Gaganyaan Crew Module

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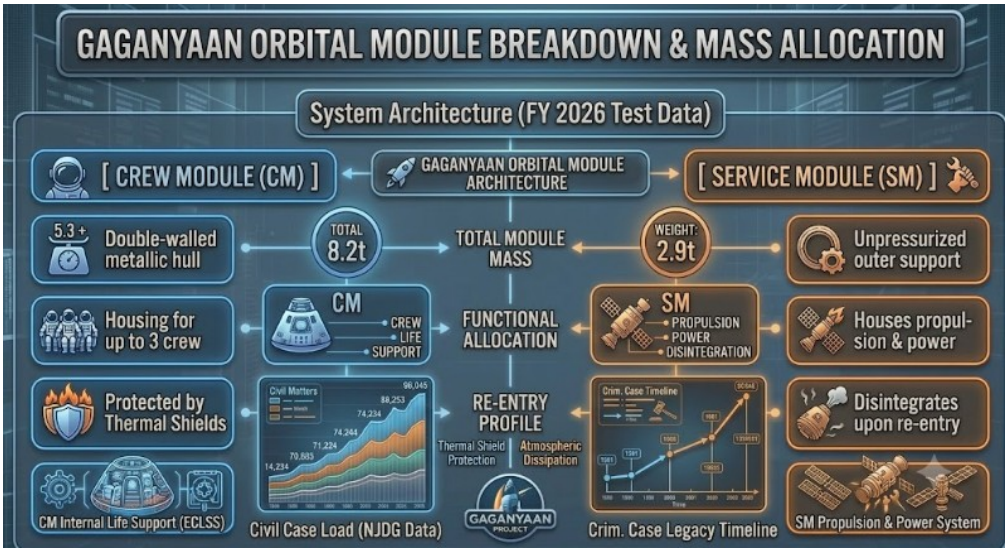
Why in News?

The Gaganyaan Crew Module (CM) is an engineering masterpiece built to withstand the extreme, unforgiving environments of space launch, orbital flight, atmospheric re-entry, and ocean splashdown.

- The Indian Space Research Organisation (ISRO) successfully conducted ***3 major qualification tests*** on the Crew Module systems to validate astronaut safety and system.
- **Proven Subsystems**
  1. The Crew Module Uprighting System (CMUS).
  2. The separation of the Crew-Service Umbilical mechanism (CSU-2).
  3. The structural integrity during the Apex Cover Separation.

The Architecture

- The outer shape of a spacecraft dictates how it behaves physically when hitting the atmosphere at orbital velocities.
- **The Design Choice -** A ***spherical capsule*** (like the Soviet Union's historical ***Vostok***) offers the maximum internal volume for the minimum structural mass.
- However, it generates no aerodynamic lift, falling straight down and exposing astronauts to extreme, dangerous G-forces.
- A ***conical body*** provides high lift and aerodynamic stability for a controlled descent, but is less volume-efficient.
- **The Gaganyaan Solution -** ISRO selected a ***truncated sphere-cone configuration*** weighing approximately 5.3 tonnes.



The Survival Life-support Systems

Subsystem	Function & Mechanism
Environmental Control & Life Support (ECLSS)	• Maintains a highly conditioned, Earth-like atmosphere. • It regulates oxygen supply, keeps cabin pressure at 0.8 atm, controls temperature at 20-26°C, and manages humidity between 30% and 70%. • It is to prevent static discharge or microbial buildup. • It also scrubs carbon dioxide and controls waste.
Thermal Protection System (TPS)	• Thermal shield on the module's exterior designed to safeguard the metallic pressure hull and the crew from re-entry heat loads exceeding thousands of degrees Celsius.
Deceleration System	• Consists of a highly redundant system utilizing 10 different parachutes.
Crew Escape System (CES)	• Acts as a high-speed "lifeboat". • In case of a catastrophic booster failure on the launchpad or during ascent, 5 quick-firing solid fuel motors instantly pull the crew module away to safety.

The Re-Entry & Recovery Capsule

- **De-orbit & CSU-2 Separation -** The Service Module fires its propulsion system to decelerate the vehicle.
- The Crew Module Umbilical (CSU-2) system executes a clean separation, detaching the Service Module, which burns up in the atmosphere while the Crew Module proceeds alone.

- **Apex Cover Jettison-** Before the main parachutes deploy, the protective apex cover is cleanly jettisoned.
- **Parachute Deployment & Splashdown -** The parachute sequence triggers, slowing the module down to terminal velocity before it splashes down in the ocean.
- **Active Uprighting (CMUS)-** Upon hitting the water, the module might land upside down.
- To prevent this, the ***Crew Module Uprighting System (CMUS*)** uses stored, high-pressure cold-gas to automatically inflate flotation devices, rotating the module back to an upright position to protect the crew and secure communication antennas.

Reference

The Hindu | Gaganyaan crew module

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