1.0 Introduction: How a Jet Engine Works in a Nutshell

At its heart, a turbojet engine is a powerful air-breathing machine that works on a continuous, four-step cycle: intake, compression, combustion, and exhaust. Imagine it like this: the engine breathes in a massive amount of air, squeezes it tightly, adds fuel and ignites the mixture in a controlled burn, and then fires the resulting hot gas out the back at incredible speed. The 40KG turbojet, while compact, operates on this exact same powerful principle. This entire operation is a direct application of **Newton's Third Law of Motion**: the action of forcing a high-velocity jet of gas backward creates an equal and opposite reaction, pushing the engine forward with immense force.

Now, let's look at the specific mechanical parts inside the 40KG turbojet that work together to make this powerful cycle happen.

2.0 The Journey of Air: The Core Mechanical Components

To understand the engine, it's best to follow the path of the air as it travels through each of the core components, from the front to the back.

2.1 The Inlet Runner: The "Mouth" of the Engine

Think of the Inlet Runner as the mouth of the engine. It's the very first component that interacts with the outside air. Its single, critical job is to efficiently capture and guide a smooth, uniform flow of air into the compressor.

2.2 The Compressor: The "Lungs" That Squeeze the Air

Once inside, the air enters the compressor, which acts like a powerful set of lungs that dramatically squeezes the air. Its primary job is to rapidly increase the pressure and temperature of the air it receives from the inlet. This high-pressure air is essential for achieving powerful and efficient combustion in the next stage. The key component of the 40KG's compressor is the **Billet wheel**, a precisely machined impeller characteristic of a centrifugal compressor. The term "billet" refers to its manufacturing process, where the wheel is machined from a single, solid piece of metal, which gives it its characteristic strength and robustness.

For a micro-turbine like the 40KG, using a centrifugal compressor offers several key advantages:

- **Simplicity:** It has fewer parts compared to other compressor types.
- **Robustness:** Its solid construction makes it very durable and resistant to damage.
- **Compact Size:** It can achieve a high-pressure increase within a single, compact stage.

2.3 The Combustion Chamber: The "Furnace" Where Power is Unleashed

The highly compressed air then flows into the combustion chamber, the furnace of the engine where immense heat energy is added. Here's how the power is unleashed in three simple steps:

1. **Fuel Injection:** The **Injectors** spray a fine, atomized mist of fuel into the chamber, allowing it to mix thoroughly with the compressed air.
2. **Ignition:** During the engine's startup sequence, the **Glow Plug** heats up until it is red hot, igniting the fuel-air mixture.
3. **Combustion:** After ignition, a continuous and controlled burn takes place, which dramatically increases the temperature and volume of the gases inside the chamber.

2.4 The Turbine: The "Powerhouse" That Sustains the Engine

After combustion, the super-heated, high-pressure gases expand rapidly into the turbine section. The turbine acts as the engine's powerhouse, and its most critical job is to extract energy from the high-energy stream of rapidly expanding gases.

This extracted energy is then used to spin the **Turbine Shaft**, which connects the turbine directly to the compressor at the front of the engine. This mechanical link is the key to the entire system—it uses a portion of the engine's own power to drive the compressor, creating the self-sustaining cycle that defines a jet engine.

The turbine section works as a two-part team. First, the hot gas passes through a set of stationary vanes called the **NGV** (Nozzle Guide Vanes). The NGV acts like a set of vents that precisely aim and accelerate the gas into a powerful stream. This stream is directed onto the blades of the rotating **Turbine wheel**, which captures the energy with maximum efficiency, much like a pinwheel spinning in a focused jet of air.

2.5 The Exhaust Nozzle: The "Jet" That Creates Thrust

After exiting the turbine, the hot gas still possesses a great deal of pressure and heat energy. The exhaust nozzle is the final stage in the journey, and its job is to convert this remaining energy into the kinetic energy of a high-velocity jet. It takes the hot gases that have already passed through the turbine and accelerates them out of the back of the engine at an extremely high velocity. This powerful, focused jet of exhaust is what produces the forward thrust.

While these mechanical parts perform the heavy lifting, they are all controlled by a sophisticated electronic system that acts as the engine's brain and nervous system.

3.0 The Brain and Nerves: The Electronic Control System

While the mechanical components do the physical work of moving and heating air, a sophisticated electronic system is required to manage and control the entire operation safely and efficiently from startup to shutdown.

3.1 The Engine Control Unit (ECU): The "Brain" of the Operation

The Engine Control Unit (ECU) is the central computer—the "brain"—of the 40KG turbojet. It processes information from sensors and makes real-time decisions to keep the engine running optimally. For a user, its three most important jobs are:

- **Automated Startup/Shutdown:** The ECU manages the complex sequence of events required to start the engine. Just as importantly, it controls the automated cool-down cycle after shutdown, which is critical for preventing heat damage to the internal components.
- **Real-time Monitoring & Protection:** The ECU constantly watches vital parameters like exhaust gas temperature (EGT)—the temperature of the gas leaving the **Turbine**—and RPM. If these values approach unsafe limits, the ECU automatically reduces fuel flow to protect the engine from destroying itself.
- **Precise Fuel Control:** From the first drip of fuel at ignition to the flow required for full power, the ECU sends precise commands to the fuel pump. This ensures the engine gets the exact amount of fuel it needs for every stage of operation, providing stable and responsive performance.

3.2 Key Accessories: The "Muscles" Controlled by the Brain

The ECU sends commands to several key electrical and mechanical accessories that act as the muscles to carry out its instructions.

Component	Function
Fuel Pump	Receives commands from the ECU to deliver fuel to the combustion chamber at a precise rate.
Starter Motor	An electric motor that spins the engine's main shaft during startup until it reaches a speed where it can run on its own.
Glow Plug	An electrical heater that gets red hot to ignite the fuel-air mixture when the engine is first starting.

Together, the mechanical components that handle the airflow and the electronic systems that control them form a single, integrated system capable of generating incredible power.