EEE 416 – Microprocessor and Embedded System Laboratory
Jan 2025 Level-4 Term-1 Section B
**Final Project Demonstration**

# ENHANCED SMART HELMET FOR RIDER SAFETY AND ACCIDENT ALERTS

SUBMITTED BY – GROUP 1
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## Outline

1. Summary
2. Introduction
3. Design
4. Implementation
5. Analysis and Evaluation
6. References

# 1. Summary

- ✔ **Arduino-Based System** – Central controller for all safety functions
- **Wear Detection** – Prevents vehicle ignition if helmet is not worn
- **Alcohol Detection** – MQ-3 sensor detects alcohol in rider's breath
- **Crash Detection** – Accelerometer senses sudden impact or fall
- **RF Communication** – Sends signals from helmet to vehicle unit
- **Alert Mechanism** – Uses LEDs and buzzers to notify warnings; sends SMS to family members.
- **Safety Actions** – Triggers alerts or disables ignition in unsafe cases
- **Cost-Effective** – Affordable and accessible for riders and developers
- **Beginner-Friendly** – Easy to build with basic electronics knowledge



# 2. Introduction

# 3.1 Design: Problem Formulation (PO(b))
## 3.1.1 Identification of Scope

Motorbike accidents remain a critical public safety concern in Bangladesh. One of the major causes is the **high number of accidents** due to poor road behavior and lack of protective measures. There's also **limited enforcement of helmet use**, leaving many riders unprotected. In the event of a crash, there's typically **no automatic alert system** to notify emergency responders, leading to **delays in medical assistance**. These issues highlight the urgent need for an intelligent helmet system that can actively detect risks, ensure safety compliance, and initiate rapid emergency response.



# 3.1 Design: Problem Formulation (PO(b))
## 3.1.3 Literature Review

**Alcohol Detection in Helmets**
Prevents riding under the influence by assessing breath alcohol levels.

- **MQ-3 Alcohol Sensor:**
  Bharath et al. (2019) demonstrated the MQ-3 sensor's effectiveness in real-time alcohol detection, widely used in low-cost embedded systems.

- **Breath Analysis Systems:**
  Patel et al. (2020) reviewed devices requiring the rider to blow into a sensor. These often use **IR spectroscopy** or **chemical sensors** for high-accuracy measurement.

# 3.1 Design: Problem Formulation (PO(b))
## 3.1.3 Literature Review

🚨 **Crash Detection in Helmets**
Triggers alerts in the event of sudden impacts or accidents.

- **Accelerometer-Based Detection:**
  Khan et al. (2017) applied MEMS accelerometers to detect high-impact collisions and alert emergency contacts immediately.
- **Smart Sensor Fusion:**
  Zhao et al. (2018) proposed a system with accelerometers, gyroscopes, and pressure sensors to evaluate crash severity and provide nuanced feedback.



# 3.1 Design: Problem Formulation (PO(b))
## 3.1.4 Literature Review

⚙ **Integrated Smart Helmet Systems**
Combining all three detection features into one robust system.

- **Ghosh et al. (2020):** Designed a multi-sensor smart helmet that detects wear, alcohol presence, and crashes—also capable of disabling vehicle ignition.
- **Srinivasan et al. (2019):** Developed an **IoT-enabled helmet** transmitting data to a mobile application for real-time monitoring and alerts.

# 3.1 Design: Problem Formulation (PO(b))
## 3.1.5 Literature Review

⚠ **Identified Gaps in Literature**
Despite innovations, current solutions face limitations:

1. **High Cost:** Advanced sensors increase manufacturing expenses.
2. **Limited Real-Time Feedback:** Affordable solutions often lack seamless real-time alerts.
3. **Accuracy in Dynamic Environments:** Sensor performance may drop in real-world conditions like weather changes or non-standard riding behavior.



# 3.1 Design: Problem Formulation (PO(b))
## 3.1.5 Analysis

The Smart Helmet System is analyzed based on functionality, integration challenges, and sensor selection. The focus is on ensuring accurate **wear detection**, **alcohol monitoring**, and **crash detection** using reliable, low-cost sensors. Key challenges include real-time communication, environmental adaptability, and system reliability. The goal is to deliver a **cost-effective**, **robust**, and **responsive safety solution** for real-world conditions.

# 3.2 Design Methods (PO(a))

🔍 **Requirement Analysis**

Define key safety and functionality needs:

- Detect helmet wear, alcohol presence, and crash events
- Enable real-time RF communication with vehicle
- Ensure low power consumption, comfort, and affordability

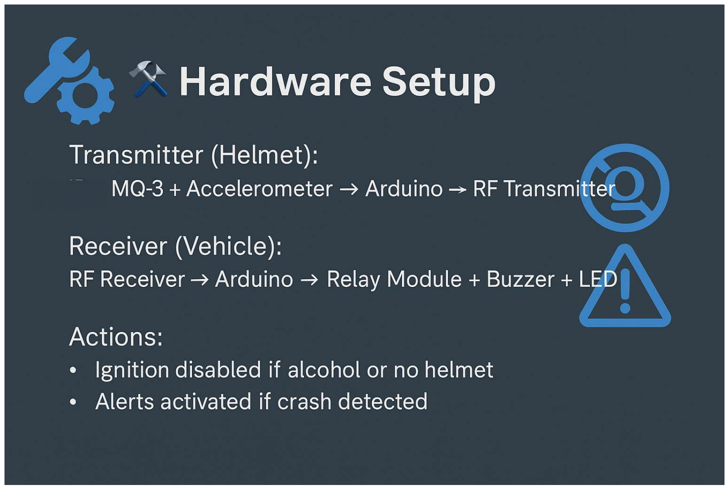


# 3.2 Design Methods (PO(a))

**Component Selection**

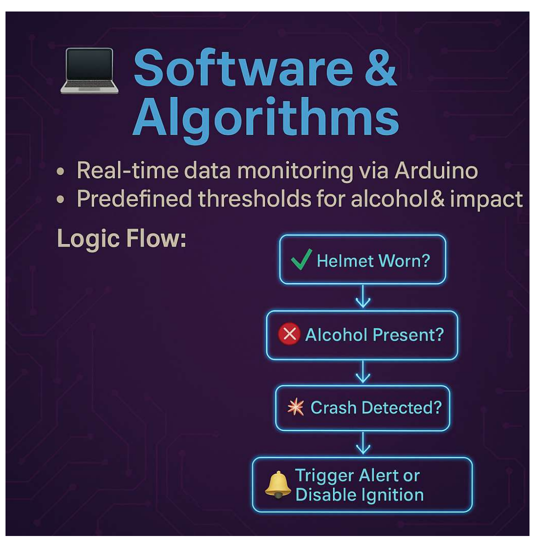
| Feature | Component | Functionality |
|---|---|---|
| Wear Detection | Transmitter Circuit | Detect helmet is worn mor not |
| Alcohol Detection | MQ-3 Gas Sensor | Monitor breath alcohol level |
| Crash Detection | Accelerometer (MPU6050) | Detect sudden impact or motion change |
| Communication | RF Module (433 MHz) | Wireless data transmission |
| Processing Unit | Arduino UNO or Similar | Sensor integration & control logic |
| SMS Alert | GSM900A | Sends SMS via SIM |
| Location Detection | U-Box Neo-6M | Detects the location |
| Power Supply | Li-ion/LiPo Battery | Rechargeable and compact energy source |
| Status | I2C LCD Display 16x2 | For showing status |
| Others | LED , Buzzer , Switch | Alert , ON/OFF |

# 3.2 Design Methods (PO(a))






# 3.2 Design Methods (PO(a))



# 3.2 Crash Detection

1. Read Accelerometer Data (mpu6050)

2. Calculate Acceleration Magnitude A=(ax2+ay2+az2).

3. Compute Change in Acceleration (Delta) ΔA=|A−1.0|

5.Check if ΔA>IMPACT_THRESHOLD.

6. Yes: ash Trigger CrDetection
- Set crashState = true
- Send crash signal via RF
- Print GPS coordinates
-Turn on crash detection LED
- Send crash Location vai SMS
- Reset Crash state after 10s

**6.No:**
•Continue normal monitoring.



# 3.2 Design Methods (PO(a))

### 🔗 Integration & Testing

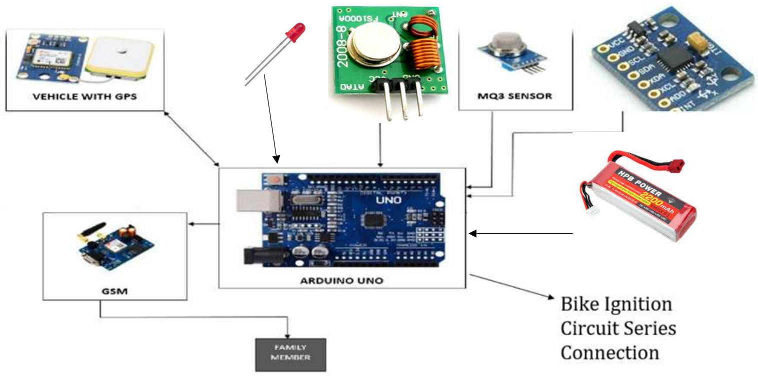
•Assemble transmitter + receiver units
•Test:
- Sensor accuracy
- RF reliability
- Power endurance
- Real-time responsiveness

### 🔧 Optimization

- Power-saving modes to enhance battery life
- Sensor calibration for real-world adaptability
- Compact design for comfort

# 3.3 Design: Circuit Diagram

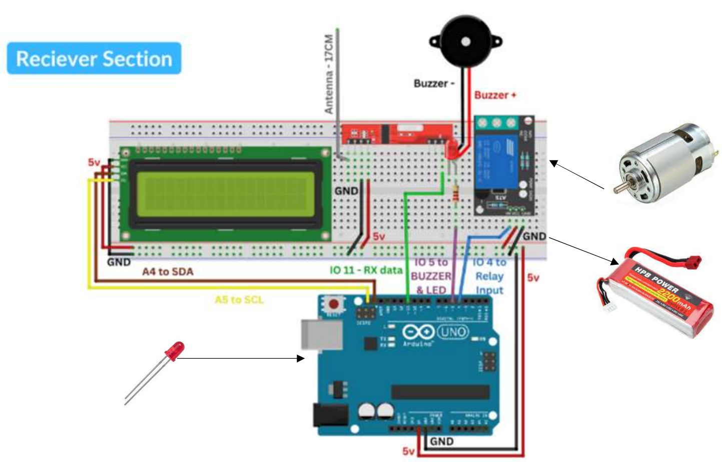
**Transmitter Circuit**





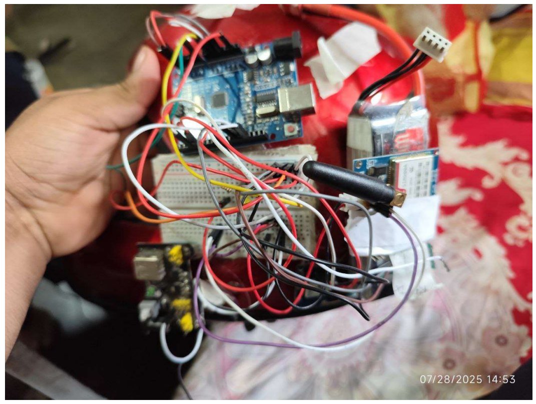

# 3.3 Design: Circuit Diagram

**Receiver Circuit**



# 3.5 Hardware Design

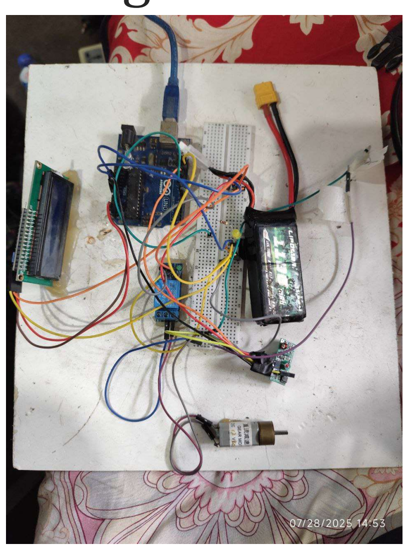
**Transmitter Circuit**





# 3.5 Hardware Design

**Receiver Circuit**



# 4 Implementation: Demonstration



# 5. Design Analysis and Evaluation

- 5.1 Novelty
- 5.2 Design Considerations (PO(c))
- 5.3 Investigations (PO(d))
- 5.4 Limitations of Tools (PO(e))
- 5.5 Impact Assessment (PO(f))
- 5.6 Sustainability and Environmental Impact Evaluation (PO(g))
- 5.7 Ethical Issues (PO(h))

# 5.1 Novelty

| Feature | Description |
|---|---|
| Multi-feature Integration | Combines wear detection, alcohol detection, and crash detection in one helmet. |
| Affordability & Comfort | Designed to be cost-effective and comfortable for daily use. |
| Proactive Monitoring | Monitors rider status using sensors and RF communication in real-time. |
| Immediate Safety Response | Triggers alerts and disables vehicle ignition during unsafe conditions. |
| Wireless Communication | Sends helmet status to the vehicle system via RF modules. |
| Scalable & User-Friendly | Easy to implement and encourages responsible riding habits. |



# 5.2 Design Considerations (PO(c))

| Subsection | Key Points |
|---|---|
| 5.2.1 Public Health and Safety | • Ensures helmet is worn properly to reduce head injuries<br>• Disables vehicle if alcohol is detected, preventing impaired riding<br>• Sends crash alerts for faster emergency response<br>• Promotes safety compliance, reducing injury-related fatalities in high-risk areas |
| 5.2.2 Environmental Considerations | • Uses low-power and energy<br>• efficient components<br>• Rechargeable battery reduces disposable waste<br>• Made from recyclable, modular materials for long-term use<br>• Eco-friendly packaging (biodegradable and recycled)<br>• Local sourcing reduces carbon footprint |
| 5.2.3 Cultural & Societal Considerations | • Encourages helmet use in cultures with low compliance<br>• Affordable design suitable for low-income riders<br>• Addresses alcohol-related societal issues<br>• Easy to use with LED/buzzer indicators<br>• Enhances safety and fosters responsible riding behavior |

# 5.4 Limitations of Tools (PO(e))

| Component / Feature | Limitation |
|---|---|
| MQ-3 Alcohol Sensor | Susceptible to temperature and humidity, may cause false positives/negatives. |
| GSM900A | Network issue. Can't send message immediately. |
| Accelerometer (Crash Detection) | May not detect rotational or low-intensity crashes effectively; needs careful sensitivity calibration. |
| U-box Neo M6 | Network Issue, Can't detect location in closed space |
| RF Communication Module | Limited range and prone to interference in high electromagnetic environments. |
| Battery Life | Continuous wireless communication can drain power quickly during long rides. |
| System Integration | Multiple sensor inputs may overwhelm processing unit, causing delays or inconsistent performance. |



# 5.5 Impact Assessment (PO(f))

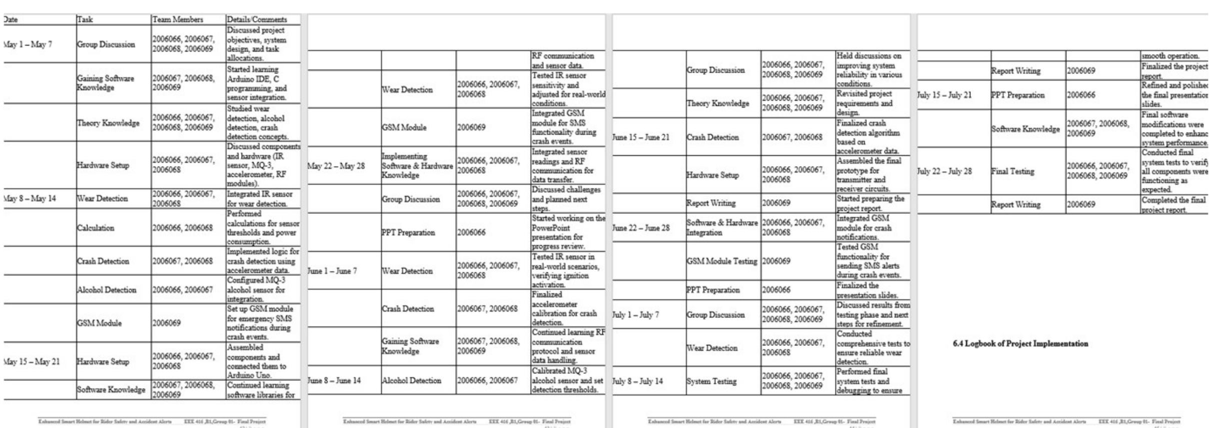
| Section | Key Assessment Points |
|---|---|
| 5.5.1 Societal and Cultural Issues | • Promotes helmet compliance through wear detection.<br>• Encourages cultural shift toward safety-conscious behavior.<br>• Affordable design aims for economic inclusivity.<br>• Tackles impaired driving through alcohol detection. |
| 5.5.2 Health and Safety Issues | • Reduces head injury risk via wear enforcement.<br>• Prevents alcohol-impaired riding by disabling ignition.<br>• Crash alerts enable quicker emergency response, improving survival rates.<br>• Overall enhancement in rider safety. |
| 5.5.3 Legal Issues | • Supports compliance with helmet laws, reducing legal penalties.<br>• Raises privacy and legal concerns regarding alcohol detection and ignition control.<br>• RF communication may trigger data security and consent-related concerns. |

# 6.1 Individual Contribution of Each Member

| Task | Team Members |
|---|---|
| Group Discussion | 2006066, 2006067, 2006068, 2006069 |
| Gaining Software Knowledge | 2006066, 2006067, 2006068 |
| Theory Knowledge | 2006066, 2006067, 2006068, 2006069 |
| Calculation | 2006068, 2006069 |
| Hardware Setup | 2006066, 2006067, 2006068 |
| Wear Detection | 2006066, 2006067, 2006068 |
| Crash Detection | 2006066, 2006068 |
| Alcohol Detection | 2006066, 2006067, 2006069 |
| GSM Module & GPS Module | 2006066, 2006067, 2006068 |
| Implementing Software & Hardware Knowledge | 2006066, 2006067, 2006068 |
| PPT Preparation | 2006066, 2006067, 2006068, 2006069 |
| Report Writing | 2006066, 2006067, 2006068, 2006069 |



# 6.3 Logbook of Project



| Date | Task | Team Members | Details/Comments |
|---|---|---|---|
| May 1 – May 7 | Group Discussion | 2006066, 2006067, 2006068, 2006069 | Discussed project objectives, system design, and task allocations. |
| | Gaining Software Knowledge | 2006067, 2006068, 2006069 | Started learning Arduino IDE, C programming, and sensor integration. |
| | Theory Knowledge | 2006066, 2006067, 2006068, 2006069 | Studied wear detection, alcohol detection, crash detection concepts. |
| | Hardware Setup | 2006066, 2006067, 2006068 | Discussed components and hardware (IR sensor, MQ-3, accelerometer, RF modules). |
| May 8 – May 14 | Wear Detection | 2006066, 2006067, 2006068 | Integrated IR sensor for wear detection. |
| | Calculation | 2006066, 2006068 | Performed calculations for sensor thresholds and power consumption. |
| | Crash Detection | 2006067, 2006068 | Implemented logic for crash detection using accelerometer data. |
| | Alcohol Detection | 2006066, 2006067 | Configured MQ-3 alcohol sensor for integration. |
| | GSM Module | 2006069 | Set up GSM module for emergency SMS notifications during crash events. |
| May 15 – May 21 | Hardware Setup | 2006066, 2006067, 2006068 | Assembled components and connected them to Arduino Uno. |
| | Software Knowledge | 2006067, 2006068, 2006069 | Continued learning software libraries for |

Enhanced Smart Helmet for Rider Safety and Accident Alerts EEE 416 ,B1,Group 01- Final Project 42 | Page

| | | | |
|---|---|---|---|
| | | | RF communication and sensor data. |
| | Wear Detection | 2006066, 2006067, 2006068 | Tested IR sensor sensitivity and adjusted for real-world conditions. |
| | GSM Module | 2006069 | Integrated GSM module for SMS functionality during crash events. |
| May 22 – May 28 | Implementing Software & Hardware Knowledge | 2006066, 2006067, 2006068 | Integrated sensor readings and RF communication for data transfer. |
| | Group Discussion | 2006066, 2006067, 2006068, 2006069 | Discussed challenges and planned next steps. |
| | PPT Preparation | 2006066 | Started working on the PowerPoint presentation for progress review. |
| June 1 – June 7 | Wear Detection | 2006066, 2006067, 2006068 | Tested IR sensor in real-world scenarios, verifying ignition activation. |
| | Crash Detection | 2006067, 2006068 | Finalized accelerometer calibration for crash detection. |
| | Gaining Software Knowledge | 2006067, 2006068, 2006069 | Continued learning RF communication protocol and sensor data handling. |
| June 8 – June 14 | Alcohol Detection | 2006066, 2006067 | Calibrated MQ-3 alcohol sensor and set detection thresholds. |

Enhanced Smart Helmet for Rider Safety and Accident Alerts EEE 416 ,B1,Group 01- Final Project 43 | Page

| | | | |
|---|---|---|---|
| | Group Discussion | 2006066, 2006067, 2006068, 2006069 | Held discussions on improving system reliability in various conditions. |
| | Theory Knowledge | 2006066, 2006067, 2006068, 2006069 | Revisited project requirements and design. |
| June 15 – June 21 | Crash Detection | 2006067, 2006068 | Finalized crash detection algorithm based on accelerometer data. |
| | Hardware Setup | 2006066, 2006067, 2006068 | Assembled the final prototype for transmitter and receiver circuits. |
| | Report Writing | 2006069 | Started preparing the project report. |
| June 22 – June 28 | Software & Hardware Integration | 2006066, 2006067, 2006068 | Integrated GSM module for crash notifications. |
| | GSM Module Testing | 2006069 | Tested GSM functionality for sending SMS alerts during crash events. |
| | PPT Preparation | 2006066 | Finalized the presentation slides. |
| July 1 – July 7 | Group Discussion | 2006066, 2006067, 2006068, 2006069 | Discussed results from testing phase and next steps for refinement. |
| | Wear Detection | 2006066, 2006067, 2006068 | Conducted comprehensive tests to ensure reliable wear detection. |
| July 8 – July 14 | System Testing | 2006066, 2006067, 2006068, 2006069 | Performed final system tests and debugging to ensure |

Enhanced Smart Helmet for Rider Safety and Accident Alerts EEE 416 ,B1,Group 01- Final Project 44 | Page

| | | | |
|---|---|---|---|
| | | | smooth operation. |
| | Report Writing | 2006069 | Finalized the project report. |
| July 15 – July 21 | PPT Preparation | 2006066 | Refined and polished the final presentation slides. |
| | Software Knowledge | 2006067, 2006068, 2006069 | Final software modifications were completed to enhance system performance. |
| July 22 – July 28 | Final Testing | 2006066, 2006067, 2006068, 2006069 | Conducted final system tests to verify all components were functioning as expected. |
| | Report Writing | 2006069 | Completed the final project report. |

**6.4 Logbook of Project Implementation**

Enhanced Smart Helmet for Rider Safety and Accident Alerts EEE 416 ,B1,Group 01- Final Project 45 | Page

# 8. Project Management and Cost Analysis (PO(k))

| Component Name | Current Cost (TK) | Bulk Cost (TK) |
|---|---|---|
| MQ3 Sensor | 150 | 120 |
| MPU 6050 | 220 | 190 |
| RF Receiver & Transmitter (433 MHz) | 200 | 170 |
| Arduino UNO (2 pieces) | 1200 | 600 (Nano) |
| Relay Module | 95 | 80 |
| Buzzer | 12 | 10 |
| LED (2 pieces) | 10 | 8 |
| Battery (Lithium) | 300 | 250 |
| Helmet | 700 | 650 |
| GSM Module | 750 | 700 |
| GPS Module | 440 | 400 |
| I2C Display | 290 | 270 |
| DC Motor | 350 | |
| **Total** | **4717** | **3448** |



# 9. Future Work (PO(l))

## Future Directions

1. Enhanced Sensor Accuracy
   - Improved Alcohol Detection: Future iterations could integrege mαre-ardvanced alcohol sensors that less sensitive to environmental factors like temperature and humidity
   - Integration with Mobile Applications: Develop moblle-app could automatically sent
2. Integration with Mobile Appllcations
   - Improved crash detection: Ensuring legai ćompıınsŀ
   - Personarlized alerts Solar charging
3. Machine Learning Integration
   - Improved Crash detection: Personalizimat
4. Extended Battery Life
   - Power optimization: Ensure inding Solar charging
5. Regulatory Compliance and Standardization
   - Legal compliance: Industry collaboration
6. Global Accessibility and Affordability
   - Low-cost manufacturing: Language suppport
7. Integration with Vehicle Systems
   - Environmental sustainability: Eco-rely materials

# Mapping to Cos and POs

| COs | PO(1) | PO(2) | PO(3) | PO(4) | PO(5) | PO(6) | PO(7) | PO(8) | PO(9) | PO(10) | PO(11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | |
| CO2 | | | ok | | | | | | | | |
| CO3 | | | | | | | | | | | |
| CO4 | | | | | | ok | ok | | | | |
| CO5 | | | | | | | | | ok | | |
| CO6 | | | | | | | | | | ok | |
| Co7 | | | | | | | | | | | ok |



# Mapping to Cos and POs

| | |
|---|---|
| CO4 PO(7) | Describe sustainability and impact of the work in societal and environmental contexts |
| CO2 PO(3) | **Practical demonstration of the project**: show evidence that specific technical requirements have been attained by the project |
| CO4 PO(6) | Describe **any necessary modification proposed to address** public health and safety, cultural, societal, and environmental considerations related to the project |
| CO5 PO(9) | Describe multidisciplinary aspects of the project |
| CO7 PO(11) | Describe how **engineering management principles and economic decision-making applied to the project** |
| CO6 PO(10) | Use multimedia and necessary documentation (user manual, video demonstration and project report) to **clearly communicate the project** |

# Mapping of Knowledge Profile

| | |
|---|---|
| K5 | Knowledge that supports engineering design in a practice area |
| K6 | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline |
| K7 | Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability |



# 10. References


1. **Mohan, P., et al.** (2017). *Wearable Smart Helmet System for Driver Safety*. International Journal of Engineering & Technology.
2. **Chen, Y., et al.** (2018). *Capacitive Helmet Sensing for Wear Detection*. IEEE Transactions on Consumer Electronics.
3. **Bharath, K., et al.** (2019). *Alcohol Detection using MQ-3 Sensor for Road Safety*. Journal of Sensors and Actuators.
4. **Khan, S., et al.** (2017). *Impact Detection in Helmets using MEMS Accelerometers*. Journal of Mechanical Engineering.
5. **Zhao, L., et al.** (2018). *Smart Helmets with Multi-Sensor Integration for Safety Applications*. IEEE Access.
6. **Ghosh, S., et al.** (2020). *Multi-Sensor Smart Helmet System for Enhanced Rider Safety*. International Journal of Innovative Research.
7. **Srinivasan, S., et al.** (2019). *IoT-Based Smart Helmet with Real-Time Monitoring*. International Journal of Computer Applications.
8. **Patel, R., et al.** (2020). *Review of Breath Alcohol Detection Methods and Devices*. Journal of Breath Research.
9. **Srinivasan, S., et al.** (2020). *Affordable Smart Helmet Systems for Low-Income Regions*. Journal of Sustainable Engineering.
10. **Zhao, Y., et al.** (2020). *Advancements in Smart Helmet Systems and Integration with Vehicle Communication*. Journal of Transportation Safety.


THANK YOU!