ENGINEERING PHYSICS LAB PORTFOLIO

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LAB FACILITIES

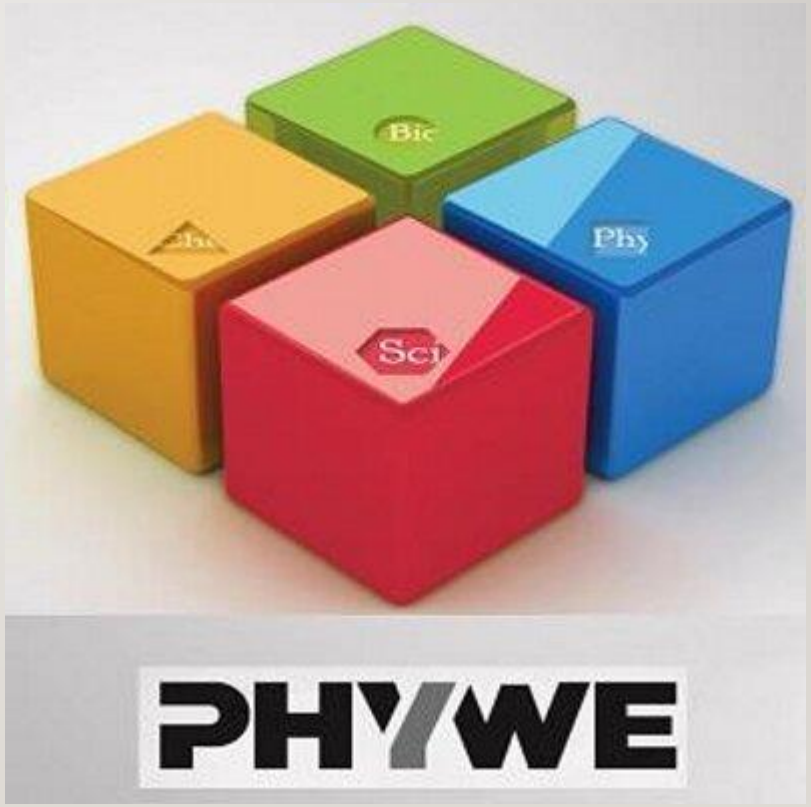
- All the classrooms and labs at SZABIST campuses are fully air-conditioned to provide comfortable learning and productive environment to the students.
- The lab is equipped with state-of-the-art PHYWE apparatus with COBRA3 interference to provide graphical results that will help students to understand the experiment better.
- For simulations and software based experiments, dedicated computer labs are used.
- Engineering physics lab is newly built at 153 campus and inaugurated by Madam Azra Pechuho (Chancellor) in Feb 2018 and is used for both mechatronics engineering and computer science students as per schedule.

A PICTORIAL VIEW OF PHYSICS LAB

A PICTORIAL VIEW OF WORKSTATIONS/EQUIPMENT

EXPERIMENTS AVAILABLE AT PHYSICS LAB FOR MECHATRONICS PROGRAMME

- Acoustic Doppler Effect
- Centrifugal Force
- Inductance of Solenoids
- Laws of Gyroscope
- Mechanical conservation of energy
- Momentum and angular momentum
- Moment of Inertia and Angular acceleration
- Projectile Motion
- Stefan-Boltzmann Radiation
- Velocity of Sound



ACOUSTIC DOPPLER EFFECT

- **Objective:** To measure and analyze the frequency changes for different relative velocities of source and observer.
- **Description:** If a source of sound is in motion relative to its medium of propagation, the frequency of the waves that are emitted is displaced due to the Doppler effect.
- **Related Topics:** Propagation of sound waves, Doppler shift of frequency.

Experimental set-up for the case of a moving observer and sound source at rest

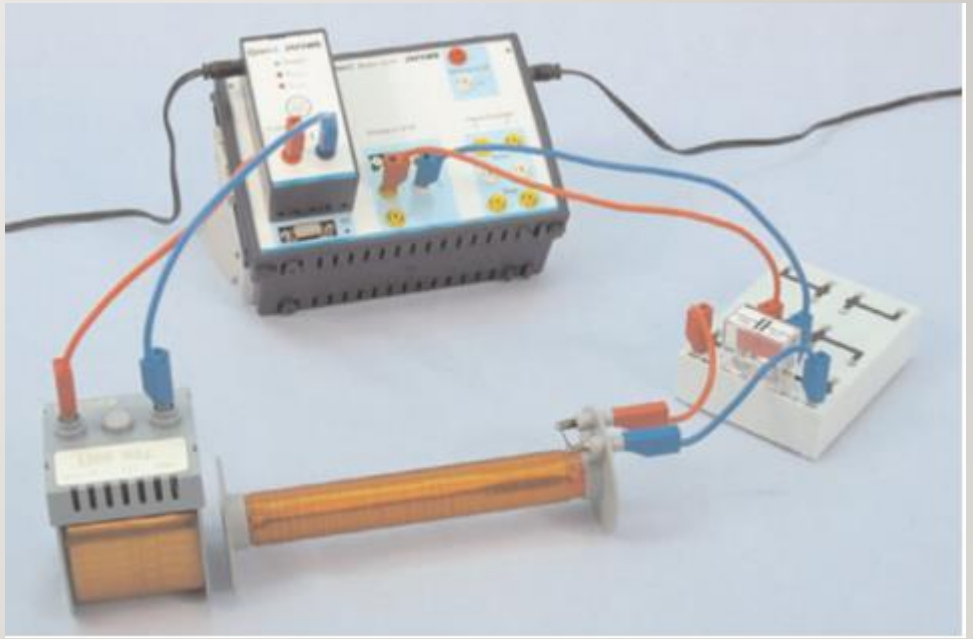
CENTRIFUGAL FORCE

- **Objective:** Determination of the centrifugal force as a function of: **i)** mass, **ii)** angular velocity, **iii)** the distance from the axis of rotation to the centre of gravity of the car.
- **Description:** A body with variable mass moves on a circular path with adjustable radius and variable angular velocity. The centrifugal force of the body will be measured as a function of these parameters.
- **Related Topics:** Centripetal force, rotary motion, angular velocity, apparent force.

Experimental set-up for the measurement of centrifugal force

INDUCTANCE OF SOLENOIDS

- **Objectives:** To connect coils of different dimensions (length, radius, number of turns) with a known capacitance C to form an oscillatory circuit. From the measurements of the natural frequencies, to calculate the inductances of the coils and determine the relationships between: **i)** Inductance and number of turns, **ii)** Inductance and length, **iii)** Inductance and radius.
- **Description:** A square wave voltage of low frequency is applied to oscillatory circuits comprising coils and capacitors to produce free, damped oscillations. The values of inductance are calculated from the natural frequencies measured, the capacitance being known.
- **Related Topics:** Law of inductance, Lenz's law, self-inductance, solenoids, transformer, oscillatory circuit, resonance, damped oscillation, logarithmic decrement, *Q*-factor.



Experimental set-up for the measurement of inductance

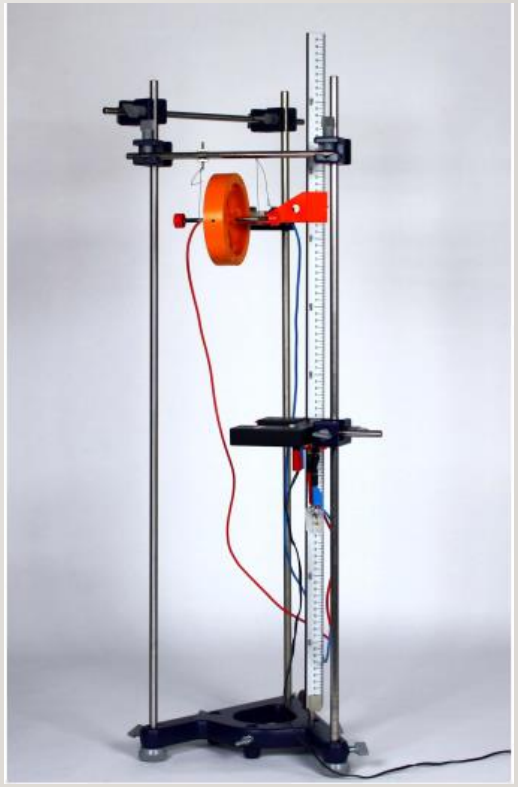
LAWS OF GYROSCOPE

- **Objectives:** 1. Determination of the momentum of inertia of the gyroscope by measurement of the angular acceleration. 2. Determination of the momentum of inertia by measurement of the gyro-frequency and precession frequency. 3. Investigation of the relationship between nutation frequency and gyro-frequency.
- **Description:** The momentum of inertia of the gyroscope is investigated by measuring the angular acceleration caused by torques of different known values. In this experiment, two of the axes of the gyroscope are fixed. The relationship between the precession frequency and the gyro-frequency of the gyroscope with 3 free axes is examined for torques of different values applied to the axis of rotation. If the axis of rotation of the force-free gyroscope is slightly displaced, a nutation is induced. The nutation frequency will be investigated as a function of gyro-frequency.
- **Related Topics:** Momentum of inertia, torque, angular momentum, precession, nutation.

Experimental set-up for the 3-axis gyroscope

MECHANICAL CONSERVATION OF ENERGY

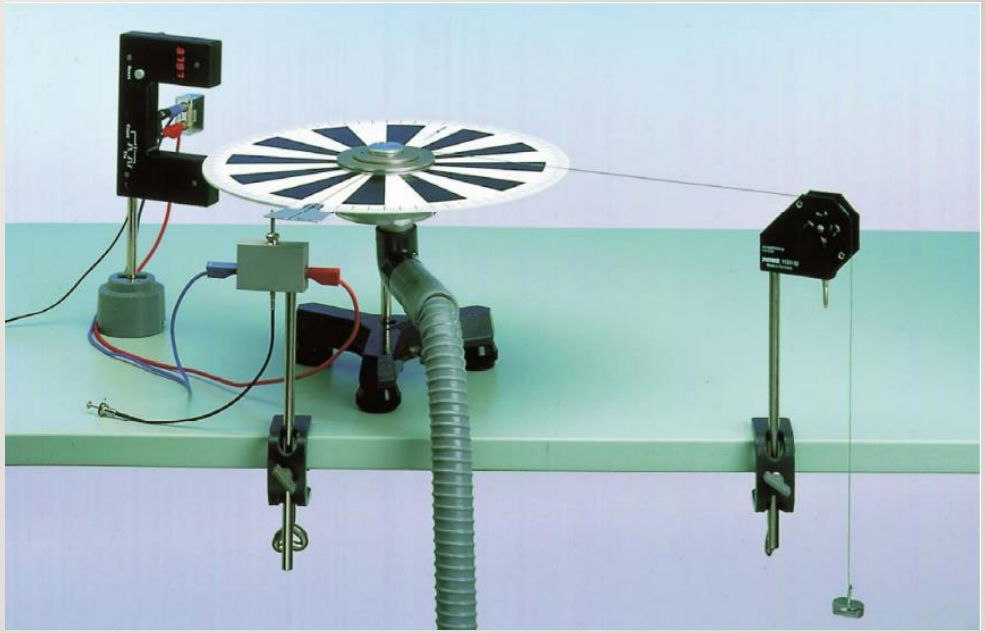
- **Objective:** To determine the moment of inertia of the Maxwell disk. Using the Maxwell disk, following are determined as a function of time: **i)** the potential energy, **ii)** the energy of translation, **iii)** the energy of rotation.
- **Description:** A disk, which can unroll with its axis on two cords, moves in the gravitational field. Potential energy, energy of translation, and energy of rotation are converted into one another and are determined as a function of time.
- **Related Topics:** Maxwell disk, energy of translation, energy of rotation, potential energy, moment of inertia, angular velocity, angular acceleration, instantaneous velocity, gyroscope.



Experimental set-up for investigating the conservation of energy, using the Maxwell disk.

MOMENTUM AND ANGULAR MOMENTUM

- **Objective:** To determine the following with uniformly accelerated rotary motion: **i)** the angle of rotation as a function of time, **ii)** the angular velocity as a function of time, **iii)** the angular acceleration as a function of the force, **iv)** the angular acceleration as a function of the lever arm.
- **Description:** The angle of rotation and angular velocity are measured as a function of time on a body which is pivoted so as to rotate without friction and which is acted on by a moment. The angular acceleration is determined as a function of the moment.
- **Related Topics:** Circular motion, angular velocity, angular acceleration, moment of inertia, Newton's Laws, rotation.

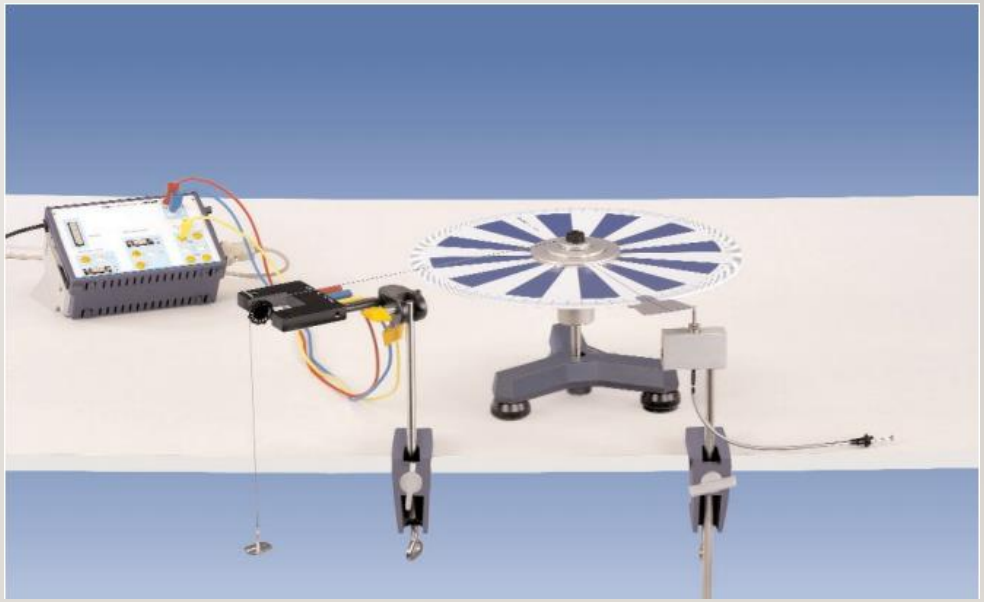


Experimental set-up for determining momentum

MOMENT OF INERTIA & ANGULAR ACCELERATION

- **Objectives:**
  1. Measure angular velocity and angle of rotation vs. time for a disc with constant torque applied to it for different values of torque generated with various forces on three different radii.
  2. Calculate the rotational energy and the angular momentum of the disc over the time.
  3. Calculate the energy loss of the weight from the height loss over the time and compare these two energies.
- **Description:** A known torque is applied to a body that can rotate about a fixed axis with minimal friction. Angle and angular velocity are measured over the time and the moment of inertia is determined. The torque is exerted by a string on a wheel of known radius. The known energy gain of the lowering mass is converted to rotational energy of the body under observation.

Related Topics: Rotation, angular velocity, torque, angular acceleration, angular moment, moment of inertia, rotational energy.



Experimental set-up for determining moment of inertia

PROJECTILE MOTION

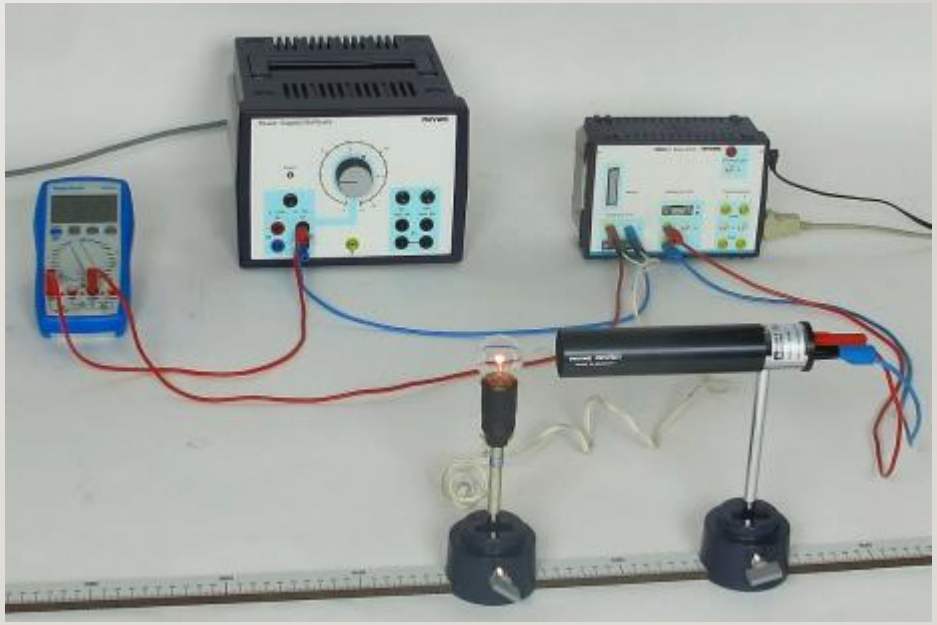
- **Objective:**
  1. To determine the range as a function of the angle of inclination.
  2. To determine the maximum height of projection as a function of the angle of inclination.
  3. To determine the (maximum) range as a function of the initial velocity.
- **Description:** A steel ball is fired by a spring at different velocities and at different angles to the horizontal. The relationships between the range, the height of projection, the angle of inclination, and the firing velocity are determined.
- **Related Topics:** Trajectory parabola, motion involving uniform acceleration, ballistics.

Experimental set-up for measuring the maximum range of a projectile with additional equipment to measure the initial velocity.

STEFAN-BOLTZMANN RADIATION

- **Objective:**
  1. To measure the resistance of the filament of the incandescent lamp at room temperature and calculate the filament's resistance at 0°C.
  2. To measure the energy flux density of the incandescent lamp at different values of lamp current.
- **Description:** The energy emitted by a black body per unit area and unit time is proportional to the fourth power of the body's absolute temperature (Stefan-Boltzmann law). In this experiment the filament of an incandescent lamp is taken as a model for a grey body and its emission is investigated as a function of its temperature.

Related Topics: Black body radiation, thermoelectric e.m.f. (electro motive force), temperature dependence of resistances.



Experimental set-up for measuring the intensity of radiation.

VELOCITY OF SOUND

- **Objective:**
  1. To determine transmission times for different distances apart of the transmitter and the receiver.
  2. Plot a graph of the path lengths of the sound pulses against their transmission time.
  3. To determine the velocity of sound from the graph.
- **Description:** An ultrasonic transmitter emits sound pulses onto a reflector, from which recording of them by a receiver shows a time delay. The velocity of sound is calculated from the path length and transmission time of the sound pulses.
- **Related Topics:** Longitudinal waves, sound pressure, phase- and group velocity, sonar principle.

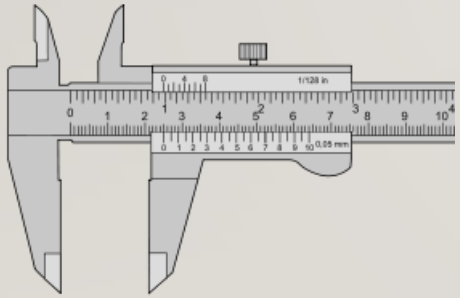
Experimental set-up for determining velocity of sound

EXPERIMENTS AVAILABLE AT PHYSICS LAB FOR COMPUTING PROGRAMME

- Vernier Caliper/Screw Gauge
- Hooke's Law
- Simple Pendulum
- Inclined Planes
- Properties of Liquids
- Introduction to basic electronics devices and components
- Series/Parallel circuit combinations
- Circuit Simulation Software (Multisim/Proteus)

VERNIER CALIPER/SCREW GAUGE

- **Objective:** To determine the volume of a solid cylinder and capacity of test tube using a Vernier caliper.
- To determine volume of a small sphere and the area of cross section of a wire using micro meter screw gauge.



- **Description** In this experiment, students learn to use the **Vernier Caliper** to measure the internal diameter, external diameter and the depth of an object and **Screw Gauge** for measuring diameter of small sphere and cross-section area of wire or other objects. They are also taught to find out the zero error of the given instrument (if any).

HOOKE'S LAW

- **Objective:** To verify the validity of Hook's law and find out spring stiffness constant (K).
- **Description:** A weight of known value is hanged with a spring of constant (K). Then change is length is noted from the original value and then put in the Hooke's Law equation (F=-Kx) by which the spring constant (K) is calculated.
- **Related Topics:** Hooke's law, spring constant, limit of elasticity, elastic hysteresis, elastic after-effect

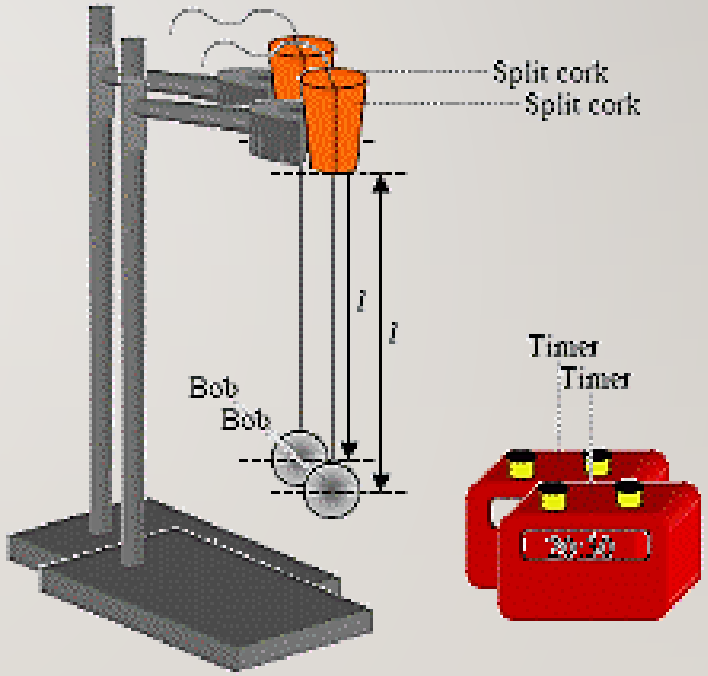
Experimental set-up for Hooke's law

SIMPLE PENDULUM

- **Objective:** To determine time period of a simple pendulum.
- **Description:** A simple pendulum is attached to a string of length (L) and then oscillated from a point, then total time taken for certain oscillations is noted. The time period is calculated using **total time/no. of oscillation** and then verified using:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

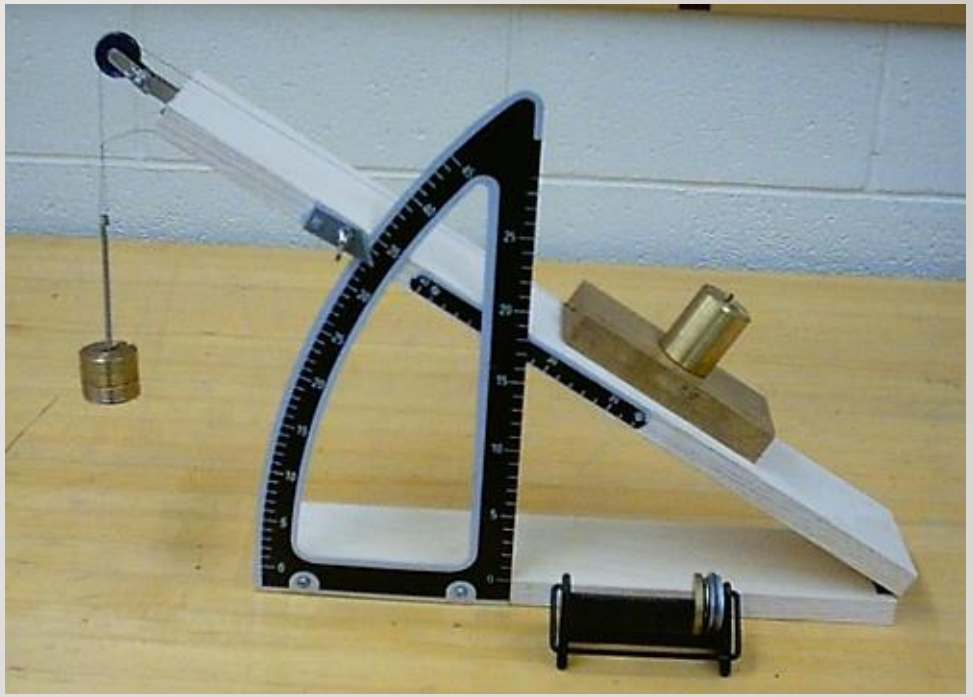
- **Related Topics:** Duration of oscillation, period, amplitude, harmonic oscillation, gravity.



Experimental set-up for Simple Pendulum

INCLINED PLANES

- **Objective:** To determine relationship between angle and velocity and efficiency of inclined planes.
- **Description:** A block of certain mass is put on the top of the inclined plane and then left for sliding on the inclined plane with different angles. The total length of the inclined plane and time to reach from top to bottom is calculated to find out the velocity of the sliding object. In 2nd part, the load is placed on the inclined plane and effort is put on the hanger on the roller. At different angles, the effort is observed for lifting the same load.
- **Related Topics:** Mechanical advantages, type of levers, simple machines, load and effort.



Experimental set-up for inclined plane

PROPERTIES OF LIQUIDS

- **Objective:** To determine the viscosity and density of liquids.
- **Description:** This experiment is specially designed to eradicate the confusion between viscosity and density in the mind of students. Viscosity is the drag force of a liquid and found out using free-fall sphere method while density is ratio between mass and volume of a fluid found using graduated beaker in milliliters for determining volume and digital weighing scale for determine mass.
- **Related Topics:** Archimedes' principle, density, viscosity, fluid friction, buoyancy, drag force.

Experimental set-up finding out density

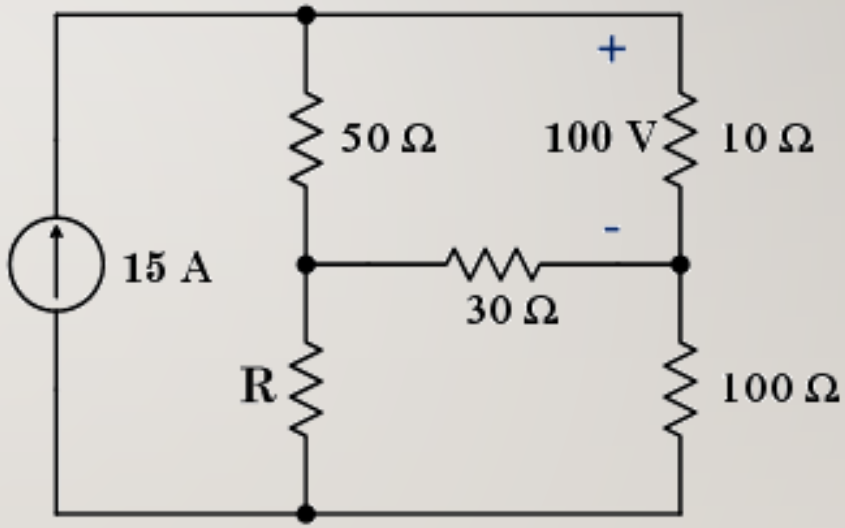
INTRODUCTION TO BASIC ELECTRONICS DEVICES AND COMPONENTS

- **Objective:** To make students familiar with basic electronics devices and components.
- **Description:** In this experiment, computer science students are familiarized with DC Power supply, digital multi-meters, oscilloscope and function generators. This lab is further divided in to following parts:
  - Reading color code from resistors.
  - Understanding Ohm's Law.
  - Making circuit on breadboard.
- **Related Topics:** Ohm's law, circuit design, digital logic, AC/DC power, series/parallel circuits, etc.

Basic electronics components at lab

SERIES/PARALLEL CIRCUIT COMBINATIONS

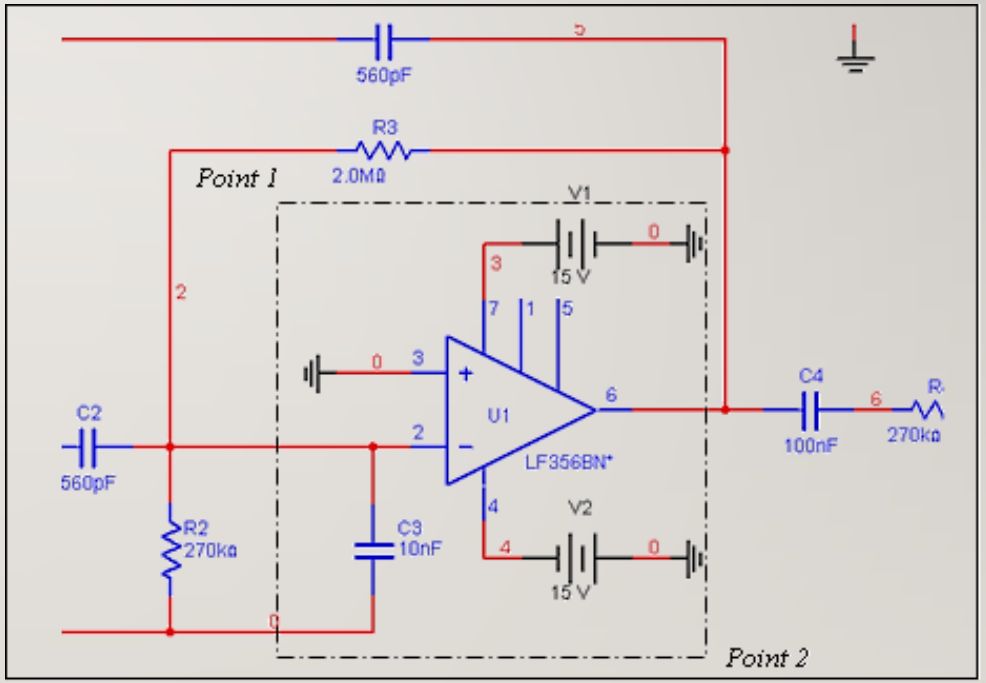
- **Objective:** To make students learn and solve series, parallel circuits and combination of them.
- **Description:** In this experiment, the current and voltage across resistors in series/parallel and complex circuit is determined using formula and multi-meters. For this purpose, students should learn following first in their theory class:
  - Solving equivalent resistance in series/parallel.
  - Ohms Law
  - KCL and KVL
- **Related Topics:** Ohm's law, KCL, KVL, transformers, amplifiers, transistors.



Example circuit for this experiment

CIRCUIT SIMULATION SOFTWARE

- **Objective:** To make students familiar with circuit designing and simulation software (multisim).
- **Description:** In this experiment, students are familiarized with circuit simulation software like **Multisim** or **Proteus,** so they can simulate their projects before buying actual components that would save their time and cost by selecting right component. Also it saves them from any injuries due to wrong component selection. This experiment will also help them in future courses like digital logic design in 3rd semester.
- **Related Topics:** Circuit design and simulation, PCB designing, microcontrollers, automation.



Example circuit on multisim

THANK YOU ☺

- FOR ANY QUERIES REGARDING PHYSICS LAB, KINDLY EMAIL ME AT:

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