DEPARTMENT OF AEROSPACE ENGINEERING

Manufacturing Rocket Parts with 3D Printing

Definition:

- **3D Printing for Rocket Parts**: It involves using additive manufacturing techniques to create components and hardware for rockets and spacecraft.
- **Materials**: These parts can be made from various materials, including metals, plastics, and composites.

Working Principle:

1. **Layer-by-Layer Fabrication**:
   - 3D printing builds objects layer by layer.
   - For rocket parts, this means selectively depositing material (such as metal powder or filament) to create intricate shapes.

2. **Advantages of 3D Printing for Rockets**:
   - **Design Freedom**: 3D printing allows complex geometries that traditional manufacturing methods struggle with.
   - **Weight Reduction**: By optimizing designs and using lightweight materials, rockets become more fuel-efficient.
   - **Rapid Prototyping**: Engineers can quickly iterate and test designs.
   - **Customization**: Tailoring components for specific missions becomes feasible.

3. **Disadvantages**:
   - **Material Properties**: Some 3D-printed materials may not match the strength and durability of traditional materials.
   - **Precision**: Achieving high precision can be challenging.

Applications:

1. **Rocket Engine Components**:
   - **Combustion Chambers**: 3D printing allows intricate cooling channels and optimized shapes.
   - **Injectors and Nozzles**: Complex designs improve performance.
   - **Pumps and Valves**: Customized components for specific needs.
2. **Cost Reduction**:
   - 3D printing reduces costs by streamlining production and minimizing waste.
   - It also enables on-demand manufacturing.
3. **Future Prospects**:
   - NASA's **RAMPT (Rapid Analysis and Manufacturing Propulsion Technology)** project pioneers additive manufacturing for rocket parts.
   - Companies are exploring 3D-printed rocket components to enhance safety, reduce costs, and accelerate space exploration.

SKYROOT AEROSPACE 3D PRINTED ROCKETS

1. **Dhawan-II: The More Powerful 3D Printed Cryogenic Engine**:
    - Back in 2020, Skyroot Aerospace introduced Dhawan-I, a 3D printed cryogenic engine. Now, they've unveiled its successor: **Dhawan-II**.
    - Dhawan-II is a more powerful model and has successfully completed testing.
    - Like its predecessor, this engine is also 3D printed.
    - It uses two rocket propellants: liquid natural gas (LNG) and liquid oxygen (LoX), which require extremely low temperatures for storage and operation.
    - The tests were conducted at Solar Industries' propulsion test facility in Nagpur, India.

2. **Impressive Results**:
    - Dhawan-II registers a maximum thrust of 3.5 kN (compared to Dhawan-I's 1 kN).
    - The endurance tests lasted 200 seconds (about 3.5 minutes).
    - Skyroot Aerospace considers these results impressive and a landmark achievement for the Indian private space sector.

3. **Vikram-II and Beyond**:
    - Dhawan-II will be used for the upper part of the **Vikram-II**, Skyroot Aerospace's heaviest spacecraft.
    - The decision to incorporate a cryogenic engine aims to improve the rocket's payload capacity.
    - Skyroot Aerospace's first orbital flight with the **Vikram-I** rocket is expected by the end of this year.
    - The Vikram-II launch, featuring the 3D printed cryogenic engine, is planned for 2024.

4. **Advancing Cryogenic Technologies**:
    - Pawan Kumar Chandana, co-founder and CEO of Skyroot Aerospace, expressed pride in developing advanced cryogenic technologies using 3D printing and green thrusters.