

**Capstone Project – Introduction (PROJ2999), 7<sup>th</sup> Semester**  
**Academic year: 2025-26**

**Project Title:** Ear wearable SpO<sub>2</sub> Monitoring System for low ventilation area workers

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**Section:** B

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**Abstract:**

Workers employed in low-ventilation environments such as underground mines, tunnels, storage tanks, and sealed industrial facilities are exposed to conditions that can lead to reduced oxygen saturation (hypoxia) and associated health hazards. Continuous physiological monitoring in such settings is essential for safety, but conventional finger-based pulse oximeters are unsuitable for long-term use because they are uncomfortable, restrict hand movement, and are prone to motion artefacts.

This project focuses on the design and development of an **ear-wearable SpO<sub>2</sub> and heart-rate monitoring device** intended for industrial workers. The system will integrate a compact MAX3010x optical sensor module mounted on an ergonomically designed ear-clip housing to acquire photoplethysmography (PPG) signals directly from the ear, which is a stable and less intrusive measurement site. The acquired data will be processed by a microcontroller (Arduino/ESP32) and transmitted for analysis.

To improve measurement reliability, a **machine-learning model** will be trained on collected sensor data to differentiate genuine low-oxygen events from noise and motion-induced artefacts. This approach is expected to minimize false alarms while ensuring timely alerts through visual and acoustic indicators when a verified SpO<sub>2</sub> drop occurs.

So far, a comprehensive **literature survey** has been completed to study existing wearable SpO<sub>2</sub> sensors, collected sample PPG data, PPG signal processing techniques, and ML-based health monitoring approaches. The **future work** includes designing the hardware prototype, implementing Arduino-based data acquisition, collecting experimental data, training the ML model, refining the ear-clip design, and validating the system under real low-ventilation conditions.

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