SEMESTER PROJECT REPORT

APPLIED PHYSICS

**PROJECT TITLE:**

The Science Behind Traffic Lights – An Applied Physics Approach.

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1. **INTRODUCTION:**

Traffic lights are essential devices used worldwide to regulate road traffic, ensure safety, and maintain discipline at intersections. This project explores the underlying principles of how traffic lights operate, focusing on their construction, electronic control, and how physics particularly electricity, electronics, and optics makes them functional.

1. **PROJECT OBJECTIVES:**

* To understand the design and function of traffic lights.
* To explore the physical principles (electricity, electronics, light) used in traffic signaling.
* To investigate modern advancements in traffic light systems (e.g., sensors and automation).
* To highlight the importance of physics in solving real-world problems.

1. **BACKGROUND AND HISTORY:**

The first traffic signal was installed in London in 1868, operated manually using gas lamps. The evolution of electric traffic lights began in the early 20th century, and today they are automated, often smart, and powered by LEDs. These lights are now critical for managing growing urban traffic.

1. **COMPONENTS AND PHYSICAL PRINCIPLES:**

Traffic light systems typically include the following components:

* LEDs (Light Emitting Diodes): Convert electric energy into light. Color depends on the energy band gap.
* Resistors: Regulate current to protect LEDs.
* Timers / Microcontrollers: Control the timing sequence.
* Power Supply: Provides required voltage.
* Sensors (in advanced systems): Detect vehicle presence.

Physics Concepts Involved:

* Ohm’s Law (V=IR): Used to determine resistor values.
* Semiconductor Physics: LEDs work on electron-hole recombination.
* Optics: LED light emission and visibility depend on optical clarity.
* Electromagnetism: Inductive loop vehicle sensors use magnetic field changes.

1. **WORKING MECHANISM:**

Traffic lights operate in a timed loop:

* Red: Stop – usually the longest duration.
* Yellow: Warning – prepare to stop.
* Green: Go – allows movement.

A basic circuit uses a 555 timer or microcontroller to manage switching. Advanced systems adjust timing based on sensor input to manage traffic density.

int red = 9;

int yellow = 8;

int green = 7;

void setup(){

pinMode(red, OUTPUT);

pinMode(yellow, OUTPUT);

pinMode(green, OUTPUT);

}

void loop(){

digitalWrite(red, HIGH);

delay(15000);

digitalWrite(red, LOW);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(green, HIGH);

delay(20000);

digitalWrite(green, LOW);

//

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

digitalWrite(yellow, HIGH);

delay(1000);

digitalWrite(yellow, LOW);

delay(500);

}

1. **REAL-LIFE APPLICATIONS:**

* Regulating traffic at busy intersections
* Managing pedestrian crossings
* Improving traffic flow in urban areas
* Reducing accident risks
* Emergency vehicle priority systems (smart traffic control)

1. **ROLE OF APPLIED PHYSICS:**

Applied Physics plays a key role in traffic light systems:

* Electricity: Powers the entire circuit
* Electronics: Controls the sequence and timing
* Optics: Ensures lights are visible in all weather
* Sensors & Automation: Improve system efficiency and adaptability

1. **SMART TRAFFIC SYSTEMS (Modern Advancement):**

Modern traffic lights use technologies such as:

* Infrared or Ultrasonic sensors
* AI-powered signal control
* IoT-based monitoring
* Solar-powered systems

These systems reduce human error, improve fuel efficiency, and manage traffic dynamically.

1. **ADVANTAGES AND DRAWBACKS:**

**ADVANTAGES:**

* Prevents accidents and confusion
* Enhances traffic flow and reduces congestion
* Energy-efficient (especially with LED and solar usage)
* Can be automated and sensor-based

**DRAWBACKS:**

* Power outages can disable them
* Malfunctioning can lead to accidents
* Fixed timers may not match real-time traffic needs (without sensors)

**10. CONCLUSION:**

Traffic lights are more than just red, yellow, and green signals. They are a brilliant application of physics, electronics, and engineering. This project has provided insight into how basic physics principles are used in real-world systems that affect millions of lives daily. Understanding their design and function reveals the importance of interdisciplinary knowledge in solving urban challenges.

