1. Discuss the contributions of contemporary Indian scientists in the field of space technology.

Approach

The candidate needs to discuss the contributions of contemporary Indian scientists in the field of space technology in the answer along with proper examples and substantiations.

Introduction

India owes a lot of its space success to the existing breed of excellent space scientists that are relentlessly pushing the boundaries of what is possible in the field of space technology which have brought laurels to the Indian space technology arena as well as led to establishment of India as one of the powerhouses of space exploration and technology.

Body

In this regard, the contributions of contemporary Indian scientists in the field of space technology can be seen from the following points –

- Jayant Vishnu Narlikar is an Indian astrophysicist. Narlikar is a proponent of steady state cosmology. He developed with Sir Fred Hoyle the conformal gravity theory, commonly known as Hoyle–Narlikar theory. It synthesises Albert Einstein's Theory of Relativity and Mach's Principle. It proposes that the inertial mass of a particle is a function of the masses of all other particles, multiplied by a coupling constant, which is a function of cosmic epoch. In cosmologies based on this theory, the gravitational constant G decreases strongly with time.
- Mars Orbiter Mission: India's first inter planetary mission, the Mars Orbiter Spacecraft was successfully launched on November 5, 2013 on-board PSLV-C25. Its success made India one of the four nations in the world to send space mission to Planet Mars. Mars Orbiter Mission is mainly intended to establish the Indian technological capability to reach Martian orbit and to explore Mars surface features, morphology, mineralogy and Martian atmosphere by indigenous scientific instruments.
- Thanu Padmanabhan is an Indian theoretical physicist and cosmologist whose research spans a wide variety of topics in Gravitation, Structure formation in the universe and Quantum Gravity. He has published more than 260 papers and reviews in international journals and ten books in these areas. Many of his contributions, especially those related to the analysis and modelling of dark energy in the universe and the interpretation of gravity as an emergent phenomenon, have made significant impact in the field.
- Remote Sensing and National Natural Resource Management System: The Indian Remote Sensing Satellites (IRS) System, with currently 11 satellites in

orbit, is one of the largest constellations of remote sensing satellites in operation in the world today. It provides inputs for management of natural resources and various developmental projects across the country using space based imagery. During the last decade, 13 remote sensing satellites have been launched and operationalized.

- Ritu Karidhal has been dubbed as the 'Rocket Woman of India', she was the Mission Director of the Chandrayaan-2 mission, and was feted for role in helming one of India's most ambitious lunar projects. She was responsible for detailing and the execution of the craft's onward autonomy system that independently operated the satellite's functions in space and responded appropriately to malfunctions.
- The successful flight testing of indigenous cryogenic stage on-board GSLV-D5 Flight on January 5, 2014. Geosynchronous Satellite Launch Vehicle (GSLV) is capable of placing 2 Tonne class communication satellite into Geosynchronous Transfer Orbit (GTO) and India is one among six countries in the world to demonstrate such launch capability to GTO with the use of complex cryogenic technology. It clearly demonstrated the capability of Indian scientists in complex space technologies.
- Byrana Nagappa Suresh is an Indian aerospace scientist. He served as the Director of Vikram Sarabhai Space Centre (VSSC), Thiruvananthapuram during the period 2003–2007. He is known for his contribution to development of Indian launch vehicles and Space Capsule Recovery Experiments (SRE). Dr. Suresh also served as the founding Director of Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram.
- Kamakshi Sivaramakrishnan is part of the team that developed a technology, which is now on-board NASA's New Horizon mission, which is probing Pluto. It is NASA's farthest space mission. She is responsible for building the algorithm and the chip that is responsible for bringing information from Pluto, whose existence as a planet was being questioned. The chip on board the spacecraft collects signals and sends them back to the space station which is three billion miles away.

Conclusion

Many people have contributed towards the expansion of scientific contemplation in modern India, especially in space technology, where contemporary Indians are raising the bar continuously towards rapid advancements in space technology as well as growth of a space based technology ecosystem in India which would help in overall scientific growth of the nation.

2. Examine the recent achievements of Indian scientists in building indigenous weapon systems.

Approach

Candidates are expected to write about Indian indigenous weapon system and then examine the recent achievements of Indian scientists in building the indigenous weapon system.

Introduction

Over dependence on the Soviet Union, brought about a change in India's approach to defence industrialisation from licence-based production to production based on indigenous design. From the mid-1980s, the government pumped resources into R&D to enable the DRDO to undertake high profile projects.

Body

Indigenisation of Defence and weapon system:

- Indigenisation 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. India's defence R & D and industry mainly government and public sector so far have designed and developed a number of indigenous platforms and weapons systems over the years.

Recent achievements by Indian scientists in the building indigenous weapon system:

- In 2016, DRDO successfully tested its first indigenously developed heavy duty drone, Rustom 2, an unmanned armed combat vehicle developed on the lines of the US's Predator drone.
- Third generation 'fire-and-forget' anti-tank missile with a range of 4-8km. HELINA (Helicopter Launched NAG) is the air-to-surface version of the NAG integrated into Dhruv Helicopters. DRDO developed Muntra, India's first unmanned tank for detecting mines and for operation in areas where there is a nuclear radiation or biological/chemical weapon risk.
- DRDO co-developed and operationalised India's first nuclear ballistic missile submarine, INS Arihant, with the development of which, India completed its nuclear triad and became capable of firing nuclear weapons from land, air and sea.
- DRDO announced its development of an electronic intelligence satellite, EMISAT which would be launched by ISRO (Indian Space Research Organisation). Weighing about 436 kg, EMISAT is based on ISROs Indian Mini Satellite-2 (IMS-2) bus platform and is intended for electromagnetic spectrum measurement.
- DRDO developed India's first anti-satellite system (ASAT) that made India the fourth nation in the world to possess this capability. India tested its first ASAT which is capable of destroying satellites in the low earth orbit-a major achievement.

- After several years of flight testing and four phases of dedicated testing, the LCA (Navy) Flight Test Team successfully executed a textbook arrested landing at the SBTF.

The Self-Reliance Index (SRI) which may be defined as the ratio of indigenous content of defence procurements to the total expenditure on defence procurements in a financial year is at an abysmal 0.3. Let us analyse the challenges in indigenisation of weapon system.

- Infrastructural deficit increases India's logistics costs thus reducing the country's cost competitiveness and efficiency.
- Lack of an institutional capacity and capability to take different policies aimed at indigenisation of defence to its logical conclusion.
- Land acquisition issues restrict entry of new players in the defence manufacturing and production.
- In a 2011 report to the Parliament, 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.
- CAG report also revealed that not all technologies developed by DRDO were suitable for use by the armed forces. The three services have rejected 70 per cent of the products developed at the ARDE Pune, in the last 15 years costing Rs 320 crore because the products did not meet their standard and requirement.

Wayforward:

- Preference to 'Buy (Indian)', 'Buy & Make (Indian)' & 'Make' categories of acquisition over 'Buy (Global)' category, thereby giving preference to Indian industry in procurement.
- DRDO former chief V.K. Saraswat has called for the setting up of a Defence Technology Commission as well as a bigger role for DRDO in picking production partners for products developed by the agency.
- Committee chaired by P. Rama Rao suggested DRDO should be restructured in a leaner organisation also recommended for setting up a commercial arm of the organisation to make it a profitable entity, besides cutting back on delays in completing projects.

Conclusion

Indigenisation in defence is critical to national security also. It keeps intact the technological expertise and encourages spin-off technologies and innovation that often stem from it. Strategic Capability increases with self sufficient and self reliant defence industry also it will place India among the top global powers.

3. What are the factors that have contributed towards India's global leadership role as the vaccine capital? Discuss.

Approach- Candidate is expected to highlight the role of India in vaccine supply to the world. With the help of data and examples, the future of India's vaccine market can be shown.

Introduction

The Indian vaccine market, which has carved out a place for itself at the global level, is expected to reach a valuation of Rs 252 billion by 2025. The Indian market size was Rs 94 billion in 2019. Two coronavirus vaccine candidates, out of a total 11 worldwide, are from India.

Body

What are the factors behind?

- India currently is one of the leading manufacturers and suppliers of vaccines in the world. It solely accounts for around 60% of the total vaccines supplied to the UNICEF.
- Over the years, India has emerged as one of the leading manufacturers of vaccines worldwide, and supplies large quantities of basic and advanced vaccines across the globe. Currently, more than two thirds of the total volume of the vaccines manufactured is exported while the rest is utilised domestically.
- One of the major drivers of the Indian vaccine market is the strong government support to the manufacturers. Steady government funding and successful initiatives have resulted in considerable market development over the years.
- One of the primary forces that is stimulating the market growth is the increasing investments in research and development (R&D) by government funding agencies like the Department of Biotechnology, the Indian Council of Medical Research, and the Ministry of Health and Family Welfare.
- Some of the other factors positively influencing the market growth are increasing population, elevating incomes, improving cold chain logistics and active NGO participation.
- The launch of the Universal Immunization Program (UIP) aimed at increased immunization coverage against vaccine preventable diseases in the country, has also significantly added to the market growth.
- With advancement in technology, the vaccine production capacity along with cold chain storage facilities have also been improved. Besides this, the advent of a number of privately owned firms in India have positively transformed the industry.
- These firms have been making efforts to bring low cost solutions and are increasingly shifting their focus on innovation so as to increase their revenues. Owing to these factors, India has emerged as a global vaccine manufacturing hub.

- The cost of manufacturing and clinical trials in India is relatively lower than in developed countries.
- Indian vaccines have shown less side effects and are low cost and are easier to store and transport.
- Looking forward, the Indian vaccine market value is projected to reach INR 252 Billion by 2025, expanding at a CAGR of 17.8% during the forecast period (2020-2025).
- Some of the major vaccines being developed are Bacillus Calmette–Guérin (BCG), Haemophilus influenzae type b (Hib), Influenza, Varicella, Typhoid, Japanese Encephalitis, Measles, Tetanus Toxoid, Hepatitis A, Rubella, Diphtheria, Tetanus and Pertussis (DPT), Oral Polio Vaccine (OPV), Measles, Mumps and Rubella (MMR), Rotavirus, Hepatitis B, Pneumococcal, Meningococcal, Rabies, Human Papillomavirus (HPV), Hexavalent and Dengue.

Conclusion

India is a leading force in vaccine development. India has exported more vaccines than the total vaccination at home. With robust infrastructure and government support, India has become a vaccine capital of the world. India is competing with china but with the help of soft diplomacy, India can play a major role in streamlining the vaccine supply to the world.

4. What were the key objectives of the Chandrayaan mission? What were the key learnings from the project?

Approach

Mention the objectives followed by the key learning of the mission.

Introduction

Initial indications are that the premature end to India's Chandrayaan-1 lunar orbiter mission was the result of a miscalculation by scientists at the Indian Space Research Organisation (ISRO) of the thermal stresses the spacecraft would encounter in its operating environment.

Body

The key objectives of the Chandrayaan mission:

- The Chandrayaan-1 mission performed high-resolution remote sensing of the moon in visible, near infrared (NIR), low energy X-rays and high-energy X-ray regions.
- One of the objectives was to prepare a three-dimensional atlas (with high spatial and altitude resolution) of both near and far side of the moon.
- It aimed at conducting chemical and mineralogical mapping of the entire lunar surface for distribution of mineral and chemical elements such as Magnesium, Aluminium, Silicon, Calcium, Iron and Titanium as well as high atomic number elements such as Radon, Uranium & Thorium with high spatial resolution.
- Various mission planning and management objectives were also met. The mission goal of harnessing the science payloads, lunar craft and the launch vehicle with suitable ground support systems including Deep Space Network (DSN) station were realised, which were helpful for future explorations like the MOM.
- Mission goals like spacecraft integration and testing, launching and achieving lunar polar orbit of about 100 km, in-orbit operation of experiments, communication/ telecommand, telemetry data reception, quick look data and archival for scientific utilisation by scientists were also met.

Key learnings from the project:

- The technical error that ultimately doomed Chandrayaan-1 likely could have been avoided given all that has been learned about the lunar-orbit environment through measurements taken by NASA and other space agencies dating back to the 1960s.

- The experience will inform ISRO's future planetary endeavors, just as NASA has had to learn from past mistakes like the measurement-conversion error that led to the Mars Climate Orbiter failure a decade ago this month.
- Hopefully, ISRO also has learned something about managing the disclosure of information about civilian space missions, particularly those involving international partners, even if the news is bad. Unfortunately, Chandrayaan-1 stands out as an example of how not to do it.
- In announcing that Chandrayaan-1's orbit had been raised to 200 kilometers, for example, ISRO said the probe's primary mission had essentially been completed and couched the maneuver as a means of carrying out additional studies. No mention was made of the overheating problem that appears to have been the actual reason for the maneuver.

Conclusion

- ISRO demonstrated its ability to lead an international mission with Chandrayaan-1, and is collaborating with Russia on a follow-on mission that will include a lander and rover. Part of the responsibility that comes with such a leadership role is being forthright and up front with details when things go wrong. ISRO can and should do better. It can start by including representatives of its partner agencies in the investigation of Chandrayaan-1's premature failure, and then by making the results of that probe fully available to the public.

5. Discuss the geopolitics of the Suez Canal during the aftermath of WWII.

Approach:

Question is straight forward in its approach students are expected to write about Suez canal and geopolitics arising out of it during the aftermath of WWII. Also it is important to give a brief about geography of Suez canal in the introduction of the answer.

Introduction:

The Suez Canal is an artificial sea-level waterway running north to south across the Isthmus of Suez in Egypt to connect the Mediterranean Sea and the Red Sea. The canal separates the African continent from Asia, and it provides the shortest maritime route between Europe and the lands lying around the Indian and western Pacific oceans. It is one of the world's most heavily used shipping lanes. The canal is extensively used by modern ships , as it is the fastest crossing from the Atlantic Ocean to the Indian Ocean .Tolls paid by the vessels represent an important source of income for the Egyptian government. The Canal runs between Port Said harbor and the Gulf of Suez , through soils which vary according to the region. At Port Said and the surrounding area, the soil is composed over thousands of years of silt and clay sedimentations deposited by the Nile waters drifted by Damietta branch.

Body:

Geopolitics of Suez canal during the aftermath of WWII-

- Colonel Gamal Abdel Nasser, one of the participants at the conference of non-aligned African and Asian countries held in Bandung in 1955, was seeking to unify the Arab world around Egypt, of which he became President in June 1956. In order to stimulate the economic and agricultural transformation of the country, he planned the construction of a huge dam at Aswan, but the United States, despite seeing Nasser as a preferable alternative to communism, refused to contribute to the enormous building costs. So on 26 July 1956, Nasser announced his intention to nationalise the Suez Canal Company. The majority of shareholders in this internationally vital waterway were French and British, and their concession was not due to expire until 1968. For Nasser, the revenue from operating the canal was necessary to allow Egypt to finance the building of the Aswan Dam.
- France, angered by the aid given by Egypt to the Algerian rebels, and Britain, which wanted to maintain its control over the strategically important Suez passage, decided to launch a joint military attack with a view to regaining control over the administration of the canal. They were supported militarily by Israel — a state that since its creation in 1948 had felt directly threatened by any hint of Arab expansionism or reinforcement. Moreover, Nasser had never stopped proclaiming his desire to destroy Israel. On 29 October 1956, Israeli forces took the Sinai Peninsula, a vital area for the protection of the Jewish

state. One week later, Anglo-French troops disembarked in Port Said. The operation was entirely successful — the Egyptian army was defeated in a few days, even though Nasser had ordered the sinking of some forty ships in order to block the Suez Canal completely.

- However, the world powers did not appreciate the actions of France and Britain in the slightest. The Soviet Union, which was in the process of forcibly putting down the insurrection in Hungary, threatened Paris and London with nuclear reprisals. For their part, the United States, despite being traditional allies of the European powers, complained that they had not been consulted beforehand. They did not appreciate this kind of neo-colonial gunboat diplomacy at all, and exerted enormous financial pressure on the United Kingdom through the United Nations — so much so that the Anglo-French force had to withdraw despite its military success. Israel also evacuated Sinai. The UN took on the task of repairing the Suez Canal, which was reopened to shipping in April 1957. In the meantime, Nasser had ordered the destruction of several oil pipelines, meaning that Western European countries faced their first cuts in fuel supplies.
- The upshot of all this was that Nasser, boosted by his political and diplomatic victory, enjoyed immense prestige in the Arab world. He exploited to the full his image as the victim of an imperialist plot. The European powers were forced to recognise once and for all that they were not world powers and that their role on the international stage could not be more than that of supporting the United States. Indeed, it became difficult for them to pursue an independent policy on the world stage. Their influence in the Middle East became almost non-existent. The Suez Crisis therefore ended in a moral defeat and a diplomatic fiasco for the former colonial powers, while Colonel Nasser consolidated his position as defender of the Arab cause and champion of decolonisation.
- Today, nearly a decade on from the beginning of the Arab Spring, things have changed. It has become necessary for states across the region to reassert themselves and seek to restore stability and economic development. Key to this process will be economic cooperation within the bounds of power politics in two leading geographical areas of the Middle East and North Africa (MENA) region: the Red Sea and the Eastern Mediterranean.
- Both “Saudi Vision 2030” and “Egyptian Vision 2030” place great emphasis on the optimum economic utilization of the Red Sea area, inclusive of the Red Sea’s waters, coastlines, and islands, with all the touristic and mineral resources the sea offers and its potential to serve as a multidimensional bridge between the Arabian Peninsula and Egypt. In fact, Saudi Vision 2030 views the bridge as a means to bolster the Saudi geo-strategic position by extending it to the Eastern Mediterranean via the Suez Canal. It was no coincidence that the agreements signed during the visit by the Saudi monarch to Cairo in April 2016 included a $1.5 billion Sinai development project and a plan to build a King Salman Mosque in Ras Sudr on the eastern shore of the Gulf of Suez.

Conclusion:

About 12% of world trade passes through the canal each year, everything from crude oil to grains to instant coffee. Without Suez, a supertanker carrying Mideast crude oil to Europe would have to travel an extra 6,000 miles around Africa's Cape of Good Hope, adding some $300,000 in fuel costs (although there would be savings from avoiding the Suez passage tolls, which can run hundreds of thousands of dollars.) Because it has no locks, it can even handle aircraft carriers. With this the geostrategic importance of Suez canal has become even more significant which the world powers has realised since the Suez crisis of 1956.