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PAPER – III - UNIT-II
ROLE AND IMPACT OF SCIENCE AND TECHNOLOGY IN THE DEVELOPMENT OF INDIA

பொது அறிவு
GENERAL STUDIES

கால அளவு: மூன்று மணி நேரம்   மொத்த மதிப்பெண்: 250

Duration : 3 Hours   **Total Marks : 250**

பிரிவு - அ
SECTION - A

குறிப்பு : **i)** ஒவ்வொரு வினாவிற்கும் **150 சொற்களுக்கு மிகாமல்** விடையளிக்கவும்.

Note : Answer **not exceeding 150 words** each.

ii) ஒவ்வொரு வினாவிற்கும் **பத்து மதிப்பெண்கள்.**

Each question carries **ten marks.**

iii) கொடுக்கப்பட்டுள்ள **பதின்மூன்று** வினாக்களில் எவையேனும் **பத்து** வினாக்களுக்கு மட்டும் விடையளிக்கவும்.

Answer any **ten** questions out of **thirteen** questions.

(10 x 10 = 100)

1. ஹைட்ரஜன் எரிபொருள் செல்களின் நன்மைகள் மற்றும் தீமைகளை ட்டியலிடுக.

List out the advantages and disadvantages of Hydrogen fuel cells.

Introduction:

- Hydrogen fuel cells are a clean, reliable, quiet, and efficient source of high-quality electric power.
- They use hydrogen as a fuel to drive an electrochemical process that produces electricity, with water and heat as the only by-products.

- Hydrogen is one of the most abundant elements on earth for a cleaner alternative fuel option.
- The National Hydrogen Energy Mission (NHM) was launched in the Union Budget for 2021-22 to promote hydrogen production and its uses.

Significance of Hydrogen fuel cells:

- **Best Zero Emission Solutions**: It is one of the best Zero Emission solutions. It is completely environment friendly with no tailpipe emissions other than water.
- **Quiet operation**: The fact that the fuel cells make little noise means that they can be used in challenging contexts, such as in hospital buildings.
- **Easier scaling**: Operation times of fuel cells are longer than those of batteries, with fuel cells, only the amount of fuel needs to be doubled to double the operation time, while batteries require the capacity of the components to be doubled to achieve the same.

Issues associated with Hydrogen fuel cells:

- **High Cost**: Green hydrogen makes up only 0.03% of global hydrogen production and it is up to five times more expensive than 'grey' hydrogen produced from natural gas or worse, 'brown' hydrogen produced from coal.
- **Hydrogen Storage**: Storage and transportation of hydrogen is more complex than that required for fossil fuels. This implies additional costs to consider for hydrogen fuel cells as a source of energy.
  Hydrogen Extraction: Despite being the most abundant element in the Universe, hydrogen does not exist on its own so needs to be extracted from water via electrolysis or separated from carbon fossil fuels.
- Both of these processes require a significant amount of energy to achieve. This energy can be more than that gained from the hydrogen itself as well as being expensive.
- In addition, this extraction typically requires the use of fossil fuels, which in the absence of carbon capture and storage (CCS) undermines the green credentials of hydrogen.
- Another alternative that many hydrogen councils across the world are pushing for is 'blue' hydrogen, which is grey hydrogen coupled

with additional installations for carbon capture and storage incorporated into the production facility.

- This way, up to 90% of the CO2 emitted during hydrogen production can be captured for reuse or storage and prevented from escaping into the atmosphere.

2. நானோ தொழில்நுட்பம் என்றால் என்ன? மற்றும் இது விவசாயத் துறையில் எவ்வாறு உதவுகிறது?

What is nanotechnology and how is it helping in the agriculture sector?

Nanotechnology is understanding and control of matter at nanoscale, at dimensions between approximately 1 and 100 nanometres, where unique phenomena enable novel applications. It involves the ability to see and to control individual atoms and molecules.

APPLICATIONS IN AGRICULTURE

- **Nano fertilisers**: At nanoscale, plants can better assimilate fertilisers and increase fertiliser use efficiency.
- **Nano pesticides**: Can be designed to target specific pests, reducing the need for broad-spectrum pesticides.
- **Nano sensors**: Can be used to monitor soil moisture, nutrient levels, detect microbial pathogens and contaminants in soil and water.
- They can provide real-time data to farmers, allowing them to optimise their irrigation and fertiliser practices.
- **Nanocarriers**: Nanocarriers can be used to deliver nutrients, pesticides, and other substances directly to plants. This can improve the efficiency and effectiveness of these inputs.
- **Nano packaging of food products**: Can be used to create smart packaging materials that can monitor and control the storage conditions of agricultural products to reduce spoilage and increase shelf life.
- Nano sensors & delivery systems can allow for precision farming through efficient use of natural resources like water, nutrients, chemicals etc.
- Liquid Nano Urea is sprayed directly on leaves of plants and gets absorbed by the stomata- pores found on the epidermis of leaves.

3. விண்வெளி தொழில்நுட்பத்தின் பாதுகாப்பு சார்ந்த முக்கியத்துவம் யாது?
What is the strategic importance of space technology?

- Survey of various mineral and natural resources have been made possible through remote sensing.
- Management of these resources, their development conservation and formulation of various policies are effectively done with the use of information derived through remote sensing.
- Various meteorological services including information about monsoon, climate flood, cyclonic activities etc are provided through the technologies.
- It has developed communication technology in India.
- They have proved very useful in spread of education.
- Even in remote areas, the expertise educations have been made possible through the talk back channels of INSAT-3D satellite.
- They have helped in environment conservation programmes estimation of agricultural production and water resources information's.
- Green revolution had been made possible through this technology.
- The concept of "Gramsat" satellites have emerged to provide the basic requirements of villages.
- Apart from these various uses, the space programme has helped in social cultural and scientific consolidation and harmony.

Indian Space Program Milestones:

- In 1962, the Indian National Committee for Space Research (INCOSPAR) was established by the Ministry of Nuclear Energy. Construction of the Thumba Equatorial Rocket Launch Station (TERLS) has begun
- On November 21, 1963, the first rocket was launched from TERLS.
- In 1967, the Satellite Communications Earth Station was established in Ahmedabad.
- ISRO (Indian Space Research Organization) was established on August 15, 1969, under the Ministry of Nuclear Energy.
- On June 1, 1972, the Space Commission and the Space Agency were formed.
- India's first ISRO satellite, Aryabhata, was launched on April 19, 1975.

- On June 7, 1979, an experimental satellite called Bhaskara I was launched for earth observation.
- On March 17, 1988, the first operational Indian remote sensing satellite, IRS1A, was launched.
- On May 26, 1999, the Indian remote sensing satellite IRSP4 (OCEANSAT) was launched by a polar satellite launch vehicle (PSLVC2) from Sriharikota, along with DLRTUBSAT in Germany and KITSAT3 in South Korea.

4. தமிழ்நாட்டில் கடற்கரை காற்றாலை ஆற்றலின் ஆற்றல் வளம் குறித்து விவாதிக்க.

Discuss about the offshore wind energy potential in Tamil Nadu.

- Tamil Nadu holds second rank in wind power among the states of India
- Tamil Nadu is having an Onshore wind potential of 95 GW at 150-meter height.
- With the total installed wind capacity of 9,015.09 MW in State Transmission Utility, around 13,000 MU of wind power is generated every year which contributes to 9.91% of State consumption.
- As per the study done by National Institute of Wind Energy (NIWE), the Coast of Tamil Nadu from Kannyakumari to Nagapattinam is having the Offshore Wind potential of 35 GW.
- The SECI (Solar Energy Corporation of India) has floated tender for leasing of sea bed for installation of 4 GW of offshore wind generation capacity.
- Almost 53% of installed power generation capacity from renewable energy, including hydropower
- Wind power constitutes 84% of the state's renewable energy potential followed by solar (14%)
- Tamil Nadu's installed wind power capacity contributes to almost 1/4th of India's installed wind power capacity
- State hosts 51% of India's captive wind installed capacity and 17% of captive solar installed capacity
- Home to the world's leading wind manufacturing companies: Nacelle plants (Vestas, Siemens Gamesa, Nordex), TPI Composites (Blades exports)
- 100s of MSMEs engaged in domestic and global wind supply chain

- Green hydrogen production requires 10-50 units of electricity per kg: Co-locating green power generation and hydrogen production may bring down costs.

Significance:
- Wind speeds tend to be higher offshore than on land. A wind turbine operating at a wind speed of 24 kph can generate twice as much energy as a turbine operating at a wind speed of 19 kph
- The wind offshore tends to be more consistent, with higher power capture for a greater number of hours per day.
- Onshore wind requires land resources. Offshore wind is built in the open sea where land rights are cheaper, and it is easier to go to bigger blades.
- Offshore wind does not impose noise pollution upon the human population.

5. தகவல் தொடர்பு செயற்கைக் கோள் என்றால் என்ன? இஸ்ரோ உருவாக்கிய GSAT தகவல் தொடர் செயற்கைக்கோள்களின் பயன்பாட்டை விளக்குக.

What is a Communication Satellite? Explain the application of GSAT Series of satellite developed by ISRO.

A communication satellite is an artificial satellite that transmits the signal via a transponder by creating a channel between the transmitter and the receiver at different Earth locations. Telephone, radio, television, internet, and military applications use satellite communications.

GSAT 7 Series Satellites:

GSAT-7 (Rukmini):
- It is India's first military satellite.
- It was launched in August 2013 from an Ariane 5 ECA rocket from Kourou in French Guiana.
- It is an advanced communication satellite developed by ISRO and primarily provides communication services to the Indian Navy.

GSAT 7A:
- It primarily provides communication services to the Indian Air Force.
- It also helps in satellite-controlled operations of UAVs.

GSAT 7B:
- It is a communication satellite part of the GSAT-7 series.

- GSAT 7 series satellites are advanced communication satellites developed by the Indian Space Research Organisation (ISRO) to meet the communication needs of the defence services.
- The GSAT 7B will primarily fulfil the communication needs of the Indian Army.
- It is a geostationary satellite which will considerably enhance the communication capability of the Indian Army by providing mission-critical beyond-the-line-of-sight communication to troops and formations as well as weapon and airborne platforms.
- It is the first-ever in the five-tonne category that will be designed indigenously by the ISRO.

GSAT-6A:

- GSAT-6A, similar to its predecessor GSAT-6, is a high-power S-band communication satellite.
- The GSAT-6A is intended to provide communication services through multibeam coverage.
- The satellite would also provide services to the Indian Armed Forces.
- GSLV - The GSLV F08 is an improved and a fully operational version of ISRO's heavy-lift GSLV Mk II rocket series.
- The GSLV, specifically the GSLV F10, is the designated rocket to fly India's second mission to the Moon, the Chandrayaan 2.
- In the absence of heavy-lift rocket technology, India has been relying on France for launching its communication satellites.

6. 5G தொழில்நுட்பத்தின் நன்மைகள் மற்றும் தீமைகளை ஆராய்க.

Explore the advantages and disadvantages of 5G technology.

Advantages of 5G technology:

- It will support high-speed data services that have industrial applications like smart grid, smart metering in the energy sector, robotics and precision manufacturing.
- It will support critical infrastructure like health by way of telemedicine, tele-control of surgical robots, financial transactions by integrating secure blockchain technology.
- It will further integrate systems as per 4th Industrial Revolution's needs like Digital economy, Internet of Things, Artificial Intelligence based systems.

However, adoption and integration of 5G technology in India will have to overcome many challenges like:

- The huge investment required from the government for research, manpower and capacity development and by private players in making it a profitable venture. This should be seen in the backdrop of the crisis faced by Telecom companies currently in India.
- It will require large scale optical fibre connectivity. Currently, such connectivity is limited to metropolitan cities of India while hinterlands surrounding them remain aloof of even good 4G connectivity.
- With a growing digital economy, the threat of cyber-attacks will loom large. India already ranks low on the Global Cyber Security index.

Conclusion:

- Earlier adoption of 5G will help India encash on current programmes like Digital India, Startup India towards becoming a frontrunner in 4th Industrial Revolution driven by enhanced digital connectivity and greater, a diversified market which helps overcome issues like poverty, unemployment, increased presence in the global supply chain.

7. **செயற்கை நுண்ணறிவின் நன்மைகள் மற்றும் தீமைகளை பட்டியலிடுக.**

List out the advantages and disadvantages of Artificial Intelligence.

- It is a branch of computer science that deals with creating computers or machines as intelligent as human beings.
- It refers to the ability of the machines to perform human intelligence processes like thinking, perceiving, learning, problem-solving and decision making.

Advantages:

Healthcare:

- It aims to enhance diagnosis accuracy, enable personalized treatment, improve patient outcomes, streamline healthcare operations, and accelerate medical research and innovation.
- Recently, the Indian Council of Medical Research (ICMR) issued a guiding document- "The Ethical Guidelines for Application of AI in Biomedical Research and Health care", which outlines 10 key

patient-centric ethical principles for AI application in the health sector.

Business:

- AI in the business sector helps optimize operations, enhance decision-making, automate repetitive tasks, improve customer service, enable personalized marketing, analyze big data for insights, detect fraud and cybersecurity threats, streamline supply chain management, and drive innovation and competitiveness.

Education:

- AI could open new possibilities for innovative and personalised approaches catering to different learning abilities.
- IIT Kharagpur has collaborated with Amazon Web Services to develop the National AI Resource Platform (NAIRP), the future possibilities of which include monitoring eye movement, motion and other parameters for better teaching and learning.
- As demonstrated by ChatGPT, Bard and other large language models, generative AI can help educators and engage students in new ways.

Judiciary:

- It is used to improve legal research and analysis, automate documentation and case management, enhance court processes and scheduling, facilitate online dispute resolution, assist in legal decision-making through predictive analytics, and increase access to justice by providing virtual legal assistance and resources

SUVAS (Supreme Court Vidhik Anuvaad Software):

- It is an AI system that can assist in the translation of judgments into regional languages.
- This is another landmark effort to increase access to justice.

SUPACE (Supreme Court Portal for Assistance in Court Efficiency):

- It was recently launched by the Supreme Court of India

Cybersecurity/Security:

- It is used in security and cybersecurity to detect and prevent cyber threats, identify anomalous activities, analyze large volumes of data for patterns and vulnerabilities, enhance network and endpoint security, automate threat response and incident management, strengthen authentication and access control, and provide real-time

threat intelligence and predictive analytics for proactive defense against cyber-attacks.

Disadvantages of AI:

- **Job Displacement:** AI automation may lead to the displacement of certain jobs as machines and algorithms can perform tasks that were previously done by humans. This can result in unemployment and require re-skilling or retraining of the workforce.

- **Ethical Concerns: AI** raises ethical concerns such as the potential for bias in algorithms, invasion of privacy, and the ethical implications of autonomous decision-making systems.

- **Reliance on Data Availability and Quality:** AI systems heavily rely on data availability and quality. Biased or incomplete data can lead to inaccurate results or reinforce existing biases in decision-making.

- **Security Risks:** AI systems can be vulnerable to cyber-attacks and exploitation. Malicious actors can manipulate AI algorithms or use AI-powered tools for nefarious purposes, posing security risks.

- **Overreliance**: Blindly relying on AI without proper human oversight or critical evaluation can lead to errors or incorrect decisions, particularly if the AI system encounters unfamiliar or unexpected situations.

- **Lack of Transparency:** Some AI models, such as deep learning neural networks, can be difficult to interpret, making it challenging to understand the reasoning behind their decisions or predictions.

- **Initial Investment and Maintenance Costs:** Implementing AI systems often requires significant upfront investment in infrastructure, data collection, and model development. Additionally, maintaining and updating AI systems can be costly.

8. ரோபோடிக்ஸ் துறையில் உள்ள சவால்கள் மற்றும் வாய்ப்புகள் என்ன?

What are the challenges and opportunities in the field of Robotics?

- Robotics is a branch of engineering that involves the conception, design, manufacture and operation of robots.

- Robot is any automatically operated machine that replaces human effort.

- The objective of the robotics field is to create intelligent machines that can assist humans in a variety of ways.

Advantages:

- In many situations robots can increase productivity, efficiency, quality and consistency of products.
- Robots can work in environments which are unsafe for humans as they don't have the same environmental requirements that humans do – such as lighting, air conditioning or noise protection.
- Robots have some sensors/actuators which are more capable than humans.
- Unlike humans, robots don't get bored. Until they wear out, they can do the same thing again and again.
- They can be very accurate – to fractions of an inch (as is needed for example in manufacturing of microelectronics).

Disadvantages:

- The use of robots can create economic problems if they replace human jobs.
- Robots can only do what they are told to do – they can't improvise.
- This means that safety procedures are needed to protect humans and other robots.
- Although robots can be superior to humans in some ways, they are less dexterous than humans.
- Robotics lack emotional intelligence, which plays a critical role in intense situations.
- Often robots are very costly – in terms of the initial cost, maintenance, the need for extra components and the need to be programmed to do the task.
- Surveillance concerns pose a problem of entering a privacy nightmare.

9. இந்தியாவில் அதிவேக கணினிகளின் வரலாற்றை விளக்குக.

   Elucidate the history of supercomputers in India.

   Supercomputer:

   - A supercomputer is the world's fastest machine, capable of processing and counting massive datasets very quickly. Such computing systems are substantially better and more sophisticated than general computers.
   - The major goal of supercomputer development was to boost computational power in huge corporations.

- This type of computer is capable of processing trillions and trillions of calculations and instructions per second.
- FLOPS [Floating Point Operation Per Second] is the unit of measurement for speed.
- A supercomputer can process trillions of operations per sec while maintaining 100% correctness.
- A supercomputer is employed in space research, space inspection, nuclear technology, genetic manipulation, and military applications, among other things. Because supercomputers emit heat, they require air conditioning.

History of Supercomputers in India:

- In India, supercomputing goes back to the 1980s.
- The Indian government established an indigenous development plan.
- In August 1991, a 64-node computer was deployed. PARAM 8000 was the series' initial machine, and it was constructed from the ground up.
- PARAM 8600 replaced the PARAM 8000 in 1992.
- India is now ranked 23rd for the most powerful supercomputer.

History of Supercomputers in the World:

- The very first supercomputer was nearly the same height as four bookshelves. In the 1950s, several emerging tech companies were competing to build the fastest computer.
- IBM was the industry leader with its super-fast IBM 7030 Stretch.
- Then in 1957, a group of computer engineers started CDC (Control Data Corporation).
- In 1964 they completed CDC 6600, which was at least 3 times more powerful than the most popular IBM 7030 Stretch.
- In 1992, NASA contractors Don Becker and Thomas Sterling built the Beowulf Supercomputer with innovation in the cluster model.
- In 1997 Intel designed its supercomputer using the same cluster model.

10.இந்திய விண்வெளி கொள்கை 2023 - ஐ விளக்குக.

The Indian Space Policy 2023 - Explain.

- This year, the Indian Space Research Organisation (ISRO) released the Indian Space Policy 2023 that had been in the works for some years.
- The policy has been welcomed as a progression towards India's entry in a New Space age. However, it needs to be followed up with suitable legislation, accompanied by clear rules and regulations.
- Until the early 1990s, India's space industry and space economy were defined by ISRO. Private sector involvement was limited to building to ISRO designs and specifications.
- **The Indian Space Policy 2023** unveils the government's plan to let private enterprises carry out end-to-end activities - from launching satellites and rockets into space to operating Earth stations.
- The First Satellite Communication Policy: It was introduced in 1997, with guidelines for foreign direct investment (FDI) in the satellite industry that were further liberalised but never generated much enthusiasm.
- **Remote Sensing Data Policy**: It was introduced in 2001, which was amended in 2011; in 2016, it was replaced by a National Geospatial Policy that has been further liberalised in 2022.
- **Draft Space Activities Bill**: It was brought out in 2017, which went through a long consultative process and lapsed in 2019 with the outgoing Lok Sabha.
- The government was expected to introduce a new Bill by 2021, but it appears to have contented itself with the new policy statement released by ISRO.
- **Vision**: The 'Vision' is to "enable, encourage and develop a flourishing commercial presence in space" that suggests an acceptance that the private sector is a critical stakeholder in the entire value chain of the space economy.
- The policy creates four distinct, but related entities, that will facilitate greater private sector participation in activities that have usually been the traditional domain of the ISRO.
- InSPACe (Indian National Space Promotion and Authorisation Centre): It will be a single window clearance and authorisation

agency for space launches, establishing launch pads, buying and selling satellites, and disseminating high-resolution data among other things.

- It will also share technologies, products, processes and best practices with NGEs (non-government entities and this will include private companies) and government companies.
- IN-SPACe will create a "stable and predictable regulatory framework" that will ensure a level playing field for the NGEs.
- It will act as a promoter by setting up industry clusters and as the regulator, issue guidelines on liability issues.
- **New Space India Limited (NSIL):** It will be responsible for commercialising space technologies and platforms created through public expenditure, as well as, manufacturing, leasing, or procuring space components, technologies, platforms and other assets from the private or public sector.

Department of Space:

- It will provide overall policy guidelines and be the nodal department for implementing space technologies and, among other things, co-ordinate international cooperation and coordination in the area of global space governance and programmes in consultation with the Ministry of External Affairs.
- It will also create an appropriate mechanism to resolve disputes arising out of space activity.

Rationalising the role of ISRO:

- It states that ISRO will "transition out of the existing practice of being present in the manufacturing of operational space systems.
- Hereafter, mature systems shall be transferred to industries for commercial usage. ISRO shall focus on R&D in advanced technology, proving newer systems and realisation of space objects for meeting national prerogatives".
- ISRO will share technologies, products, processes and best practices with other government and non-government companies.
- This will make ISRO use its all its strength on cutting edge research and development and long-term projects such as Chandrayaan and Gaganyaan.

Private Sector's Role:

- The NGEs (this includes the private sector) are "allowed to undertake end-to-end activities in the space sector through establishment and operation of space objects, ground-based assets and related services, such as communication, remote sensing, navigation, etc.".
- Satellites could be self-owned, procured or leased; communication services could be over India or outside; and remote sensing data could be disseminated in India or abroad.
- NGEs can design and operate launch vehicles for space transportation and establish their own infrastructure.

11. பொருட்களின் இணையம் (IOT) என்றால் என்ன? அதன் நடைமுறை பயன்பாட்டுகளை எடுத்துக்காட்டங்களுடன் விளக்குக.

What is Internet of Things (IOT)? Explain its practical applications with examples.

- IoT is the interlinking of digital devices, people, machines, appliances, and other objects with one another through wireless networks.
- It allows machines and people to be connected to each other and communicate as well.
- It is considered the future of the internet. This version of the internet is about data that is created by things.

Internet of Things Explained:

- Any device that can be connected will be connected.
- Any device that can be switched on and off will be connected.
- Most of the connected devices will have an Internet Protocol (IP) address. With IPv6, billions of devices can be connected with ease.

Things can be connected with IoT:

- **Connected Homes:** interlinking of household appliances to the network.
- **Connected Wearables:** smartphones, smartwatches, fitness bands, etc.
- **Connected Cars:** vehicles connected to the network.
- **Connected Cities:** smart meters that can analyze the usage of gas, water, electricity, etc.; connected traffic signals; smart bins, etc.

Different networks would be connected to each other, like as mentioned below:

- BAN (Body Area Network) – Wearables
- LAN (Local Area Network) – Smart Homes
- WAN (Wide Area Network) – Connected Cars

Internet of Things Applications:

- **Daily life:** IoT can be used to do small tasks in daily life such as coffee-making as soon as the owner of the house returns home, refrigerator indicating that vegetables need to be bought and/or ordering them automatically from the e-store, etc. It can also be used in offices.
- **Industry:** IoT can be used to reduce human error, increase efficiency, and improve productivity, etc.
- **Agriculture:** IoT can be used to improve overall productivity by having enhanced weather forecasting, soil nutrient content, pest infestation, etc.
- **Healthcare:** there are several benefits to the medical industry. Better diagnosis of diseases, wearable monitors of vitals, sophisticated connected equipment, etc.
- **Transportation:** IoT can be used on toll booths, traffic management, driverless cars, etc. It can also be used in fleet management, safety assistance, improved logistics, etc.
- **Media/Advertising:** Companies can use IoT to analyze and predict consumer behavior and apply target marketing for better ROI in advertising/marketing campaigns, etc. Big data and data mining concepts can be used in this regard.
- **Smart Cities:** IoT can be used to make cities better places to live. It can be applied in solid waste management, smart power grids, smart energy management systems, etc.
- **Government policies and services:** the government can use IoT to offer better citizen services.

12.குவாண்டம் கணினி என்றால் என்ன? அதன் பயன்பாடுகள், சவால்கள் மற்றும் இந்தியாவின் சமீபத்திய முயற்சிகளைக் குறித்து எழுதுக.

Explain Quantum Computing? and write about its uses, challenges, and India's recent initiatives.

- Quantum computing is a rapidly-emerging technology that harnesses the laws of quantum mechanics to solve problems too complex for classical computers.

- Quantum mechanics is a subfield of physics that describes the behavior of particles — atoms, electrons, photons, and almost everything in the molecular and submolecular realm.

- It is an exciting new technology that will shape our world tomorrow by providing us with an edge and a myriad of possibilities.

- It is a fundamentally different way of processing information compared to today's classical computing systems.

Features:

Different from Traditional Computers:

- While today's classical computers store information as binary 0 and 1 states, quantum computers draw on the fundamental laws of nature to carry out calculations using quantum bits.

- Unlike a bit that has to be a 0 or a 1, a qubit can be in a combination of states, which allows for exponentially larger calculations and gives them the potential to solve complex problems which even the most powerful classical supercomputers are not capable of.

Significance:

- Quantum computers can tap into the quantum mechanical phenomenon to manipulate information and are expected to shed light on processes of molecular and chemical interactions, address difficult optimization problems, and boost the power of artificial intelligence.

- These could open the door to new scientific discoveries, life-saving drugs, and improvements in supply chains, logistics and the modelling of financial data.

The Initiatives taken by the Indian Government:

- **National Mission on quantum technologies and applications**: The Government in its 2021 budget allocated INR 8000 Crore towards the National Mission on quantum technologies and applications to

spur developments in quantum computing, cryptography, communications, and material science.

- **Quantum Computing Laboratory**: In December 2021, the Indian Army set up a quantum computing laboratory and an AI centre at a military engineering institute at Mhow, Madhya Pradesh. It is also backed by the National Security Council Secretariat (NSCS).
- **Quantum Communication Lab**: The Centre for Development of Telematics (C-DOT) launched a quantum communication lab in October 2021. It can support more than 100 km of standard optical fibre.
- **Collaborations**: The Defence Institute of Advanced Technology (DIAT) and the Centre for Development of Advanced Computing (C-DAC) agreed to collaborate and develop quantum computers.
- **I-HUB Quantum Technology Foundation**: The Department of Science and Technology and about 13 research groups from IISER Pune launched I-HUB Quantum Technology Foundation (I-HUB QTF) to further enhance the development of quantum tech.
- **Startups**: A number of Start-Ups such as Qunu Labs, Bangalore; BosonQ, Bhilai have also emerged and as a result, they are making inroads in this area.

13. இயற்கை வழி வேளாண்மையின் கோட்பாடுகள் மற்றும் கட்டமைப்புகள் யாவை?

What are the principles and components of organic farming?

Organic Farming:

- Organic Farming is an agricultural system that uses organic fertilizers such as green manure, compost manure, bone meal, etc., and gives emphasis on the techniques such as companion planting and crop rotation. Organic Farming shows that there is no need to use chemical-rich products when you can get better crops with biological fertilizers or by using the organic method.
- This system of agriculture production combines biodiversity with healthy practices that lead to preserving natural resources. Organic Farming is expected to become INR 75000 crore market by 2025.

Characteristics of Organic Farming:

- Go through the details below to understand the Characteristics of Organic Farming in India in detail.

- Protecting the fertility of soils by providing organic matter levels, boosting soil biological activity, and careful mechanical intervention.
- Organic Farming provides nutrients to the crop indirectly by using relatively insoluble organic sources.
- Disease, weed, and pest control depend majorly on natural predators, crop rotations, organic manuring, diversity, limited thermal, resistant varieties, and chemical and biological intervention.
- Conservation of natural habitats and wildlife, and giving careful attention to the impact of the farming system on the environment.
- Meeting nitrogen self-sufficiency by using biological nitrogen fixation, legumes, and also effective recycling of the organic materials.

Components of Organic Farming:

Following are the components of Organic Farming

- Selection of variety
- Manage soil health
- Water management
- Maintain genetic diversity
- Weed management
- Pest and disease management
- Livestock management
- Nutrient management

Types of Organic Farming:

- There are two types of Organic Farming, namely- Integrated Organic Farming and pure Organic Farming.
- Integrated Organic Farming includes the combination of nutrient management and pest management to achieve ecological demands and requirements.
- Pure Organic Farming avoids all unnatural chemicals. In this process, all fertilizers and pesticides are obtained from only natural sources such as blood meal and bone meal.

Organic Farming in India:

- Below mentioned are the Initiatives to Promote Organic Farming by the Government

- Mission Organic Value Chain Development for North East Region (MOVCD)
- MOVCD or Mission Organic Value Chain Development for North East Region, is a central sector scheme, and it is a sub-mission under the NMSA (National Mission for Sustainable Agriculture)
- Ministry of Agriculture and Farmers Welfare launched the MOVCED in 2015 for implementation in the states of Assam, Meghalaya, Arunachal Pradesh, Mizoram, Manipur, Sikkim, Nagaland, and Tripura.
- The aim of this scheme was to enhance certified organic production in a value chain model, which will establish a link between the growers and consumers to promote Organic Farming.

பிரிவு - ஆ
SECTION - B

குறிப்பு : i) ஒவ்வொரு வினாவிற்கும் **250 சொற்களுக்கு மிகாமல்** விடையளிக்கவும்.

Note : Answer **not exceeding 250 words** each.

ii) ஒவ்வொரு வினாவிற்கும் **பதினைந்து மதிப்பெண்கள்.**

Each question carries **fifteen marks.**

iii) கொடுக்கப்பட்டுள்ள **பதின்மூன்று** வினாக்களில் எவையேனும் **பத்து** வினாக்களுக்கு மட்டும் விடையளிக்கவும்.

Answer any **ten** questions out of **thirteen** questions.

(10x 15 = 150)

14. சந்திரயான்-III மற்றும் சந்திரயான்-IIயின் தொழில்நுட்ப முன்னேற்றங்களை ஒப்பீடு செய்க.

Analyze the technological advancements made in Chandrayaan-III in comparison with Chandrayaan-II.

- Lunar exploration mission by ISRO, a follow-on mission to Chandrayaan-2.
- Comprised an indigenous propulsion system, lander module (Vikram) and a rover (Pragyan).
- Successfully demonstrated ISRO's end-to-end capability in safe landing and roving on the Lunar surface.
- Chandrayaan-3 landing site is located about 600 kilometres from the South Pole of the Moon, on the near side of the Moon.

Major objectives:

Demonstrate a safe and soft landing on the surface of the Moon ○ Conduct rover operations on the Moon

Conduct on-site experiments on the Lunar surface.

- On August 23rd, 2023, Vikram Lander made its historic touchdown on Moon and subsequently Pragyan rover was deployed.
- Duration: Rover operated for one lunar day (roughly equals 14 Earth days).
- The lander and the rover have scientific payloads to collect samples of the moon, do in-situ experiments. The Vikram lander would transmit data back to Earth for comprehensive analysis by scientists.
- The Virtual Launch Control Centre at the Vikram Sarabhai Space Centre played a vital role in continuous real-time monitoring of the launch activities from SHAR.
- The International Astronomical Union (IAU) has approved the name "Statio Shiv Shakti" for the landing site of Chandrayaan-3's Vikram lander.
- With the success of the mission, India joined the United States, Russia, and China to successfully land on the Moon.

Advanced Technologies in Chandrayaan-3:

Propulsion module:

- Spectro-polarimetry of Habitable Planet Earth (SHAPE) to gather data on the polarisation of light reflected by Earth to assist with exoplanet searches.

Lander payloads:

- Chandra's Surface Thermophysical Experiment (ChaSTE) to measure thermal conductivity and temperature on the surface.
- Instrument for Lunar Seismic Activity (ILSA) to detect Moonquakes.
- Radio Anatomy of Moon Bound Hypersensitive ionosphere and Atmosphere (RAMBHA) to measure the density of near-surface plasma, encompassing ions, and electrons, and monitor its temporal variations.
- Langmuir Probe to estimate the density and variation of plasma, or superheated gas, in the Moon's environment.

- Laser Retroreflector Array (from NASA) to measure distances using laser ranging to understand the dynamics of the Moon system.

Rover payloads:

- Alpha Particle X-ray Spectrometer (APXS) to look for elements in the lunar soil and rocks
- Laser Induced Breakdown Spectroscopy (LIBS) to examine the chemical and elemental composition of the lunar surface.

15. ஆதித்யா-L1 பணியின் முக்கியத்துவத்தை விவாதிக்க.

Discuss the significance of the Aditya-L1 mission.

India's first space-based observatory to study the Sun successfully launched from SHAR in September 2023.

- Launched into low earth orbit using PSLV. Aditya-L1 went multiple orbital manoeuvres and took around 126 days to travel to its final destination at Lagrangian Point L1.
- **Objectives:** To study Solar upper atmospheric dynamics (photosphere, chromosphere, and Corona), coronal heating mechanism, origin of coronal mass ejections, and flares etc.
- **PAYLOADS:** Weighing 1475 kg, it will carry seven payloads, including:
- **Solar Ultraviolet Imaging Telescope (SUIT):** To image the Sun in 200-400 nanometre (nm) of Ultraviolet band. SUIT's imager will continuously record the entire disk of the Sun. Images of various layers could improve understanding of the Sun's immediate atmosphere.
- Visible Line Emission Coronagraph (VELC) is the Corona/Imaging and Spectroscopy payload to focus on Sun's Corona.
- Solar Low Energy X-ray Spectrometer (SoLEXS) and High Energy L1 Orbiting X-ray Spectrometer (HEL1OS) will study X-ray flares emitted by the Sun over a wide range of X-ray energy range.
- Aditya Solar wind Particle Experiment (ASPEX), during the cruise phase, will turn on and start performing insitu measurements of solar particles and ions.
- Plasma Analyser Package for Aditya (PAPA) will study solar wind and energetic ions.
- Magnetometer (MAG) to measure low-intensity interplanetary magnetic field in space.

Significance:

- Aditya-L1 would help in a deeper understanding of the Sun's behaviour and its impact on Earth. It hopes to generate user-friendly information to issue space weather alerts that can help safeguard a range of satellite-dependent operations such as telecommunications, mobile-based Internet services, navigation, power grids, etc.

- It would study solar upper atmospheric dynamics and understand the physics of the solar corona and its heating mechanism.

- The difference between the Sun's upper atmosphere's temperature of 1-3 million degrees Celsius and its lower temperature of 5500 degree Celsius is one of the most significant unresolved problems in the study of solar physics.

- To understand this issue, it will capture near-simultaneous photos of the many layers of the Sun's atmosphere, revealing how energy is routed and transported from one layer to the next.

Lagrange Points:

- Lagrange points are positions in a moving two-body system where the combined gravitational forces of two large bodies (such as the Sun and Earth or Earth and the Moon) acting on a third body of smaller mass cancel each other out.

- While absolute neutralisation is not achievable due to the influence of other celestial bodies (such as Moon, Mars, and Venus etc.), they provide a stable position where a spacecraft may be "parked" to make observations.

- There are five Lagrange points located along the line connecting the two larger celestial bodies.

- L1 point: Located roughly 1.5 million kilometres from Earth. It provides an uninterrupted view of the Sun (the satellite can view the Sun without eclipses).

- L2 point: Provides an unobstructed view of the Universe and is stable enough for long-duration observations. Location for space-based observatories (James Webb Space Telescope).

- L3 point: Lies behind the Sun, opposite to Earth. Offers the potential to observe the far side of the Sun. Possible location for a future space-based observatory.

- L4 and L5 point: Stable locations but are relatively farther from Earth than L1.

16.ராம்ஜெட் மற்றும் ஸ்கிராம்ஜெட் எஞ்சின் என்பதற்கிடையேயான முதன்மை வேறுபாடு என்ன?

What is the primary difference between a Ramjet and a Scramjet Engine?

Jet Engines

A jet engine is an internal combustion engine that propels aircraft using the rearward discharge of a jet of fluid, usually hot exhaust gases generated by burning fuel with air drawn in from the atmosphere.

Ramjet Engine

- A ramjet engine is a jet propulsion system that utilises the exhaust velocity of a combustion process to achieve thrust.
- Unlike turbojets, ramjet engines do not require an external compressor and turbine, instead relying solely on the speed of incoming air to ignite fuel in the combustion chamber and create thrust.
- This makes them an efficient option for high-speed applications, as they can be smaller and lighter than traditional turbojets while delivering comparable performance.
- The Ramjet engine has no moving parts and relies on high-speed motion for operation.
- It operates efficiently at supersonic speeds (around Mach 3 to 6)

Advantages of Ramjet

- The Ramjet engines offer several advantages over traditional turbojets, such as,
- They have a compact size and lightweight construction.
- They do not require external compressors or turbines, as ramjets use the speed of incoming air to ignite fuel.
- They are more efficient for high-speed applications than turbojets.

Disadvantages of Ramjet

- The Ramjet engines have some drawbacks, such as,
- They are likely to be inefficient at low airspeeds and may require large intakes to ensure efficient operation.
- They require a considerable amount of fuel compared to traditional turbojets, which are often more expensive to operate and maintain

Scramjet Engine

- A scramjet engine is an upgraded variant of a ramjet where combustion occurs due to supersonic airflow.
- This supersonic flow allows the jets to achieve even faster speeds than the standard ramjets.
- This engine does not need to slow the incoming air for combustion like a typical turbojet or even ramjet.
- It carries liquid Hydrogen as fuel and liquid Oxygen for combustion (oxidiser) to generate thrust.
- The fuel efficiency of the scramjets tends to be significantly better than that of traditional turbojets and ramjets.
- It makes them ideal for various high-speed applications.
- Due to the complexities of maintaining the supersonic airflow, scramjets are often more expensive and difficult to manage than other engines.
- They operate more efficiently at very high speeds (Mach 12 to 24).
- Just like the Ramjet engines, they also have no moving parts

Advantages of Scramjet

- The Scramjet engines offer some distinct advantages over other types of jet engines, such as,
- The primary benefit is the potential for increased speed, as combustion takes place in supersonic airflow and does not need to be slowed down for combustion.
- They are also more fuel-efficient.
- They could potentially improve the performance during acceleration.
- Disadvantages of Scramjet
- The scramjets come with their drawbacks, such as,
- It does not have a compressor to compress the air; hence, it uses its high-speed forward motion to compress the air. Therefore, efficient thrust is difficult to produce unless boosted to high speed.
- The tolerances required to maintain supersonic airflow often make them harder to manage.
- They are more expensive than other types of jet engines.
- These engines can also sacrifice some thrust compared to traditional turbojet and ramjet designs

17. "விண்வெளி சார்ந்த இணையம்" வாய்ப்புகள் மற்றும் சவால்களைப் பரிசீலிக்க.

Examine the opportunities and challenges of space-based internet.

- Satellite internet is wireless internet beamed down from satellites (Low Earth Orbit or Geostationary) orbiting the Earth instead of optical fibre or mobile networks. India's Space Policy 2023 permits foreign entities to set-up infrastructure and offer satellite-based services, after obtaining permission from INSpace.

- Growing availability of satellite-based internet services, provided by companies like SpaceX's Starlink, OneWeb, Amazon's Project Kuiper, JioSpaceFiber can provide high-speed internet services in remote and underserved areas, where conventional ground-based internet cannot be set up, E.g., unreachable terrains of Himalayas, aspirational districts etc.

Advantages of space based internet

- **High Bandwidth**: Satellite internet connections can handle high bandwidth usage, so internet speed/ quality should not be affected by lots of users or "peak use times."
- **Viability**: Signals from satellites in space can overcome obstacles faced by fibre-optic cables or wireless networks easily.
- Quick recovery post-disaster.
- We do not need a phone line for satellite internet.

Challenges associated with satellite internet

- **Limited coverage**: Satellite internet is most effective in areas with clear line-of-sight to the satellites which would be challenging in densely populated urban areas or regions with obstructive terrain.

- **Latency**: Higher latency compared to terrestrial internet technologies like fibre optic or cable as signals must travel between Earth and satellites in orbit. This makes it less suitable for real-time applications like online gaming, video conferencing etc.

- **Affordability**: Equipment-cost related to satellite dish passed on to end-users may present barriers in adoption, in comparison to cheaper broadband internet.

- **Logistic Challenge**: There are logistical challenges with launching thousands of satellites into space as well.

- **Difficulty in Space Observation:** Satellites can sometimes be seen in the night skies which creates difficulties for astronomers as the satellites reflect sunlight to earth, leaving streaks across images.
- **Interruptions**: Satellites travelling at a lower orbit can interrupt frequency of those orbiting above them.
- **Space Junk**: There are already almost one million objects larger than 1cm in diameter in orbit, a by-product of decades of space activities. Those objects, colloquially referred to as 'space junk,' have potential to damage spacecraft or collide with other satellites. Launch of thousands of satellites for internet constellations has further raised concerns about increasing space debris.
- **Cyber security**: Satellites are prone to jamming and cyber-attacks which can disrupt internet communication.
- **Regulation Issues**: During days of Sputnik and Apollo missions, governments dominated & regulated spacebased activities. Most LEO based internet initiatives are being developed by private companies. regulation of these companies, especially given the large number of nations that contribute to individual projects. It makes the regulatory framework complicated.
- **Telecom and Internet regulations**: Currently, TRAI regulates telecom and internet companies in
- It is not clear how access to space-based internet will be regulated in India. Current regulations need to be updated.

18. பின்வருவனவற்றை விளக்குக:

Explain the following:

a. **LI-FI**

எல்.ஐ-ஃபை

b. **GENETIC ENGINEERING APPRAISAL COMMITTEE**

மரபணு பொறியியல் மதிப்பீட்டு குழு.

a. **LI-FI:**

- Li-Fi, or light fidelity, is a Visible Light Communications (VLC) system.
- Unlike Wi-Fi, which uses radio waves, Li-Fi runs on visible light.
- It transmits data at terabits per second speeds — more than 100 times the speed of Wi-Fi.

- Transmitting power wirelessly, wherein smartphones will not only receive data through Li-Fi, but will also receive power to charge itself.
- It accommodates a photo-detector to receive light signals and a signal processing element to convert the data into 'stream-able' content.

Advantages of LI-FI:

- Li-Fi could make a huge impact on the internet of things, with data transferred at much higher levels with even more devices able to connect to one another.
- Due to its shorter range, Li-Fi is more secure than Wi-Fi
- Li-Fi systems consume less power.

Disadvantages of LI-FI

- Main challenge is to create a Li-Fi ecosystem, which will need conversion of existing smartphones into Li-Fi enabled ones by the use of a converter/adapter.
- Visual light can't pass through opaque objects and needs line of sight for communication.
- Interference from external light sources, such as sunlight and bulbs.

Applications Of LI-FI

- They can be used in aircraft, where most of control communication is performed through radio waves.
- Li-Fi can easily work underwater, where Wi-Fi fails completely, thereby throwing open endless opportunities for military & navigational operations.
- Vehicles having LED-based headlights and tail lamps can communicate with each other and prevent accidents by exchanging information.

b. GENETIC ENGINEERING APPRAISAL COMMITTEE

- It is the statutory committee constituted under the "Rules for the Manufacture, Use/Import/Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells (Rules, 1989)" framed under Environment (Protection) Act, 1986.
- It functions under the Ministry of Environment, Forest, and Climate Change (MoEF&CC).
- Functions:

- It is responsible for the approval of activities involving large-scale use of hazardous living microorganisms and recombinants in research and industrial production from an environmental perspective.
- The committee is also responsible for the appraisal of proposals relating to the release of genetically engineered (GE) organisms and products into the environment, including experimental field trials.
- Clearance of GEAC is mandatory for the environmental release of GM crops.
- The committee or any person authorized by it has the power to take punitive action under the Environment Protection Act.
- Composition:
- GEAC is chaired by the Special Secretary/Additional Secretary of MoEF&CC and co-chaired by a representative from the Department of Biotechnology (DBT).
- Presently, it has 24 members and meets every month to review the applications in the areas indicated above.
- The members comprise experts from other ministries as well as institutions such as the ICAR, ICMR, CCMB, and so on.

19.தேசிய நிலைப்படம் கொள்கை 2022-ஐ விளக்குக.

Explain the National Geospatial Policy 2022.

- Geospatial Data (also known as "spatial data") is used to describe data that represents features or objects on the Earth's surface. Whether it is man-made or natural, if it has to do with a specific location on the globe, then it is geospatial.
- There are many ways geospatial data can be used and represented. Most commonly, it is used within a GIS (Geographic Information System) to understand spatial relationships and to create maps describing these relationships. A GIS can also help you regulate, customise, and analyse geospatial data.

National Geospatial Policy 2022:

- The Government of India has notified the National Geospatial Policy in 2022.
- Geospatial technology uses tools like GIS (Geographic Information System), GPS (Global Positioning System), and remote sensing for

geographic mapping and analysis. These technologies record spatial data indexed to objects' geographical location on earth (geotag)

Key highlights of the policy:

- **Aim:** Investing in high-resolution topographical surveys, building Geospatial Knowledge Infrastructure, establishing a high-accuracy Digital Elevation Model (DEM) by 2030, and continuously improving geospatial data quality and standards.

- The Survey of India's (SOI) topographic data and other Geospatial Data produced using public funds would be treated as common good to liberalise the field of geospatial data.

- Private agencies are allowed to create high-resolution maps. However, SOI remains the arbiter of maps that deal with State borders and national boundaries and continues to maintain CORS (Continuously Operating Reference Stations) that are necessary to create accurate digital maps.

- A Geospatial Data Promotion and Development Committee will be constituted at the national level which shall be the apex body for formulating and implementing appropriate guidelines, strategies and programs for promotion of activities related to the Geospatial sector.

- The Department of Science and Technology shall be the Nodal Department of the Government for Policy.

Mapping data useful for private companies

- Geospatial data is foundational and will play a vital role in every manner of planning, governance, services, infrastructure, and applications.

- This mapping data will be helpful for private companies who are seeking maps and data that suit their specific purposes. E.g., local delivery of products and services requires highly specific details of a locality within a town. This, in turn, could lay groundwork for future smart city projects.

- Advantage of privatisation of geospatial data in India: This data will help drive efficiencies in the agriculture sector. While facilitating the rise of new-age industries, increased participation of the private sector will increase the growth of new technologies, platforms, and

applications of geospatial data which will directly contribute to the country's progress.

20. பக் மினிஸ்டர் ஃபுலெரீன் மற்றும் கிராஃபீன் பற்றிய முக்கியத்துவத்தை விவாதிக்க.

Discuss the importance of Buckminsterfullerene & Graphene.

- **Buckminsterfullerene (C_{60})** is a spherical carbon allotrope where 60 atoms are assembled in pentagons and hexagons, in a geometry similar to a **soccer ball**.
- All the carbon atoms are connected by single and double bonds, these are often called **BuckyBalls**.
- Their cage structure and poly aromaticity cause the formation of a displaced electron cloud that allows these molecules to act as charge-transfer complexes.

Properties of Buckminsterfullerene

- Buckminsterfullerene is stable at high temperatures and high pressures.
- Fullerenes are covalent; hence they are soluble in organic solvents but insoluble in water.
- Solutions of pure C_{60} have a deep purple color which leaves a brown residue on evaporation.

Chemical Properties of Buckminsterfullerene

- Buckminsterfullerene can easily be reduced electrochemically to form fulleride ion, It reacts with group-1 metals forming solid K_3C_{60}, which acts as a superconductor below 18K.
- **Hydrogenation:** C_{60} addition with hydrogen to give polyhydrofullerenes. Buckminsterfullerene exhibits a small degree of aromatic character so it also undergoes Birch reduction.
- **Halogenation:** Halogens undergo addition reaction with C_{60} produces the following compounds such as $C_{60}Br_8$ and $C_{60}Br_{24}$.

Application of Buckminsterfullerene

- Fullerene in its pure state acts as insulators but can be converted to semiconductors and superconductors under suitable conditions.
- Buckminsterfullerene's ability to trap different atoms or molecules makes them useful in the medical field. For example, radioactive $C_{60}O$ can be used in **cancer** as well as **AIDS** therapy.

- Fullerenes help in improving antiwear and anti-friction properties of lubricating oils.
- It can catalyse photochemical refining in industry.
- It has a high electron affinity; hence it is used as common electron acceptor in donor/acceptor based solar cells.
- Buckminsterfullerene may be used to store hydrogen, possibly as a fuel tank for fuel cell powered cars.
- Graphene is a single layer (monolayer) of pure carbon, tightly bound in a hexagonal honeycomb lattice. It is an allotrope of carbon.
- It is extracted from graphite. Graphite is arranged in a 3D crystalline manner, whereas, graphene is a 2D crystal, only an atom thick.
- Graphene is the thinnest (one atom thick) compound known.
- It is the lightest material known and the strongest compound discovered (between 100-300 times stronger than steel, and harder than diamond).
- It is an excellent conductor of electricity and has high thermal conductivity.
- It is flexible, transparent, and has a large surface area.
- Applications
- Electronics industry: It is used in applications ranging from miniaturised electronics to biomedical devices due to its thin composition and high conductivity.
- Biomedical industry: It can be used for targeted drug delivery, 'smart' implants, etc.
- Automobile industry: Graphene is highly inert and so can act as a corrosion barrier between oxygen and water diffusion.
- Potential alternative to lithium-ion batteries: It can be used to develop smaller, slimmer batteries with higher capacity, faster charging, and increased longevity than traditional batteries.

21. மரபணு மாற்றம் செய்யப்பட்ட பயிர்களால் ஏற்படும் பொருளாதார மற்றும் சமூக தாக்கத்தை மதிப்பீடு செய்க.

Evaluate the economic and social impact of Genetically modified crops.

- Genetically modified crops, also known as **genetically engineered crops**, are plants whose genetic material has been intentionally altered using specific DNA sequences.

- These modifications aim to enhance desirable traits, such as resistance to **pests, tolerance to environmental stresses** (like drought or extreme temperatures), and improved yield.
- **Modification Techniques:** Scientists use techniques like **Agrobacterium-mediated transformation and particle bombardment** to introduce specific genes into crop plants. These genes may come from the same species or even other organisms.

GM Crops in India

- Indian farmers began cultivating **Bt cotton**, a pest-resistant GM cotton variety, in 2002-03. Bt modification involves introducing a gene from the soil bacterium **Bacillus Thuringiensis** into the cotton plant.
- Recently, the GEAC approved the commercial cultivation of **genetically modified mustard varieties.**

Regulatory Framework in India

- India has a well-established regulatory framework for GM crops. **GEAC, under the Ministry of Environment, Forest and Climate Change**, assesses proposals related to the release of GM organisms into the environment.
- The evaluation includes health, environment, food, and feed safety assessments. Various committees review data generated during the development process of GM crops.
- Guidelines issued by the **Department of Biotechnology and the Ministry of Environment** ensure safety and proper monitoring.

Impact

- Various claims around stress tolerance, nutrition and yields have turned out to be false, including in India with its Bt cotton experience.
- Cotton yield has stagnated around 460 kgs per hectare in the recent past, despite most cotton being GM. The most impressive yield growth was achieved between 2000 and 2006 (from 278 kg to 521 kg/ha) when GM cotton adoption was marginal. There has been no such yield increase thereafter.

Increased use of chemicals

- On the other hand, increased illegal use of glyphosate is bringing its own problems.

- Though GM Cotton was supposed to be more resistant to pests, chemical usage (including pesticides) in India's cotton cultivation has actually increased.
- This season, cotton farmers in North India have been protesting over pink bollworm infestation. Before that there was a white fly attack. It is noteworthy that 24 countries that are ahead of India in terms of cotton yields do not grow GM cotton.
- Corporate control over farming is facilitated by GM technology (with accompanying Intellectual Property Rights), giving them control over the food supply.
- From an economic standpoint, this poses a risk to the long-term food security by creating dependence on a single or limited number of suppliers. If the supplier company failed, then the crop it provides would not be available to the people who depend on that crop.
- GM crops are modified to include antibiotics to kill germs and pests. And when they are consumed, these antibiotic markers will persist in the body rendering the actual antibiotic medications less effective over a period of time, leading to superbug threats. This means illnesses will become more difficult to cure.
- Increased Food Production: GM crops can be engineered to be more resistant to pests, diseases, and harsh environmental conditions, leading to higher yields and potentially addressing food shortages in developing countries.
- Reduced Pesticide Use: Some GM crops are designed to produce their own natural insecticides, reducing the need for chemical pesticides and potentially benefiting the environment and farm workers' health.
- Improved Nutritional Value: GM crops can be modified to have higher levels of essential vitamins and minerals, addressing malnutrition issues in certain regions.
- Economic Benefits for Farmers: Increased yields and reduced costs associated with GM crops can lead to higher profits for farmers, particularly small-scale farmers in developing countries.

22.ஹைட்ரஜன் சேர்க்கப்பட்ட இயற்கை எரிவாயு மற்றும் அதன் நன்மைகள் மற்றும் தீமைகள் குறித்து எழுதுக.

Write about hydrogen-combined natural gas and its advantages and disadvantages.

- H-CNG is a blend of hydrogen and CNG, (i.e.: hydrogen+ CNG), the ideal hydrogen concentration being between (18-20) %.
- CNG is compressed natural gas. It is composed mainly of methane and emits much less air pollutants than petrol or diesel.
- The emissions of carbon dioxide, carbon monoxide, nitrogen oxides and particulate matter are much less thus resulting in less air pollution.

Advantages of using H-CNG

- Use of HCNG reduces emissions of CO up to 70% as compared to CNG.
- First step towards future Hydrogen economy.
- A hydrogen economy would help us in achieving sustainable development goals and will also reduce India's carbon footprint.
- H-CNG will give more hydrogen efficiency as compared to CNG.
- CNG Engines can be easily altered to make it H-CNG friendly releasing lower amounts of NO, CO.
- Ideal fuel for high load applications and heavy-duty vehicles.
- Better performance due to higher Octane rating of H2.

Disadvantages of using H-CNG

- Determining most optimised H2/NG (Natural Gas) ratio. Even though it is made to be between 18-20%, the optimised levels are yet to be finalised.
- Requires new infrastructures for preparing HCNG. It will require hydrogen reservoirs which is very expensive.
- Many steps need to be taken for commercialising it at a large scale.
- Current cost of Hydrogen is more than the cost of Natural Gas.
- The new electrolysis methods that are being implemented to split water to hydrogen and oxygen will require more infrastructure and will also require reservoirs.
- So, HCNG's cost is more than CNG.

23.5G நெட்வொர்க் என்றால் என்ன? 5G தொழில்நுட்பத்தின் பயன்பாடுகள் மற்றும் நன்மைகளை எழுதுக.

What is 5G Network? Write the application and benefits of 5G Technology.

- 5G, the 5th Generation Mobile technology, revolutionised the use of cell phones with its high bandwidth capabilities.
- The network utilises advanced technologies to deliver ultra-fast internet and enhanced multimedia experiences.
- It supports a virtual private network and offers high resolution in cell phones.
- It also provides subscriber supervision tools for fast action.

Different Bands of 5G

- A band refers to a specific range of frequencies in the electromagnetic frequency spectrum assigned to certain applications.
- There are essentially three types of 5G bands supported in India.
- Low-band 5G transmits around the 600 to 700 MHz range, providing blanket coverage but offering slow speeds around 50 Mbps.
- Mid-band 5G transmits around 1.7 GHz to 2.5 GHz, offering a solid balance between coverage and speed (100-900 Mbps).
- High-band 5G operates at 24 GHz or higher, providing the fastest speeds (1 Gbps speeds) over short distances.
- 5G Technology is the next generation cellular technology that will provide faster and more reliable communication with ultra-low latency.
- India has officially launched the 5G services in Oct 2022 and the 5G mobile subscriptions in India have already crossed the 165 million mark in March 2024. In India, 5G is expected to create a cumulative economic impact of $1 trillion by 2035.

Applications

- 5G technologies will enhance infrastructure efficiencies like 'vehicle platooning'. Platooning can double vehicle density in roads promoting efficient and safer use of the limited road infrastructure.
- In manufacturing, 5G will enable use of robotics for precision manufacturing.

- 5G can also enable better logistics to track goods from raw materials to product delivery.
- In agriculture, 5G can enable improvement in the entire value-chain, from precision farming, smart irrigation, improved soil and crop monitoring to livestock management.
- In the energy sector, 'smart grids' and 'smart metering' can be efficiently supported enabling growth of alternate energy technologies.
- In healthcare, 5G can enable more effective tele-medicine delivery, tele-control of surgical robotics and wireless monitoring of vital statistics.
- 5G will be used in key government projects such as smart cities and Digital India.

Advantages of 5G technology:

- It will support high-speed data services that have industrial applications like smart grid, smart metering in the energy sector, robotics and precision manufacturing.
- It will support critical infrastructure like health by way of telemedicine, tele-control of surgical robots, financial transactions by integrating secure blockchain technology.
- It will further integrate systems as per 4th Industrial Revolution's needs like Digital economy, Internet of Things, Artificial Intelligence based systems

Disadvantages

- The huge investment required from the government for research, manpower and capacity development and by private players in making it a profitable venture. This should be seen in the backdrop of the crisis faced by Telecom companies currently in India.
- It will require large scale optical fibre connectivity. Currently, such connectivity is limited to metropolitan cities of India while hinterlands surrounding them remain aloof of even good 4G connectivity.
- With a growing digital economy, the threat of cyber attacks will loom large. India already ranks low on the Global Cyber Security index.

24. உயிரி 3 கொள்கையின் அம்சங்களைப் ஆராய்க. (பொருளாதாரம், சூழல் மற்றும் வேலைவாய்ப்பு சார்ந்த உயிரியல் தொழில்நுட்பம்).

Examine the features of the BioE3 (Biotechnology for Economy, Environment, and Employment) Policy.

High performance biomanufacturing is the ability to produce products from medicine to materials, address farming and food challenges, and promote manufacturing of bio-based products through integration of advanced biotechnological processes.

BioE3 Policy:

To address the national priorities, the BioE3 Policy would broadly focus on the following strategic/thematic sectors:

- high value bio-based chemicals, biopolymers & enzymes;
- smart proteins & functional foods;
- precision biotherapeutics;
- climate resilient agriculture;
- carbon capture & its utilisation;
- marine and space research.
- The policy includes innovation-driven support to R&D and entrepreneurship across thematic sectors.

Significance:

- The policy will accelerate technology development and commercialization by establishing Biomanufacturing & Bio-AI hubs and Biofoundry.
- Along with prioritizing regenerative bioeconomy models of green growth, this policy will facilitate expansion of India's skilled workforce and provide a surge in job creation.
- The Policy will further strengthen Government's initiatives such as 'Net Zero' carbon economy & 'Lifestyle for Environment' and will steer India on the path of accelerated 'Green Growth' by promoting 'Circular Bioeconomy'.
- It will foster an advanced future that is more sustainable, innovative, and responsive to global challenges and lays down the Bio-vision for Viksit Bharat.

25.இந்தியாவில் இயற்கை விவசாயத்தை மேம்படுத்த இந்திய அரசு எடுத்த நடவடிக்கைகள் என்ன?

What are the initiatives taken by the Indian government for promoting organic farming in India?

Organic Farming

- According to FSSAI,'organic farming' is a system of farm design and management to create an ecosystem of agriculture production without the use of synthetic external inputs such as chemical fertilisers, pesticides and synthetic hormones or genetically modified organisms.

- Organic farm produce means the produce obtained from organic agriculture, while organic food means food products that have been produced in accordance with specified standards for organic production.

Organic Farming in India:

- Below mentioned are the Initiatives to Promote Organic Farming by the Government

- Mission Organic Value Chain Development for North East Region (MOVCD)

- MOVCD or Mission Organic Value Chain Development for North East Region, is a central sector scheme, and it is a sub-mission under the NMSA (National Mission for Sustainable Agriculture)

- Ministry of Agriculture and Farmers Welfare launched the MOVCED in 2015 for implementation in the states of Assam, Meghalaya, Arunachal Pradesh, Mizoram, Manipur, Sikkim, Nagaland, and Tripura.

- The aim of this scheme was to enhance certified organic production in a value chain model, which will establish a link between the growers and consumers to promote Organic Farming.

Paramparagat Krishi Vikas Yojana (PKVY):

- PKVY was launched in 2015, and it was an elaborated component of the SHM or Soil Health Management of the major project NMSA (National Mission of Sustainable Agriculture).

- The aim of PKCY is to promote the adoption of Organic Farming in villages by cluster approach and the PSG (Participatory Guarantee System) certification.

- Agri-export Policy 2018– Organic Farming in India has been positively impacted by focusing on the cluster and marking and promotion of "Produce of India"
- **Zero Budget Natural Farming**– this method of chemical-free agriculture draws from traditional practices to Indian practices.

PM Formalization of Micro Food Processing Enterprises (PM FME):

- This scheme was launched by the Ministry of Food Processing and Industries (MoFPI) as a part of the 'Atmanirbhar Bharat Abhiyan.
- The aim of PM FME is to bring new technology and affordable credit that would help small entrepreneurs to penetrate new markets of Organic Farming.

One District- One Product (ODOP):

- The aim of ODOP is to encourage more visibility and sale of the indigenous and specialized crafts/products of Uttar Pradesh, which would lead to employment opportunities at the district level, and boost Organic Farming.
- To bring economies of scale for small and marginal farmers, the presence of aggregators is imperative.

Certification Schemes:

- FSSAI- Food Safety and Standards Authority of India is a food regulator in the country. FSSAI is responsible for regulating organic food in the market and imports.
- Participatory Guarantee System (PGS)) is a process of certifying organic products. PGS ensures the production of organic products takes place according to the laid-down quality standards.
- NPOP or National Program for Organic Production, grants Organic Farming certification through a process of 3rd party certification for export.
- The Soil Health Card Scheme has resulted in a decline of 8-10% in the use of chemical fertilizers and also enhanced productivity by 5.6%.
- Latest on Organic Farming in India
- India ranks 1st in the number of organic farmers and 9th in terms of area under Organic Farming.
- In 2016 Sikkim became India's first fully organic state.

- The major organic exports from India are sesame, flax seeds, medicinal plants, tea, soybean, rice, and pulses
- North East India is already promoting Organic Farming in India, and here the use of chemicals is far less compared to the rest of the country. The tribal and island territories are also practicing Organic Farming.
- The demand for organic foods is increasing, and due to this, the exports from Mizoram, Assam, Manipur, and Nagaland, to USA, UK, Eswatini, and Italy have increased volumes.
  - Sustainable agriculture method
  - The rise in Agriculture productivity
  - Employment generation
  - Healthy organic food
  - Favor eco-tourism in some areas

Challenges to Organic Farming in India:

Following are the challenges faced when it comes to Organic Farming in India.

Lack of awareness:

- Inadequate infrastructure and marketing problems
- High input cost
- Shortage of Biomass

26.3D அச்சிடலின் பல்வேறு பயன்பாடுகளை விவாதிக்க.

Discuss the various applications of 3D printing.

- 3D printing is a process that **uses computer-created design** to make three-dimensional objects **layer by layer.**
- It is an additive process, in which layers of a material like **plastic, composites or bio-materials** are built up to construct objects that range in shape, size, rigidity, and colour.
- **Common 3D Printing materials include** Acrylonitrile Butadiene Styrene (ABS), Carbon Fiber Filaments, Conductive Filaments, Metal Filaments etc.

Various applications of 3D printing

- **Aerospace:** Lightweight printed aircraft and spacecraft parts can replace traditionally manufactured parts to reduce weight and material needs.

- **HAL** and **Wipro 3D** printed an air blower component for the **TEJAS aircraft** using **direct metal laser sintering (DMLS).** It achieved a 50% weight reduction compared to conventional manufacturing.
- **GE's first 3D-printed jet engine fuel nozzle** component manufactured in India improved durability and thermal efficiency.
- **Automotive:** The automotive industry uses 3D printing for rapid prototyping and to produce specialised parts and tools. Printed parts help improve design and can reduce weight.
- Mahindra produces around **200 3D-printed polymer parts** annually for vehicle prototypes. This has accelerated design verification and development.
- Tata Motors uses **selective laser sintering** to batch-produce plastic and rubber spare parts. It has reduced costs by 80-90% compared to conventional techniques.
- **Construction:** 3D printing technology is being used to construct scale models of buildings, bridges, and even full-scale houses and other structures using concrete and other materials.
- India's first **3D-printed house** was built in just 2 weeks by **Tvasta** using the concrete extrusion technique. It enables faster, sustainable construction.
- 'Amaze 28', Kerala's first 3D printed building, was constructed in just 28 days at 75% reduced labour cost.
- **Healthcare:** 3D printing is revolutionising healthcare with customised prosthetics, implants, anatomical models for surgery practice, and pharmaceuticals.
- **3D printed skull implant** by medtech startup **Yaantra** enabled surgeons to accurately visualise tumour shape and remove guesswork during surgery.
- **Ossio's 3D-printed orthopaedic implants** made from proprietary Ossioglass match natural bone strength and hardness.
- **Consumer:** With 3D printing, products can be easily customised or personalised to an individual's specs.
- **Imaginarium Rapid** offers 3D printing services to leading jewellery retailers for custom designs in gold and silver.

- Companies like **Dochub** and **Carbon Heel** adopt 3D printing for customized and flexible footwear designs.
- **Public Infrastructure: India's first 3D printed post office** built in just 45 days by L&T and IIT Madras demonstrates rapid construction capabilities.
- **Biomimicry and 3D Printing:** Biomimicry is the material design by taking analogies from the functional aspects of similar structures of living things. Examples include **spider-web-inspired lightweight structures, lotus leaf self-cleaning surfaces**, etc.
- By imitating nature's time-tested patterns, biomimicry can help 3D printing produce **optimised shapes, stronger structures, customised surfaces** and more using less material.
- Integrating biomimicry principles into 3D printing offers exciting possibilities for **sustainable manufacturing**.