**ENGI 316 – MATLAB Project Report**

# Project Title: Smart Cooling Fan for Industrial Machine

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# 1. Problem Definition and Formulation

In industrial settings, machines frequently operate under high loads, generating heat that must be effectively managed to avoid damage, inefficiency, or safety hazards. To simulate this process and design a smart solution, we created a MATLAB-based temperature control system using a variable-speed fan. The system dynamically adjusts fan speed depending on the machine’s internal temperature and external conditions, and it shuts the system down when a maximum safe temperature is reached.

The simulation leverages both software and mechanical engineering domains: the mechanical principles drive the heat generation, cooling, and ambient dissipation models; while software logic and interface design enable dynamic simulation, visualization, and interaction with system parameters.

## Variables Used

• Ta – Ambient temperature (°C)   
• T0 – Initial temperature of the machine (°C)   
• Tmax – Maximum allowable temperature before shutdown (°C)   
• L – Load percentage on the machine (0 to 100%)   
• sim\_time – Total simulation time in seconds   
• alpha – Heat production coefficient (proportional to load)   
• beta – Fan cooling efficiency coefficient   
• gamma – Heat exchange coefficient with ambient temperature   
• T – Array representing temperature at each second   
• FanSpeed – Array of categorical values: Off, Low, Medium, High   
• Status – Array representing "Running" or "Shutdown"

## Tasks Performed

1. Collect user inputs from a GUI (ambient temperature, load, etc.).   
2. Initialize simulation parameters (time range, initial state).   
3. Simulate temperature progression over time based on input variables.   
4. Dynamically adjust fan speed using temperature thresholds.   
5. Trigger system shutdown when temperature exceeds Tmax.   
6. Display temperature and fan status in 2D and 3D plots.   
7. Export final temperature data to an Excel file.   
8. Generate a report using MATLAB’s publish function.

# 2. Solution Method

The simulation models the dynamic temperature of a machine using a discrete time loop. At each time step, the temperature is updated using the following physical-based formulation:

T\_next = T\_now + α·L − β·FanLevel − γ·(T\_now − Ta)

Where:

• α·L represents heat generated by the machine load.   
• β·FanLevel models heat removed by the fan (0.2 for Low, 0.5 for Medium, 1.0 for High).   
• γ·(T\_now − Ta) models heat dissipation to the ambient air.

The fan speed is chosen dynamically using `if-elseif` logic:

• Low speed if T < 40°C   
• Medium speed if 40°C ≤ T < 60°C   
• High speed if T ≥ 60°C   
• System shutdown is triggered if T\_next ≥ Tmax

The simulation loop continues until either the simulation time is complete or the shutdown condition is reached. At the end of simulation, plots and data are displayed and exported.