe of 3-4 cm wide and a sheet of paper.

PROCEDURE

Affix the strip along the middle of one wall of the container, and the sheet of paper on the wall opposite, as shown in Fig.1. The light source is placed at a convenient distance near the strip. With the container empty, the edges of the shadow of the strip are marked on the paper sheet opposite. Now fill the container with liquid and mark again the width of the shadow, reduced compared to the previous width because of refraction.

Let L, W_e, and W_f be the widths of the strip, the shadow when the box is empty, and the shadow when the box is full, respectively. Then the simple geometry shown in the side view of Fig 2. Allows one to calculate the refractive index n of the liquid. Using Snell's law

$$n \sin q_2 = \sin q_1$$

and the approximation sin q ≈ tan q, justified by the dimensions of the apparatus, we have

$$n = W_e - L / W_f - L$$

Note that adjusting the strength of the source, the width of the container (affecting the absorption of light), and the distance of the source from the opaque strip will result in optimally sharp shadows.

NOTES

Figure 1. The setup

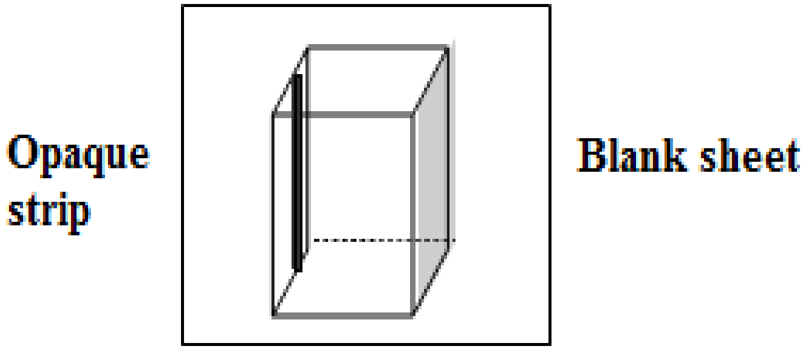
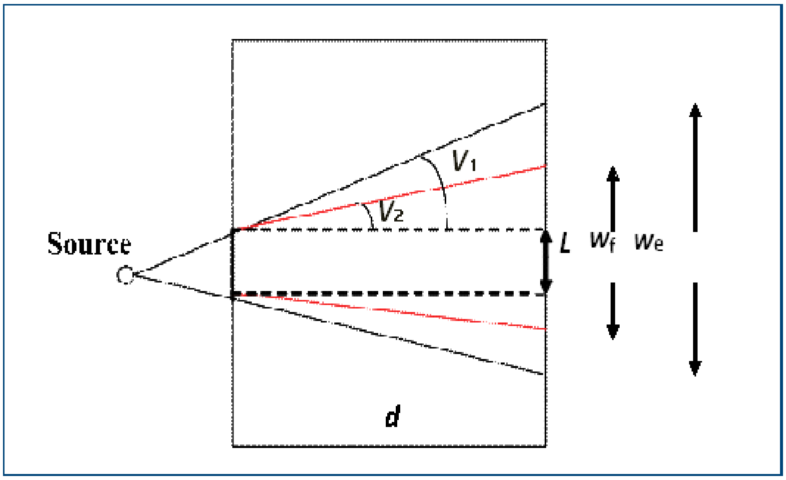


Figure 2. Geometry for finding *n*.



RESULT

Distances between the first order fringes marked on the screen should be shorter when laser beam goes through water than when it goes through air. It is better visible when you use a laser level (a product available in construction shops) instead of a laser pointer.

OPTICAL ABSORPTION STUDIES USING LASERS

AIM:

Using the optical bread board, we are going to: a) measure the refractive index of a material b) Coefficient of absorption for different colour filters c) Coefficient of absorption of a material.

APPARATUS AND COMPONENTS

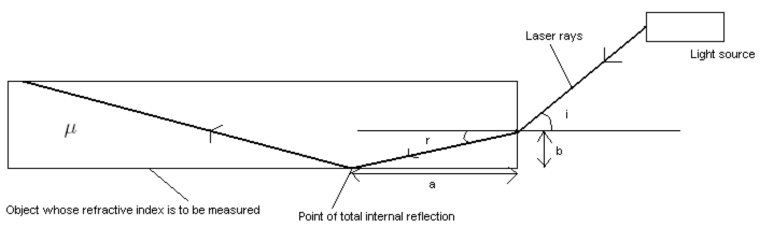
Optical bread board, rectangular block whose refractive index μ is to be measured, clamp to mount the body on the bread board, laser light source, measuring tape, white screen, detector.

THEORY OF EXPERIMENT

This experiment has three parts.

Part A- Measuring μ of a material

We have to mount the rectangular glass block and the light source as shown in figure.



Measurement of μ using optical bread board

Now, the laser light is directed on the rectangular block. The light will undergo total internal reflection. Let, the angle of incidence be i and angle of refraction be r. a and b as shown in figure. From Geometry, we can say that $r = \tan^{-1} b/a$. i is known to us from the reading of the laser light source. The laser light source has a circular scale around it which enables us to measure i. Thus, knowing i and r, we can measure μ, i.e. $\mu = \sin(i)/\sin(r)$. We take multiple readings and their average gives us the value of the refractive index.

Part B- Observation for colour filter absorption Laser is passed through filters of various colour. The light generates a current in the detector. The reading of the current gives us the intensity transmitted through the filters. The colours near red region will absorb the least while green and blue regions will absorb the most. This is because, red

NOTES

light is not absorbed by red filters while, filters of other colour absorb it readily hence transmitting very little.

Part C- Measurement of the coefficient of absorption of material Suppose, the laser light produces a light of intensity i_0. Now, a material of thickness t is inserted in the path of light. So, there will be some absorption due to which the detector will detect a lesser current i. Now, i and i_0 are related by the formula $i = i_0 e^{-\lambda t}$. Here, λ is called the absorption coefficient. So, the coefficient λ is given by: $\lambda = -1/t \ln (i/ i_0)$.

PROCEDURE

Part A- Measuring μ of a material.

The block is mounted as shown earlier. a and b are calculated using the measuring tape. r can be calculated from them. i is directly known from the circular scale of the laser source. The ratio sin(i)/sin(r) gives μ.

Part B- Observation for colour filter absorption.

Here, we have to focus the laser beam and make them pass through the filters. A smaller current will be detected in the detector. The colour and intensity are noted.

Part C- Measurement of the coefficient of absorption of material

We insert slides one by one, thus gradually increasing the thickness of the interveining material. The coefficient changes with thickness. We measure the thickness and the intensity after passing through the body. Putting these values in the relevant formula, we can get the linear coefficient of absorption i.e λ.

CALCULATIONS:
Part A - Measuring μ of a material (MODEL)

S.No.	i (in deg)	a (cm)	b (cm)	r (in deg)	μ
1	45	2.6	1.6	31.33	1.35
2	36	3.1	1.5	25.82	1.35
3	28	5.2	1.9	20.07	1.37

Hence, the average μ value is given by μ=1.36

Part A- Measuring μ of a material

S.No.	i (in deg)	a (cm)	b (cm)	r (in deg)	μ

Part B- Observation for colour filter absorption (MODEL)

Intensity of laser without filters = 32.2 Ma

S. No.	Filter Colour	Intensity (mA)
1	Green	0.5
2	Golden	4.7
3	Greyish white	14.7
4	Lemon yellow	21.7
5	Reddish yellow	29.3
6	Red	30.0

Thus, it is quite evident from the observation that RED filter absorbs least light intensity.

Part B- Observation for colour filter absorption

S. No.	Filter Colour	Intensity (mA)
1		
2		
3		
4		
5		
6		

Part C- Measurement of the coefficient of absorption of material (MODEL)

S.No.	No. of slides	Intensity (in mA)	Thickness (in mm)	λ
1	1	30.3	1.09	5.58×10^{-2}
2	2	28.4	2.18	5.69×10^{-2}
3	3	26.8	3.26	5.63×10^{-2}
4	4	25.3	4.30	5.60×10^{-2}
5	5	23.6	5.45	5.70×10^{-2}

Mean coefficient = 5.64×10^{-2}

Part C- Measurement of the coefficient of absorption of material

S.No.	No. of slides	Intensity (in mA)	Thickness (in mm)	λ

RESULT

Thus, from this experiment, we get three results:
a) μ of the given material =
b) The absorption coefficient of glass =

NOTES

DETERMINATION OF WAVELENGTH OF A LASER SOURCE BY DIFFRACTION GRATING

AIM:

To standardize the reflection grating using mercury vapor lamp and to determine the wavelength of various lines of mercury spectrum.

APPARATUS AND COMPONENTS

Spectrometer, grating holder, prism holder, prism, reflection grating mercury vapor lamp, spirit level, etc.

FORMULA

Wavelength of spectral lines in the mercury lines in the mercury spectrum when the telescope moves away from the collimeter

λ = sini-sinΦ/ Nn

Where

$\Phi = \theta - i$

i = angle of incidence

θ= vernier scale reading

n= order of the spectrum

N= Number of lines per meter in the grating

N = sini-sin Φ/nλ

PROCEDURE

The initial adjustments of the spectrum are done properly. Take the direction reading and add 90˚ to the vernier. A reading and fix the telescope at the position place the reflection grating and rotate the table to get reflective image of the source in the telescope. Now the angle of incidence is fixed at 40˚. Fix the grating table in this position. Move the grating table in this position. Move the telescope towards the collimeter. Note the reading of each line. Do the necessary calculations and find out the wavelength of the colour lines of the mercury spectrum. Then fix the same angle of incidence of fringes and move the telescope away from the collimeter. Note the reading of each color line. They are compared with the standard value wavelength.

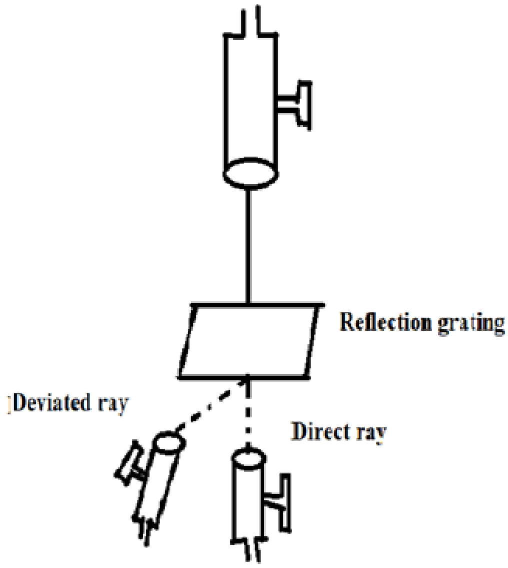


Table 1: When the telescope move towards the collimeter

Spectral lines	Vernier reading	R0-R1 degrees	R0-R degrees	Φ =θ-i	λ (A°)

Table 2: When the telescope move towards the collimator

Colour	Vernier reading	R0-R1 degrees	R0-R degrees	Φ =θ-i	λ (A°)
	Vernier A	Vernier B			

Angle of incidence =

RESULT

The wavelength of various spectral lines in mercury spectrum calculated and they are compared with the standard values.

DETERMINATION OF CHARGE OF ELECTRON USING SPECTROMETER

AIM

To determine the charge of an electron using spectrometer by the experiment.

FORMULAE

Calculate the value of the charge of an electron using Equation:

$$q = \frac{-smg}{v_o} = 1.60\times10^{-19}\text{C}$$

q = charge of an electron
s = slope of V_0 versus E graph as measured in the lab m = mass of the droplet
g = acceleration due to gravity = 9.80 m/s^2
V_o = terminal velocity of fall (its value is negative and constant) as calculated as the vertical intercept of equation or as measured directly through the Millikan Oil Drop Apparatus.

PROCEDURE

Adjusting and Measuring the Voltage

Connect the high voltage DC power supply to the plate voltage connectors using banana plug patch cords and adjust to deliver about 500 V. Use the digital multimeter to measure the voltage delivered to the capacitor plates. Measure the voltage at the plate voltage connectors, not across the capacitor plates. There is a 10 mega-ohm resistor in series with each plate to prevent electric shock. Connect the multimeter to the thermostat connectors and measure the resistance of the thermistor. Refer to the Thermistor Resistance Table located on the platform to find the temperature of the lower brass plate. The measured temperature should correspond to the temperature within the droplet viewing chamber. Although the dichroic window reflects much of the heat generated by the halogen bulb, the temperature inside the droplet viewing chamber may rise after prolonged exposure to the light. Therefore, the temperature inside the droplet viewing chamber should be determined periodically Prepare the atomizer by rapidly squeezing the bulb until oil is spraying out. Insure that the tip of the atomizer is pointed down (90° to the shaft; see Figure 4). Move the ionization source lever to the Spray Droplet Position to allow air to escape from the chamber during the introduction of droplets into the chamber. Place the nozzle of the atomizer into the hole on the lid of the droplet viewing chamber. While observing through viewing scope, squeeze the atomizer bulb with one quick squeeze. Then squeeze it slowly to force the droplets through the hole in the droplet whole cover, through the droplet entry hole in the top capacitor plate, and into the space between the two capacitor plates. When you see a shower of drops through the viewing scope, move the ionization source lever to the OFF position.

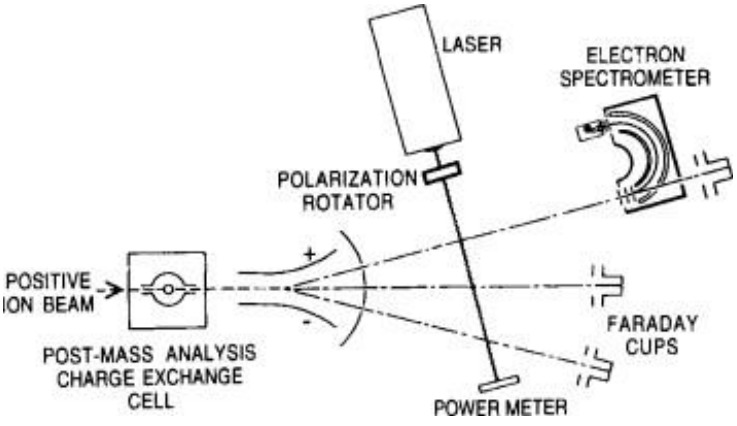


Table 1:

Accelerating Voltage(V)	Beam 1(MW)	Beam 1(MW)	Diameter of the beam path (m)	Diameter (m^2)

RESULT

The constant value of charge electron using spectrometer is =

THERMAL EXPANSION USING OPTICAL AIR-WEDGE

AIM

To study the thermal expansion by optical air wedge method.

APPARATUS AND COMPONENTS

Two optically plane glass plates, monochromatic source, crystal rod, thin mica sheet, heater coil, glass plate, microscope, etc.

FORMULA

$\alpha = L\lambda(\beta_1-\beta_2)/ 2l\beta_1\beta_2 (t_2-t_1)$ /° C

L - Length of the optically plane glass plate

λ -Wavelength of the monochromatic light

β_1- initial temperature fringe width

β_2 -final temperature fringe width

t_1- initial temperature

t_2- final temperature

l- Length of the crystal rod

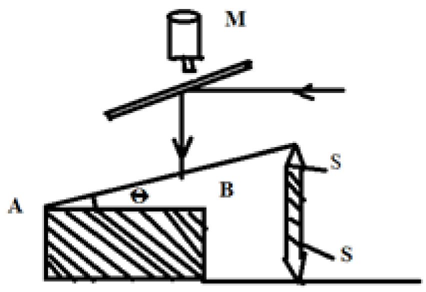
THEORY

Wedge shaped air film is formed by air wedge method, the change in fringe with β accounts for the thermal expansion. Two optically plane glass plates are supported at the pointed ends of the rod of test material to form an air film of wedge shape. When the test rod undergoes thermal expansion, the wedge angle changes and resulted in the range of the fringe width.

EXPERIMENTAL SET UP

The schematic diagram of an air wedge is shown in figure.1. Optically plane glass plates AB and AC are shown, making a small angle θ. The crystal rod R is the material under test. The two ends of the crystal rods are made points as shown in the figure. It is wrapped round by a heater coil SS. The heater coil SS is wrapped on a thin mica sheet enclosing the rod. The wrapper is used for electrical insulation. The DC current is passed through the heater coil SS. The monochromatic light is passed through the system; the wedge angle is adjusted to get a clear system straight fringes. The microscope readings are used to measure the width of the fringe β.

Figure 1. Schematic diagram of an air wedge



EXPERIMENTAL PROCEDURE

Experimental set up is explained in the above paragraph. We can form a clear fringe in an air wedge system using the microscope adjustment screws, calculate the fringe width β_1 at the temperature t_1˚C. After measuring the fringe width, current is passed through the heater coil SS and the temperature is raised to attain t_2˚C. Then, determine the width β_2 at t_2˚C. The experiment is repeated for n, n+5, n+10….at various temperatures and the corresponding widths are taken out and tabulated as follows:

Table 1: Estimated of β_1 at t_1˚C

S.No.	No. of fringes	Microscope reading	Width of 10 fringes	Width of single fringe β
1	n			
2	n+5			
3	n+10			
4	n+15			
5	n+20			

Table 2: Estimated of β_2 at t_2˚C

S.No.	No. of fringes	Microscope reading	Width of 10 fringes	Width of single fringe β
1	n			
2	n+5			
3	n+10			
4	n+15			
5	n+20			

RESULT

Thermal expansion of the given rod = ˚C

ULTRASONIC INTERFEROMETER

AIM

1) Determination of ultrasonic waves velocity in a liquid medium

2) Determination of compressibility of the given liquid.

APPARATUS REQUIRED

Ultrasonic Interferometer kit, Thermostat bath, RF Oscillator, Detector, Crystal, Crystal rectifier, Ammeter, Micrometer screw, Rheostat, Power supply, etc.

FORMULA

$$V = \nu\lambda$$
$$E = v^2\rho$$
$$\beta = 1/ v^2\rho$$

Where

ν = frequency of ultrasonic wave
λ = wavelength of the experimental liquid
V = velocity of ultrasonic waves in a liquid medium
E = bulk modulus
β = compressibility
ρ = density of the liquid medium

THEORY

The ultrasonic waves are mechanical waves which are propagated through a medium and the properties of the medium can be studied. Basically the velocity of mechanical waves depends upon the clasticity and density of the medium according to the equation (2) given above.

In this case, the reflecting plane of ultrasonic waves is made to move away or towards the ultrasonic transducers. The movement of ultrasonic waves is considered by means of micrometer screw. The Oscillator energizing transducer transfers maximum energy in case the moving platform is at the nodes of the stationary waves formed by direct and reflected waves.

EXPERIMENTAL SETUP AND PROCEDURE

We can use this experiment for transparent liquids and affords to study the effect of temperature on velocity propagation of ultrasonic waves through the test liquid. A schematic diagram of this setup is as shown in Figure 1. The double walled cylindrical vessel has a provision to circulate water between the inner and outer walls. A crystal transducer is set at the bottom of the cylinder to send waves upwards and a plat form carrying exactly similar crystal moves the bottom by means of micrometer screw.

At the top of the platform a fine micrometer screw reflector at its ends and it is immersed in the liquid. The reflector mixture can be raised or lowered through a known distance using screw.

The test liquid is filled in the inner cylinder. The space between the walls of the outer and inner cylinder works as a thermostat and maintains the test liquid at a specific temperature. The crystal transducer ‘C ‘is energized by a radio frequency power oscillator of variable frequency. The oscillator frequency is matched with the frequency of the crystal. The ultrasonic wave is sent upwards in the test liquid and the wave reflected from the platform ‘p’ is also shown in Figure 1.

The experimental setup is initially checked for proper working of each component. The experimental arrangement is described above. Fill the inner cylinder with the test liquid. The temperature of the liquid is kept constant. The power supply to the oscillator circuit is switched on. Move the platform slowly in one direction and note the maximum deflection in consecutive position. Now, move the platform in the reverse direction using the micrometer screw. Record the observations in the given tabular column. The ultrasonic velocity and compressibility of ultrasonic waves can be calculated for the given liquid at different temperatures.

NOTES

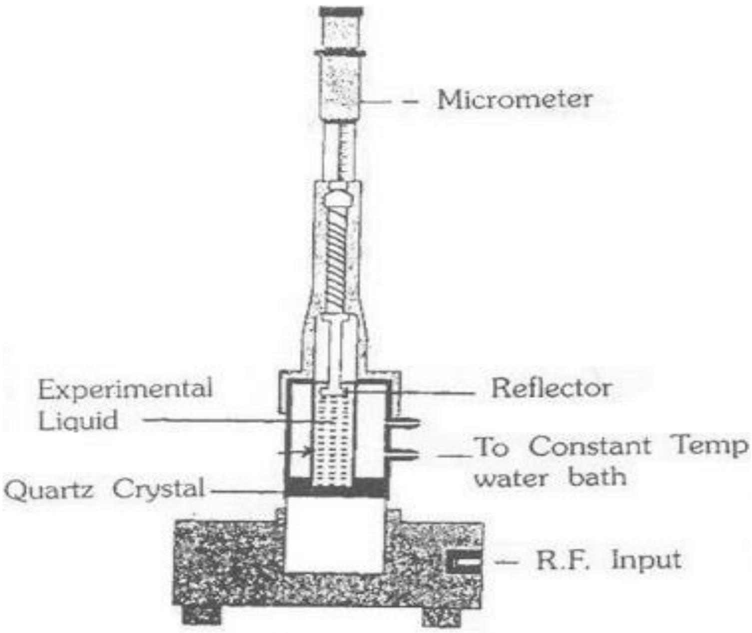


Figure 1

Table 1

S.No.	No. of nodes	Micrometer reading (mm)	Difference for say 10	Wavelength λ (mm)

RESULT

1. Ultrasonic velocity of the given liquid is m/s
2. Compressibility of the given liquid is m^2N^{-1}

ELECTRON SPIN RESONANCE SPECTROMETER

AIM

To determine the lande-g splitting factor of free electron spin and to calculate the larmour frequency.

FORMULA

H = 32 Πan/10√125 gauss
Hpp = 2√2HI gauss/amp
H0 = Hpp (QI/P) gauss
Lande-g factor
$g = h_{\gamma 0} / \mu_0 H_0$
Larmour frequency
$\omega_0 = ge / 2mc$

Where,
H→ Magnetic field (gauss)
n→ no of turns in each coil
a →radius of the coil
H_{pp}→ peak to peak magnetic field
H_0→ magnetic field on the sample at resonance
g→ lande g factor
μ_0→ base magnetron ($0.927*10^{-20}$ erg/ gauss)
ν_0 → resonance frequency
h→ planks constant ($6.627* 10^{-27}$ erg)

THEORY

A practical having magnetic moment m placed in a uniform magnetic field of intensity H_0 then the moment will be precise around H_0 with angular Larmour frequency ω_0 , being lande factor

In Helmholtz coil the two coils are exactly alike parallel to each other. So connected the current passes through than in the same direction. The two coils increasing the unforming of the field near the center of the coils are attachment is provided to keep the sample in space and to minimize shocks and variation.

EXPERIMENTAL PROCEDURE

Set frequency at the center, increase the horizontal sensitivity of oscilloscope to the maximize within the linear range. Obtain the best possible resonance peaks by varying the frequency. The sensitivity of oscilloscope by keeping current at 150mA.

The frequency is kept constant but the current is varying and the corresponding horizontal separation between two peaks 20 after adjusting the phase. A graph is plotted by taking Y1 along x-axis and Q along y axis. The straight line is obtained. The slope of the line gives the value of Q_x. keeping the set up as is it. Power can be calibrated by RF oscillator. The RF oscillator is turned on to obtain peaks. The frequency of the oscillator is read from the oscillator dial very slowly. The frequency corresponds to zero is the resonance frequency.

Table 1

Current	Distance between peaks 2div	Q div	Qmm 1div = 2mm	I/I * 10^{-3} A^{-1}

RESULT

Lande's factor g =
Larmour frequency ω_0=
Resonance frequency ν_0=

MAGNETIC HYSTERISIS LOOP TRACER

AIM

The goal of this lab exercise is to study the phenomena of magnetic hysteresis and calculate the retentivity, coercivity and saturation magnetization of a material using a hysteresis loop tracer (HLT-111). The remote trigger equipment allows you to control the applied magnetic field (H). By varying this parameter, the J-H loop, dJ/dt and d2J/dt2 loop will be produced.

APPARATUS REQUIRED

The Hysteresis Loop tracer (HLT-111).

INSTRUCTIONS FOR SIMULATOR

- Select the sample A or B.
- Click plot and the MH curve are displayed on the screen.
- Vary the material parameters and observe the characteristics of the material.
- Reset clears the input field and reset figure clears the graph.

OBSERVATIONS

- Diameter of the pick-up coil: mm .
- Gx:
- Gy:
- Length of the sample: mm.
- Diameter of sample: mm.
- Demagnetization factor β= N:

CALIBRATION (SETTINGS)

- No sample in the pick-up coil
- H balance, DC balance and Phase adjusted for horizontal line in the centre
- Demagnetization (N) at zero
- Area Ratio As/ Ac at 0.399
- Root mean square value of applied magnetic field (Ha) is 209 Gauss

CALIBRATION (OBSERVATIONS)

- Observed value of ex= 7 volts
- Since, the area ratio for the given sample is so small the signal ex was enhanced by multiplying area ratio and demagnetization by three. The finally obtained value of the intercept (below) is divided by this same factor, 3, to give the correct value of coercivity.
- Similarly for calculating G0 we set Area ratio As/Ac to 1.000 and other settings remain as calibrated, the signal ex obtained is, ex = 18 volts.

G0 can be calculated using the relation

$$ex = \frac{Ha}{Go}$$

$$\text{Go(rms)} = \frac{Ha}{ex} = \frac{209}{18} = 11.61$$

$$\text{Go(rms)} = \frac{Ha}{ex} = \frac{209}{18} = 11.61\text{gauss/volt}$$

$$\text{Go(rms)} = \frac{Ha}{ex} = \frac{209}{18} = 11.61\text{gauss/volt}$$

$$\text{Go(peak)} = \frac{Go\,(rms)}{2\sqrt{2}} = \frac{11.61}{2\sqrt{2}} = 4.105\text{gauss/volt}$$

$$\text{Go(peak)} = \frac{Go\,(rms)}{2\sqrt{2}} = \frac{11.61}{2\sqrt{2}} = 4.105\text{gauss/volt}$$

PROCEDURE

1. Power on the device.
2. Slowly vary the applied magnetic field using magnetic field slider. M-H graph corresponding to the field will be plotted, whenever the slider is stopped.
3. Tabulate the loop width, the tip-to-tip height and positive intercept to negative intercept distance for each magnetic field as shown in the table below.
4. Calculation of coercivity:

Plot the loop width of hysteresis loop against magnetic field.
The intercept of the straight line fit on the J-axis gives loop width.
Coercivity,

$$H = Go \frac{ex}{\frac{As}{Ac} - N}$$

Magnetic Hysteresis Loop Tracer

NOTES

$$Hc = \frac{Go \times (0.5 \times \text{loop-width})}{(\frac{As}{Ac} - N)}$$

5. Calculation of saturation magnetization:

Plot the positive intercept to negative intercept distance against magnetic field.

Find the asymptote and use the equation below:

Saturation magnetization,

$$Ms = \frac{Go \times \mu r \times Gx \times (0.5 \times \text{tip to tip length})}{4\pi \times Gy \times (\frac{As}{Ac} - N)} \text{gauss}$$

6. Calculation of retentivity:

Plot the tip-to-tip separation against the magnetic field.

Draw asymptote

Retentivity,

$$Mr = \frac{Go \times \mu r \times Gx \times (0.5 \times intercept\ distance)}{4\pi \times Gy \times (\frac{As}{Ac} - N)} \text{gauss}$$

7. Select the M., M.. radio buttons to observe dJ/dtand d2J/dt2.

Table 1: For calculation of coercivity, saturation magnetization and retentivity for the given sample from the loop width, the tip-to-tip height and the positive intercept to negative intercept distance of hysteresis loop respectively

S.No.	Magnetic Field (Gauss)	Loop Width (mm)	Tip-To-Tip Height (V)	Positive Intercept to Negative Intercept Distance (V)

RESULT

1. The value obtained for the coercivity of the given sample is ________ **oersted.**
2. The value obtained for the saturation magnetisation of the given sample is ________**gauss.**
3. The value obtained for the retentivity of the given sample is ________ **gauss.**

MEASUREMENTS AND INVERSES SQUARE LAW VERIFICATION

AIM

Verify the inverse square law for the intensity of radiation from a source of light.

APPARATUS REQUIRED

Stefan Boltzmann lamp, 1 Moll-Type Thermopile, 1 Measurement Amplifier (230 V, 50/60 Hz), Measurement Amplifier (115 V, 50/60 Hz), 1 DC Power Supply 0 – 20 V, 0 – 5 A (230 V, 50/60 Hz), DC Power Supply 0 – 20 V, 0 – 5 A (115 V, 50/60 Hz), 1 Digital Multimeter P1035, 1 HF Patch Cord, BNC/4 mm Plug, 1 Ruler, 2 Barrel Foot (500 g) and 1 Set of 15 Safety Experiment Leads, 75 cm.

BASIC PRINCIPLE

The inverse square law describes a fundamental relationship which applies, among other things, to the intensity of light. The intensity of the light, i.e. the power detected within a unit area is inversely proportional to the square of the distance from the light source.

For this law to apply, the source needs to be radiating light uniformly in all directions and its dimensions must be negligible in comparison to its distance from the detector. In addition, there must be no absorption or reflection of light between the source and the point where the measurement is being made.

Since the source radiates uniformly on all directions, the emitted power P is distributed across the surface of a sphere at a distance r from the source.

(1) $$\mathbf{A = 4 \pi r^2}$$

The light intensity is therefore given by the following

(2) $$\mathbf{S = dP/dA = P/4 \pi r^2}$$

Equation (2) will be verified in this experiment using an incandescent bulb. When the distance from the lamp is much greater than the size of the filament, such a bulb can be regarded as a point source of light. In order to measure the relative intensity of the radiation, a Moll thermopile is used. Instead of the absolute intensity S, the thermopile voltage U_{th} is read off as a measure of the relative intensity.

Figure 1. Square of distance

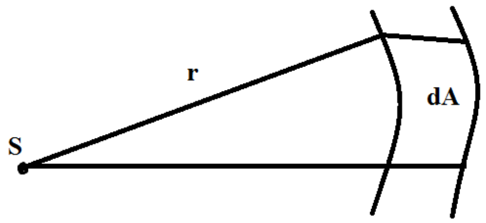
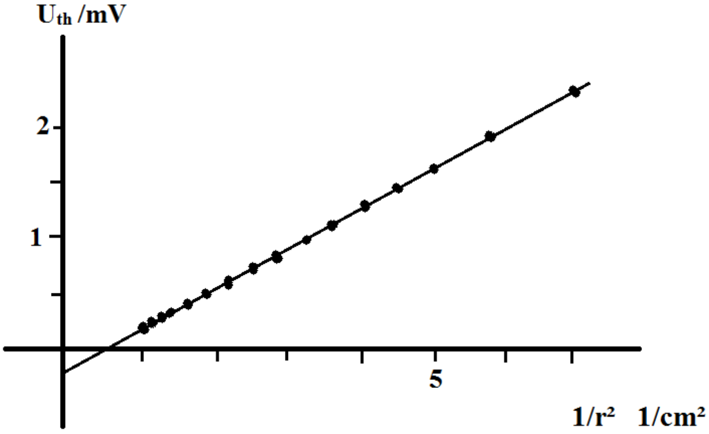


Figure 2. Measurements plotted in a graph of U_{th} against $1/r^2$



EXPERIMENTAL PROCEDURE

- Calibrate an offset to compensate for ambient light.
- Measure the relative light intensity as a function of the distance.
- Plot a graph of S against $1/r^2$.

RESULT

The inverse square law for the intensity of radiation from a source of light is verified.