



Mains Practice Question

Q. Examine the importance of GSLV technology in India's space exploration efforts. Evaluate the obstacles encountered during the development and implementation of GSLV technology for satellite launches. **(250 Words)**

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Approach

- Start the answer by introducing the Geosynchronous Satellite Launch Vehicle (GSLV).
- Illustrate the importance of GSLV technology in India's space exploration efforts.
- Evaluate the obstacles encountered during the development and implementation of GSLV technology.
- Conclude suitably.

Introduction

India's space exploration efforts have been significantly bolstered by the Geosynchronous Satellite Launch Vehicle (GSLV) technology. GSLV plays a crucial role in launching satellites into geosynchronous and geostationary orbits, enhancing communication, weather forecasting, and surveillance capabilities.

Body

Importance of GSLV Technology:

- **Enhancing Communication and Broadcasting:**
 - GSLV enables the launch of communication satellites, facilitating improved telecommunication, broadcasting, and internet services across India and neighboring regions.
 - For example, GSAT-6A launched by GSLV-F08 provides mobile communication services through multi-beam coverage.
- **Weather Forecasting and Earth Observation:**
 - GSLV launches meteorological and earth observation satellites, enhancing weather forecasting accuracy and enabling better disaster management.
 - INSAT-3DR, launched by GSLV-F05, provides high-resolution images for weather monitoring.
- **Strategic and Defense Applications:**
 - GSLV contributes to national security by launching reconnaissance and surveillance satellites, enhancing situational awareness and border monitoring.
 - For instance, The RISAT series of satellites are all-weather earth observation satellites, including synthetic aperture radar satellites RISAT-1 and RISAT-2.
- **Global Recognition and Commercial Launch Services:**
 - Successful GSLV missions have boosted India's stature in the global space community, attracting commercial satellite launch contracts.
 - GSLV-F11 launched GSAT-7A, a military communication satellite, for the Indian Air Force, showcasing India's self-reliance in space technology.

Obstacles in Development and Implementation:

▪ Technological Challenges:

- Developing cryogenic upper stages for GSLV posed technical hurdles due to the complexity of cryogenic propellant handling and engine design.
- India's early attempts, like GSLV-D1 and D3, faced failures attributed to cryogenic stage issues.

▪ International Restrictions and Technology Denial:

- In the past, India faced challenges in acquiring cryogenic technology due to technology denial regimes, leading to delays in GSLV development.
- The 1992 agreement with Russia for cryogenic technology transfer faced geopolitical hurdles.

▪ Budgetary Constraints and Cost Overruns:

- GSLV development incurred significant costs, leading to budgetary constraints and delays.
- Cost overruns in GSLV Mk III development were attributed to technological complexities and inflation.

▪ Operational Challenges and Reliability:

- GSLV missions require meticulous planning and execution due to the criticality of satellite payloads.
- GSLV-F02's failure due to a strap-on motor anomaly highlighted the challenges in ensuring mission success and reliability.

Mitigation Strategies and Future Prospects:

▪ Indigenous Technological Advancements:

- India has made significant strides in developing indigenous cryogenic technology, exemplified by successful GSLV Mk II and Mk III missions.
- Continued focus on technology indigenization enhances self-reliance in space exploration.

▪ International Collaborations and Agreements:

- Collaborations with countries like Russia, France, and the USA have facilitated technology transfer and access to advanced expertise, mitigating technological challenges and enhancing GSLV capabilities.

▪ Enhanced Quality Control and Reliability:

- ISRO has implemented stringent quality control measures and reliability enhancement strategies, resulting in successful GSLV missions like GSLV-F08/GSAT-6A and GSLV-F11/GSAT-7A.

▪ Cost Optimization and Commercialization:

- ISRO's cost-effective approach and competitive pricing for satellite launches have made GSLV a viable commercial option for international customers, furthering India's space diplomacy and revenue generation.

Conclusion

GSLV technology stands as a testament to India's space exploration prowess, enabling vital satellite launches for communication, weather forecasting, and strategic purposes. Despite initial obstacles, India has successfully developed and implemented GSLV technology, showcasing its capabilities in space science and technology.