1. What is PSLV technology? Discuss. What has been the progress with respect to indigenisation of PSLV technology? Examine.

Introduction

Indian Space Research Organization (ISRO) was established in 1969. Since its beginning, ISRO has created a niche for itself in the space technology world through continuous low-cost innovations. Recently, India's Polar Satellite Launch Vehicle (PSLV-C48) marked its 50th launch by injecting India's advanced radar imaging earth observation satellite RISAT-2BR1.

Body

PSLV earned its title **'the Workhorse of ISRO'** through consistently delivering various satellites to Low Earth Orbits, particularly the IRS series of satellites.

PSLV Technology

- Polar Satellite Launch Vehicle (PSLV) is the third generation launch vehicle of India.
- It is the first Indian launch vehicle to be equipped with liquid stages.
- It is a four-staged launch vehicle with first and third stage using solid rocket motors and second and fourth stages using liquid rocket engines.
- The PS4 is the uppermost stage of PSLV, comprising of two Earth storable liquid engines.
- The third stage of PSLV is a solid rocket motor that provides the upper stages high thrust after the atmospheric phase of the launch.
- PSLV uses an Earth storable liquid rocket engine for its second stage, know as the Vikas engine, developed by Liquid Propulsion Systems Centre.
- PSLV uses the S139 solid rocket motor that is augmented by 6 solid strap-on boosters.
- PSLV uses 6 solid rocket strap-on motors to augment the thrust provided by the first stage in its PSLV-G and PSLV-XL variants. However, strap-ons are not used in the core alone version (PSLV-CA).
- Initially, PSLV had a carrying capacity of 850 kg but has been enhanced to 1.9 tonnes.
- It comes in the category of medium-lift launchers with a reach up to various orbits, including the Geo Synchronous Transfer Orbit, Lower Earth Orbit, and Polar Sun Synchronous Orbit.
- All the operations of PSLV are controlled from the Satish Dhawan Space Center, Sriharikota.

Indigenisation of PSLV technology

India has made remarkable strides achieving 98 per cent indigenisation in launch vehicle technology and 60-70 per cent in satellite technology ISRO is making

desperate attempts to indigenizing current space technology. It is developing its own rockets, cryogenic engines, navigation, spy and communication satellites.

Some of Achievements are:

- **Chandrayaan-1** India's first mission to the Moon was launched on 22 October 2008 using the indigenously developed Polar Satellite Launch Vehicle (PSLV-C11) XL variant. The satellite made more than 3400 orbits around the Moon and the mission was concluded when the communication with the spacecraft was lost on 29 August 2009.
- **Mangalyaan** MOM was launched aboard PSLV C-25, which was an XL variant of the PSLV, one of world's most reliable launch vehicles. It is India's first interplanetary mission and made ISRO the fourth space agency to reach Mars, It made India the first Asian nation to reach Martian orbit and the first nation in the world to do so in its maiden attempt. most of the systems were indigenous
- India's Polar Satellite Launch Vehicle, in its thirty ninth flight (PSLV-C37), launches the 714 kg Cartosat-2 series satellite for earth observation and 103 co-passenger satellites together weighing about 663 kg at lift-off into a 505 km polar Sun Synchronous Orbit (SSO). PSLV-C37 was launched from the First Launch Pad (FLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota.
- PSLV-C43 lifted off on November 29, 2018 from the First Launch Pad (FLP) of Satish Dhawan Space Centre SHAR, Sriharikota and successfully launched India's Hyper spectral Imaging Satellite **(HysIS)** and 30 international co-passenger satellites. PSLV-C43 is the Core Alone version of PSLV, without the six strap-ons.
- The PSLV has helped take payloads into almost all the orbits in space including Geo-Stationary Transfer Orbit (GTO), the Moon, Mars and would soon be launching a mission to the Sun.
- It can take up to 1,750 kg of payload to Sun-Synchronous Polar Orbits of 600 km altitude.

Conclusion

The success of ISRO is testament to India's capability in frugal engineering and finding solutions with severe resource constraints and international non-cooperation. Future missions like Chandrayaan-2, Aditya-L1, Gaganyaan etc. will help India enhance its global image even further.

2. India's defence sector is yet to achieve the level of indigenisation that is worthy of a developed nation. Do you agree? Substantiate.

Introduction

As per the SIPRI (Stockholm International Peace Research Institute) report, India is the 2nd largest arms importer in the world. Though India has been spending

around 2.4% of its GDP on defence, indigenous production has not reached the desired level.

Body

Lack of indigenization in defence sector:

- High import of components: The Comptroller and Auditor General of India (C&AG) highlighted the 90% import dependency of Hindustan Aeronautics Ltd (HAL) for 'raw materials and bought out items' for the production of indigenous.
- Foreign collaboration has been mainly for finished products procurement than on technology transfer. E.g. Rafale deal with France, Howritzer Artillery guns with USA, S-400f missiles with Russia etc., None of them involve technology transfer.
- Lack of R&D: Expenditure is only around 5-6% of defence budget which is inadequate. India's Defence Research and Development Organization (DRDO) is ill equipped to produce the kind of high-quality research and tech that's essential for domestic companies to flourish.
- Technological backwardness – While developed countries have advanced technologies and developing next generation defence equipment, India lags behind. E.g. LCA Tejas of India vs F-22 Raptor with stealth capabilities.
- Private sector participation: with reserved sectors and uncertainty in defence policy and lack of predictable long-term requirements, the private sector is reluctant to invest in defence which has hampered the indigenization.
- Lack of production companies: There are only 8 Defence PSUs and 41 Ordnance Factories. This – without any participation of the private sector is inadequate for defence production.
- Inadequate production setup: Except for the recent defence corridors established, India doesn't have large defence production areas with a strong supply chain for defence production.

Indigenization in defence sector:

Indian defence indigenization has progressed over the years with increased production, investment in r&d, innovation promotion. The following shows that India has fared well in domestic development and production in defence sector:

- From leasing INS Viraat from USSR/Russia, INS Vikrant was built being the first aircraft carrier to be built in India for the Navy.
- Tejas – light combat aircraft (LCA) was designed and developed completely in India by efforts of Aeronautical Development Agency and HAL.
- Defence ministry has undertaken various indigenous development projects like
    - Project 75: Indian Navy's indigenous submarine programme which includes INS Kalvari, INS Khanderi etc.,

    - Project 15B: development of class of stealth guided missile destroyers.
- Arihant: first indigenous nuclear submarine was developed in association with BARC and DRDO.
- Agni-5 was developed indigenously under integrated guided missile development which is n ICBM (Intercontinental ballistic missile). Also, Dhanush, Nirbhaya, Prithvi, Akash missiles have also contributed to indigenization of defence.
- The Pinaka Multi Barrel Rocket Launcher is developed indigenously with near zero error possibility.
- Brahmos is designed and developed indigenously with joint collaboration with Russia.
- Arjun Tank is a third-generation main battle tank developed by DRDO. Also, Anti-Tank missiles like Nag are developed by DRDO including variants like Heli-Nag.
- Long-range artillery gun "Dhanush" called as desi Bofors has 81% of its components are indigenously sourced.
- Government policies are promoting indigenous defence production like
    - Research projects: through schemes like Innovations for Defence Excellence (iDEX), funding under Defence Innovation Fund (DIF), Technology development fund
    - Under the new Defence Procurement Procedure (DPP) 2016 promulgated in 2016, the 'Make' procedure has been simplified.
    - Strategic partnership model was announced which has promoted private sector participation.
    - Promotion through Make In India policy with local sourcing requirements, tax benefits etc.,

Challenges to defence indigenization (Not required in the answer):

- Lack of an institutional capacity and capability to take it to its logical conclusion.
- The private sector participation is abysmal. E.g. "Make" procedure for ICVs failed to achieve the results with just four companies competing for one weapon system.
- The decision-making bodies lack autonomy and authority. There is an urgent need of a permanent arbitration committee which can settle disputes expeditiously. E.g. In USA, the procurement agency DRAPA has a permanent arbitration committee which resolves such issues amicably and their decision is final.
- There is a lingering fear that the Indian strategic partners having committed their funds to infrastructure and getting the initial order would lose out to the DPSUs in the long run. This would sound the death knell of this well-intentioned idea.

- Land acquisition issues restrict entry of new players in the defence manufacturing and production.
- Some procurements are essential part of foreign diplomacy and has strategic interests.

Conclusion

Thus, though India has yet to reach its potential in defence indigenization, the production has increased and is being continuously promoted. Further promotion through streamlining private participation with long term policies, increasing r&d expenditure, establishing defence industrial corridors etc., will not only strengthen our defence capabilities, but also generate employment opportunities, improve supply chain management and technological development.

3. What is transfer of technology (ToT)? How is it different from indigenization? Illustrate.

Introduction

Technology Transfer represents the transfer of machinery, equipment and technological know-how either directly in the form of FDI or through spillover effect from the industry attracting FDI.

Some examples of TOT

- Boeing and Tata Advanced Systems have a joint venture company, Tata Boeing Aerospace (TBAL). it is being described as the sole global producer of fuselages for AH-64 Apache helicopter delivered by Boeing to its global customers including the U.S. Army. The facility will also produce secondary structures and vertical spar boxes of this multi-role combat helicopter.
- To make anti-tank guided missiles, Kalyani Rafael Advanced Systems (KRAS), a joint venture between Kalyani Strategic Systems Ltd. and Rafael Advanced Defense Systems Ltd. of Israel.
- Dassault Aviation and Anil D. Ambani's Reliance Group laid the foundation stone of the Dassault Reliance Aerospace Limited (DRAL) manufacturing facility in Mihan, Nagpur. the facility will manufacture several components of the offset obligation connected to the purchase of 36 Rafale Fighters from France, signed between the two Governments in September 2016.

Body

Technology transfer has immense benefits

- New products – Public benefits from the new manufactured goods that get to the market e.g. new age and modern technologies like Artificial Intelligence,

Cloud computing etc. are getting developed in countries like India because of its IT industry.

- Employment – Availability of the jobs which results from the improvement and sale of the products so formed.
- New markets – Markets of developed countries are already saturated, technology transfer helps exploring new markets and making market for new products.
- Revenue – The technology owner gets due reward in form of revenue which can be further utilized for improving existing technology or inventing newer ones.
- Strengthens industry – By identifying new business opportunities which contributes to enhancing the know-how and competitiveness of the technology providers. E.g. Technology transfer for defense equipment has helped promote indigenization and Make in India.
- Improved productivity – Allows for efficient use and enhanced outcomes from the given resources and factors of production e.g. HYV rice in green revolution
- Enhanced efficiency – New technology provides for efficient use using the same resources e.g. Israeli water management in agriculture.
- Joint Working between to sides may ensure cooperation in other areas like trade, people to people contacts etc.
- Dealing with global common threats like E-bola, climate change requires all countries to be equipped technologically. Here technology transfer can be an important tool.

Difference between Indigenization and ToT

It is the capability of developing and producing any defence equipment within the country for the dual purpose of achieving self-reliance and reducing the burden of imports.

A significant beginning in defence indigenization was made in 1983, when the government sanctioned the Integrated Guided Missile Development Programme (IGMDP) to develop five missile systems:

- Prithvi (surface-to-surface); Akash (surface-to-air); Trishul (the naval version of Prithvi); Nag (anti-tank); Agni Ballistic missiles with different ranges, i.e. Agni (1,2,3,4,5).
- INS Vikrant, also known as Indigenous Aircraft Carrier 1 (IAC-1), is the first aircraft carrier to be built in India for the Navy.

- Long-range artillery gun "Dhanush": first indigenous long-range artillery gun.
- Arihant: first indigenous nuclear submarine was developed in association with BARC and DRDO.
- Supersonic Cruise Missile BRAHMOS: is a Joint Venture between India and the Russian federation.
- Arjun Tank is a third generation main battle tank developed by DRDO.

ToT is a mean to achieve indigenization of technology. However indigenization requires not a clause in a technology transfer contract, but the recipient taking determined measures to ensure acquisition and absorption of technology.

India has been singularly poor at that. Further, domestic manufacturing has not in itself enabled it either. India has a long history of licensed manufacture of defence hardware, from the heydays of the self-reliance credo, the import substitution drives, and the famous “be Indian, buy Indian” slogan.

In aircraft, for example, the famous Gnat fighter, the MiG series, the Jaguar, and various French helicopters were made here. In each case, the degree of indigenization kept rising, sometimes reaching 90 per cent by value, but critical components or materials continued to be imported. India never achieved the stated goal of acquiring the capability to make the next upgrade or new model on its own. True indigenization cannot happen only with technology transfer, without developing domestic manufacturing.

Conclusion

Technology transfer and its licensing have played a crucial role in all round development and the advent of the technology which in results help in the development of the economy of the country. Hence forth helps in creating the wealth to the country.

4. What has been India’s performance and achievements in the field of supercomputing? Analyse.

Introduction

A supercomputer is a computer with a high level of performance as compared to a general-purpose computer. The performance of a supercomputer is commonly measured in floating-point operations per second (FLOPS) instead of million instructions per second (MIPS). Since 2017, there are supercomputers which can perform over a hundred quadrillion FLOPS.

Body

India’s performance and achievements in the field of supercomputing

- India's supercomputer program was started in late 1980s because Cray supercomputers could not be imported into India due to an arms embargo imposed on India, as it was a dual-use technology and could be used for developing nuclear weapons.
- This led to setting up the Centre for Development of Advanced Computing (C-DAC) in March 1988 with the clear mandate to develop an indigenous supercomputer to meet high-speed computational needs.
- PARAM 8000, considered to be India's first supercomputer was indigenously built in 1991 by the Centre for Development of Advanced Computing (C-DAC).
- Presently, Pratyush, a Cray XC40 system - an array of computers that can deliver a peak power of 6.8 petaflops, installed at the Indian Institute of Tropical Meteorology (IITM), Pune, is the fastest supercomputer in India. Launched in January 2018, it is the fourth fastest High Performance Computer (HPC) dedicated to climate modelling in the world.
- The government launched National Supercomputing Mission to connect national academic and R&D institutions with a grid of over 70 high-performance computing facilities.
- Recently NSM's first indigenously built supercomputer 'Param Shivay' WAS inaugurated at Indian Institute of Technology, BHU, Varanasi.
- India's three systems on TOP500 list ranking are:
    - Pratyush (Indian Institute of Tropical Meteorology) – 53rd rank
    - Mihir (National Centre for Medium Range Weather Forecasting) – 86th rank
    - INC1 – Lenovo C1040 (Software Company (M)) – 428th rank

India plans to indigenously develop 60 supercomputers over the next three years, Under National Supercomputing mission(NSM). India has lagged behind in the race of building supercomputers despite being a leader in the IT enabled services (ITES). Hence, National Supercomputing Mission is a step in the right direction.

Conclusion

Supercomputers are strategic in the most important sense, namely, the creation of an ecosystem that extends well beyond the boundaries of science and technology and has the capacity to transform the country. However appropriate infrastructure – both digital as well as physical is very much needed. Hence for India to become a knowledge-driven, multi-trillion-dollar economy, which is able to support cutting-edge science, investment in supercomputing is a necessity.

5. Examine the factors that are responsible for lesser number of patents registered by Indian universities/ institutions. What measures can be taken to address the same. Suggest.

Introduction

Universities and patents benefit each other. Patents help universities to improve their ranking, establish an innovation ecosystem, incubate knowledge-based start-ups, earn additional revenue and measure research activity. In this regard, India spent just 0.7% of its gross domestic product (GDP) in 2016-17 on R&D. Meanwhile, Japan, the US and China spent 3.2%, 2.8% and 2.1%, respectively, in 2017, according to the Organisation for Economic Co-operation and Development (OECD).

Body

- Patents occupy a prominent position as global indicators for ranking of the world economies. In general, there is a direct relation between the economy and the patent regime of a nation. Patent is an exclusive and territorial right granted by regional or national government.
- Patents in India are governed by the Indian Patents Act, 1970. The biggest change happened with the amendments in the early 2000s to make the law compliant with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).
- India witnessed significant changes in IPRs since the introduction of the National IPR Policy in 2016. In this context, while the disposal rates has increased, the filing rate for patents has not changed significantly. In 2016-17, the Patent Office reported a dip of 3.2% in filing compared to the previous financial year.
- As universities form the bedrock of innovation ecosystem, they face a strange human resources problem: despite the policy push to have more IP, India simply does not have enough IP professionals in the country.
- The dearth of IP professionals is due to the legal-centric approach where law schools and colleges are the only institutions which mandate teaching these subjects, which is one of the reasons why the supply of IP professionals is not keeping pace with demand.
- Poor infrastructure and limited resources have created a huge backlog which are constraining the higher educational institutes ability to bring in a dynamic IPR ecosystem.
- The lack of IP professionals to teach IP was one of the reasons that various committees could not suggest the mandatory introduction of IP courses in all technical institutes.
- India has a poor patent agent density, with only about 2,000 registered patent agents currently in practice. The last time when the Patent Office conducted the patent agent exam, in 2016, around 2,600 candidates took it, a paltry number if one looks at the ambitious goals set by the IPR Policy.
- Another problem is that researchers in India tend to focus on publishing their work in journals instead of patenting them. Many consider emphasis on research papers publishing as counterproductive to patenting. One reason why researchers are shy of patenting their ideas in India is the time taken to get a patent which in 2017 was on an average 64 months to grant a patent.

- A key factor driving patent filings in the US is industry funding of research in universities, which totalled $4.2 billion in 2016, according to the National Science Foundation. The benefits of industry-academia collaboration cannot be overstated — Stanford University was instrumental in the rise of Silicon Valley. This aspect is missing in context of India.
- Patent filings and grants in India are dominated by foreign applicants: they filed two-thirds of patent applications in 2018-19, and got four-fifths of grants, according to the Office of the Controller General of Patents, Designs and TradeMarks.

To overcome these shortcomings, the following can be some of the measures towards addressing the challenges of IPR in Indian Universities/Institutes:

- The number of patents applied for, granted and commercialised by universities and institutes is factored in in the National Institutional Ranking Framework (NIRF) rankings which clearly reveals that the top ranked engineering institutes in India are also the leading filers of patents.
- The All India Council for Technical Education (AICTE) model curriculum for its member institutions should lay emphasis on the need for IPR education in technical institutes.
- The path to patents is paved with research and funding. While Indian companies, including startups, universities and research institutes need to direct their attention towards generating more patents if India has to emerge as a hub of inventiveness, it also calls for increased spending on research and development (R&D) where India has targeted to more than double its R&D expenditure to at least 2% of GDP by 2022.
- Fine-tuning the patent agent examination to cater to the growing IP needs of the country can be a successful way to build a band of professionals and create career opportunities
- In a bigger push towards creating entrepreneurial universities, the University Grants Commission (UGC) should ask all universities in India to set up Intellectual Property (IP) Centres.
- Further, these can be some more measures -
    a. Awareness creation b. Patent Information Centres (PICs)
    c. IPR Cells in Universities d. Training programmes

Conclusion

With the advances in China and the US are making in communications, artificial intelligence and healthcare technology, India cannot afford to sit on the sidelines, and the only way for the country to get in on the action is to ramp up its R&D efforts and engender a culture of patenting in its universities and institutes.