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POLITY

Reassessing NOTA in India's Electoral Democracy

📌 **Syllabus Mapping:**
✅ **GS Paper II – Polity and Governance**

- **Election reforms and electoral processes**
- **Role of the Election Commission of India (ECI)**
- **Issues related to representation and democratic participation**

Introduction

The **Supreme Court of India** has recently questioned the **effectiveness of the NOTA (None of the Above) option** in elections, noting that **more than a decade after its introduction, it has had minimal influence on the quality of candidates fielded by political parties**. Introduced to strengthen **voter choice and democratic expression**, NOTA allows citizens to **reject all contesting candidates while still participating in the electoral process**. However, debates continue regarding whether the provision has achieved its intended objective of improving electoral accountability.

Understanding NOTA (None of the Above)

NOTA is an electoral option that enables voters to **express dissatisfaction with all candidates contesting in an election**.

Key Feature

- Voters participate in the election but **choose not to support any candidate**.

Objective

- Provide **greater electoral choice**
- Strengthen **democratic participation**
- Encourage political parties to **field better candidates**

Legal Origin of NOTA in India

The introduction of NOTA was mandated by the **Supreme Court judgment in the case of**:

People's Union for Civil Liberties (PUCL) vs Union of India (2013).

Supreme Court Directive

- Directed the **Election Commission of India (ECI)** to include **NOTA as an option on Electronic Voting Machines (EVMs)**.

Rationale

The Court argued that **freedom of expression under Article 19(1)(a)** includes the **right to reject candidates**.

First Implementation

NOTA was first used in the **2013 Legislative Assembly Elections** in:

- **Chhattisgarh**
- **Mizoram**
- **Rajasthan**
- **Madhya Pradesh**
- **Delhi**

Since then, it has been used in **all parliamentary and assembly elections**.

Significance of NOTA in Democratic Governance

NOTA serves several important functions in a democratic system.

1. Strengthening Voter Expression

NOTA allows voters to **register protest votes without abstaining from elections**.

Impact

- Encourages **active participation in elections**
- Reduces **political apathy**

2. Enhancing Electoral Transparency

The availability of NOTA reveals **public dissatisfaction with available candidates**.

Benefit: Political parties can assess **voter dissatisfaction and dissatisfaction trends**.

3. Strengthening Democratic Values

Political theorists like **Joseph Schumpeter** emphasize that democracy requires **meaningful voter choice**. NOTA attempts to broaden this choice.

Challenges and Limitations of NOTA

Despite its symbolic significance, NOTA faces several structural limitations.

1. No Impact on Election Results

Currently, even if **NOTA receives the highest number of votes**, the candidate with the **next highest votes is declared the winner**.

Implication

- NOTA functions only as a **symbolic protest**
- It does not influence **electoral outcomes**

2. Uncontested Elections

In cases where a candidate **wins unopposed**, voters cannot exercise the **NOTA option**.

Issue: This restricts the **right to reject candidates in uncontested constituencies**.

3. Limited Effect on Candidate Selection

The Supreme Court has observed that NOTA has **not significantly influenced political parties' candidate selection**.

Reason: Political parties often prioritize **electability, caste dynamics, and political calculations** over ethical considerations.

4. Ineffectiveness in Reducing Criminalization of Politics

India continues to face the issue of **candidates with criminal backgrounds contesting elections**.

According to **Association for Democratic Reforms (ADR) reports**, a significant proportion of elected representatives face **criminal charges**.

NOTA has **not effectively discouraged such candidates**.

Possible Electoral Reforms for Strengthening NOTA

Several reform proposals have been discussed to make NOTA more effective.

1. The 50% + 1 Rule

Under this proposal:

- If **NOTA receives more than 50% of valid votes**, the election would be **cancelled**.
- **Fresh elections** would be conducted.

Additional Provision

Candidates who contested earlier would be **barred from contesting again**.

International Example

A similar mechanism exists in **Colombia**, where voters can reject all candidates.

2. State-Level Innovations

Some **State Election Commissions** have experimented with stronger NOTA provisions.

Examples

Maharashtra and Haryana

- NOTA is treated as a **fictional candidate**.
- If NOTA secures a **majority**, re-elections may be ordered.

Significance

These experiments demonstrate **possible models for electoral reform**.

3. Electoral Reforms for Candidate Quality

NOTA reforms should be complemented with broader reforms such as:

- **Decriminalization of politics**
- Greater **transparency in candidate selection**
- Stronger **campaign finance regulation**

Broader Debate: Symbolic vs Effective Democracy

The debate on NOTA reflects a larger question in democratic theory.

Perspective	Argument
Symbolic value	Provides voters a voice of protest
Substantive value	Needs legal consequences to influence elections

Political thinker **Robert Dahl** emphasized that effective democracy requires **meaningful electoral competition and citizen participation**. NOTA can contribute to this only if its **institutional design is strengthened**.

Conclusion

The **NOTA option represents an important democratic innovation** aimed at empowering voters with the ability to reject unsuitable candidates. However, the **absence of legal consequences for NOTA votes limits its effectiveness in influencing political parties or improving candidate quality**. Strengthening the mechanism through reforms such as the **majority-NOTA rule, improved electoral transparency, and broader political reforms** could enhance its role in deepening **India's electoral democracy**.

Keywords: *Electoral Reform, Voter Choice, Democratic Accountability, Criminalization of Politics, Electoral Transparency.*

Mains Practice Question

The NOTA option was introduced to strengthen voter choice and democratic participation in India. Critically examine its effectiveness and suggest reforms to enhance its role in electoral democracy.

Artificial Intelligence and the Transformation of India's Legal Ecosystem

📌 **Syllabus Mapping:**
✅ **GS Paper II – Polity and Governance**

- **Judicial reforms and access to justice**
- **E-governance and technology in public service delivery**

✅ **GS Paper III – Science and Technology**

- **Artificial Intelligence and emerging technologies**

- **Technology-driven governance and innovation**

Introduction

At the **India AI Impact Summit 2026**, the growing role of **Artificial Intelligence (AI) in India's judicial system** was highlighted as a key driver of institutional modernization. AI tools are increasingly being deployed to enhance **court efficiency, legal research, language accessibility, and judicial decision support**. These technological innovations aim to address structural issues such as **case backlogs, procedural delays, and limited access to legal information**, thereby strengthening the delivery of justice in India.

Role of Artificial Intelligence in the Judiciary

AI technologies are being integrated into various stages of the **judicial process**, from documentation to decision support.

1. Improving Courtroom Efficiency

AI tools assist courts in **streamlining administrative and procedural functions**.

Applications

- **Voice-to-text transcription**
- **Automated scheduling of hearings**
- **Case prioritization systems**

Example

ASR-SHRUTI

- A voice-to-text dictation system used for **recording judicial orders and judgments**.

Impact

- Reduces **manual documentation workload**
- Accelerates **judgment writing and documentation processes**
- Helps address **judicial backlog**

2. Legal Research and Documentation

AI systems can analyze large databases of **legal precedents and statutes**.

Functions

- Identify relevant **legal provisions**
- Analyze **past judgments**
- Generate **summaries of complex rulings**

Key Platforms

SUPACE (Supreme Court Portal for Assistance in Court Efficiency)

- AI-based tool assisting judges in **legal research and case preparation**.

Saransh

- AI-powered platform that **summarizes court judgments**.

Significance

- Improves **legal research efficiency**
- Enables faster **case preparation**

3. Enhancing Language Accessibility

India's judicial system has traditionally faced a **language barrier**, as many legal proceedings occur primarily in English.

AI-Based Solutions

AI-driven translation tools enable legal information to be available in **multiple Indian languages**.

Example

SUVAS (Supreme Court Vidhik Anuvaad Software)

- Provides **AI-based translation of judicial documents into regional languages**.

Impact

- Expands **access to justice**
- Enables **citizens to understand court proceedings in their native languages**

4. Predictive Analytics in Judicial Processes

AI can analyze historical legal data to **predict potential case outcomes**.

Applications

- Estimating **probable case outcomes**
- Encouraging **alternative dispute resolution**
- Supporting **out-of-court settlements**

Benefit

- Reduces **burden on courts**
- Encourages **efficient dispute resolution**

Challenges in the Use of AI in the Judiciary

Despite its advantages, the integration of AI in legal systems raises several ethical and institutional concerns.

1. Algorithmic Bias

AI systems are often trained on **historical datasets**, which may contain embedded social biases.

Risk

Bias related to:

- **Caste**
- **Gender**
- **Community**

Constitutional Concerns

Such biases could potentially violate:

- **Article 14 – Right to Equality**
- **Article 21 – Right to Fair Procedure**

2. The “Black Box” Problem

Many AI algorithms operate as **opaque systems**, where the internal logic behind decisions is not easily explainable.

Implications

- Lack of **transparency**
- Difficulty in **judicial accountability**

3. Risk of AI Hallucinations

Generative AI systems may produce **incorrect or fictitious information**, sometimes referred to as **“hallucinations.”**

Concern

- AI tools may generate **non-existent legal precedents or judgments**
- Could undermine **judicial credibility**

4. Data Security and Privacy

Judicial systems handle **highly sensitive legal information**.

Risks

- Cybersecurity breaches
- Unauthorized data access
- Misuse of confidential legal records

5. Overdependence on Technology

Excessive reliance on AI may undermine **judicial independence and human judgment**.

Additional Issue

The **digital divide** may prevent many citizens from accessing technology-enabled judicial services.

Initiatives for Technology Integration in the Judiciary

India has undertaken several initiatives to modernize its judicial system using digital technologies.

1. e-Courts Project Phase III

The **e-Courts Project Phase III** is a **Central Sector Scheme** designed to create a **unified digital platform for the judiciary**.

Key Objectives

- Integrate **AI and emerging technologies**
- Digitize court records
- Improve **case management systems**

2. Supreme Court AI Committee

The **Supreme Court AI Committee**, chaired by a sitting **Supreme Court judge**, oversees the **structured adoption and ethical governance of AI technologies in the judiciary**.

Role

- Ensure **responsible use of AI tools**
- Develop **ethical guidelines for AI deployment**

3. Electronic Supreme Court Reports (eSCR)

The **eSCR portal** provides:

- Free access to **Supreme Court judgments**
- Digital platform to **search and download legal decisions**

Importance

- Enhances **transparency**
- Improves **public access to legal information**

Advantages of AI in the Judicial System

Dimension	Impact
Efficiency	Faster case processing
Accessibility	Multilingual legal services
Transparency	Improved access to judgments
Judicial Productivity	Reduced administrative workload

Way Forward

1. Ethical AI Framework

Develop clear guidelines ensuring **fairness, transparency, and accountability in AI systems**.

2. Human Oversight

Ensure that AI remains a **decision-support tool rather than a replacement for judicial reasoning**.

3. Strengthening Data Security

Adopt robust **cybersecurity frameworks to protect sensitive judicial data**.

4. Bridging the Digital Divide

Expand digital infrastructure and legal literacy programs to ensure **equitable access to AI-enabled legal services**.

Conclusion

Artificial Intelligence has the potential to **transform India's legal ecosystem by improving efficiency, expanding access to justice, and enhancing transparency in judicial processes**. Initiatives such as **ASR-SHRUTI, SUPACE, SUVAS, and the e-Courts Project** demonstrate India's efforts to integrate advanced technologies into the justice system. However, ensuring **ethical AI governance, transparency, and human oversight** will be critical to maintaining **judicial independence and constitutional values**.

Keywords: *AI in Judiciary, Digital Justice, Legal Technology, Judicial Efficiency, Ethical AI Governance.*

Mains Practice Question

Artificial Intelligence is increasingly transforming the functioning of judicial systems worldwide. Examine the role of AI in India's legal ecosystem and discuss the challenges associated with its adoption.

Supreme Court on Fraternity and Freedom of Expression: Constitutional Balance

📌 **Syllabus Mapping:**
✅ **GS Paper II – Polity and Governance**

- **Fundamental Rights and Duties**
- **Judicial interpretation of constitutional values**
- **Role of the Supreme Court in protecting constitutional morality**

Introduction

In **Atul Mishra v. Union of India (2026)**, the **Supreme Court of India** examined a writ petition challenging the title of a proposed film on the grounds that it allegedly **stereotyped a particular community**. The Court used this opportunity to reaffirm the **constitutional balance between fraternity and freedom of expression**. It emphasized that while **creative and artistic freedom is protected under Article 19(1)(a)**, expressions that **vilify or demean communities on the basis of caste, religion, language, or region** undermine the constitutional value of **fraternity**, which is essential for sustaining democratic harmony.

Background of the Case

The case arose when a petition was filed before the Supreme Court objecting to the **title of a proposed film**.

Key Concern Raised

- The film title allegedly **stereotyped and demeaned a specific community**.

Constitutional Question

The Court had to balance two constitutional principles:

- **Freedom of speech and artistic expression**
- **Protection of community dignity and social harmony**

Supreme Court's Key Observations

The Court emphasized that **constitutional values must coexist in harmony**, particularly **liberty, equality, and fraternity**.

1. Fraternity as a Constitutional Value

The Court reaffirmed the importance of **fraternity** in sustaining India's democratic framework.

Meaning of Fraternity

Fraternity refers to a sense of **brotherhood, solidarity, and mutual respect among citizens**.

Court's Observation

Expressions that **demean or vilify communities based on identity markers such as caste, religion, language, or region** are constitutionally unacceptable because they weaken the spirit of fraternity.

Ambedkar's Concept of the "Trinity of Democracy"

During the **Constituent Assembly debates**, **Dr. B. R. Ambedkar** emphasized the inseparable nature of **liberty, equality, and fraternity**.

Ambedkar's View

He described them as a **"union of trinity"**, stating that:

If one of these principles is separated from the others, the foundations of democracy weaken.

Interpretation

- **Liberty** ensures individual freedoms.
- **Equality** guarantees fairness and justice.
- **Fraternity** ensures social cohesion and harmony.

Thus, **fraternity is essential for maintaining democratic stability**.

2. Protection of Freedom of Artistic Expression

The Supreme Court also strongly recognized the **importance of creative and artistic freedom**.

Constitutional Basis

Article 19(1)(a) guarantees the **fundamental right to freedom of speech and expression**.

Application in Arts and Media

This protection extends to:

- Filmmakers
- Writers
- Artists
- Media creators

Creative expression plays a crucial role in **cultural dialogue and democratic debate**.

3. Reasonable Restrictions on Free Speech

The Court clarified that **freedom of expression is not absolute**.

Constitutional Provision

Under **Article 19(2)**, the State may impose **reasonable restrictions** on free speech.

Grounds for Restrictions

Restrictions may be imposed in the interests of:

- **Sovereignty and integrity of India**
- **Security of the State**
- **Friendly relations with foreign States**
- **Public order**
- **Decency or morality**
- **Contempt of court**
- **Defamation**
- **Incitement to an offence**

Court's Principle

Such restrictions must be based on **necessity and constitutional principles**, not merely on **public pressure or convenience**.

Constitutional Provisions Related to Fraternity

Fraternity occupies an important place in the **Indian constitutional framework**.

1. Preamble

The **Preamble of the Constitution** explicitly promotes:

- **Fraternity assuring the dignity of the individual**
- **Unity and integrity of the nation**

This reflects the founders' vision of **social unity in a diverse society**.

2. Fundamental Duties

Article 51A(e) imposes a **fundamental duty on citizens**.

Duty

To promote:

- **Harmony**
- **Spirit of common brotherhood among all Indians**

This reinforces the constitutional commitment to **social cohesion**.

Balancing Free Speech and Fraternity

The judgment reflects a broader challenge in democratic societies.

Constitutional Balance

Principle	Purpose
Freedom of Expression	Protects individual creativity and democratic debate
Fraternity	Maintains social harmony and dignity

The judiciary must ensure that **both principles coexist without undermining each other**.

Significance of the Judgment

The ruling has broader implications for **constitutional law and democratic discourse**.

1. Strengthening Constitutional Morality

The judgment emphasizes that **constitutional values must guide public discourse**.

2. Protecting Community Dignity

It reinforces the idea that **identity-based vilification is incompatible with democratic values**.

3. Safeguarding Artistic Freedom

At the same time, the Court reaffirmed that **creative expression cannot be suppressed merely due to public sensitivities**.

4. Clarifying Limits of Free Speech

The judgment provides guidance on how **reasonable restrictions under Article 19(2)** should be interpreted.

Broader Constitutional Perspective

Several previous Supreme Court judgments have also emphasized balancing **free speech and social responsibility**.

Example

In **S. Rangarajan v. P. Jagjivan Ram (1989)**, the Court held that **freedom of expression cannot be suppressed unless the situation created by the speech threatens public order**.

This reflects the principle that **democratic societies must tolerate dissent and diverse viewpoints**.

Conclusion

The Supreme Court's ruling in **Atul Mishra v. Union of India (2026)** underscores the need to maintain a **delicate constitutional balance between freedom of expression and the value of fraternity**. While **creative expression remains a cornerstone of democratic liberty**, it cannot justify the **demeaning of communities or erosion of social harmony**. By reaffirming the constitutional vision of **liberty, equality, and fraternity as an inseparable trinity**, the judgment strengthens the foundation of **inclusive and responsible democratic discourse in India**.

Keywords: *Fraternity, Freedom of Expression, Constitutional Morality, Article 19(1)(a), Article 19(2).*

Mains Practice Question

Discuss the constitutional balance between freedom of speech and the value of fraternity in India. How has the judiciary interpreted these principles in protecting democratic discourse?

INTERNATIONAL RELATIONS

India–Brazil Strategic Partnership: Outcomes of the Brazilian President's State Visit (2026)

📌 **Syllabus Mapping:**
✅ **GS Paper II – International Relations**

- India and the World
- Bilateral, regional and global groupings involving India and affecting India's interests
- India's relations with key global partners

Introduction

The **state visit of the President of Brazil to India (February 2026)** marked an important milestone in strengthening **India–Brazil bilateral relations**. The visit concluded with a series of agreements and policy initiatives aimed at expanding cooperation in **trade, digital technology, strategic minerals, renewable energy, and people-to-people connectivity**. Both nations also decided to **raise their bilateral trade target to $30 billion by 2030**, highlighting the growing economic and strategic convergence between two major **Global South powers**.

Key Outcomes of the Visit

1. Expansion of Bilateral Trade Targets

- India and Brazil revised their **bilateral trade goal from $20 billion to $30 billion by 2030**.
- This reflects the steady growth of economic engagement between the two emerging economies.

Trade Trends

Year	Bilateral Trade
2024	Moderate growth
2025	**USD 15.21 billion (25% growth)**
Target 2030	**USD 30 billion**

Significance

- Strengthens **South–South economic cooperation**.
- Diversifies India's trade partnerships beyond traditional Western markets.
- Promotes **agricultural trade, energy cooperation, and mineral supply chains**.

2. Strategic Agreements and Memorandums of Understanding

During the visit, **10 Memorandums of Understanding (MoUs)** were signed across key sectors.

Major Areas Covered

1. Rare Earth and Critical Minerals

- Cooperation in exploration and supply of **critical minerals essential for clean energy technologies, electronics, and defence sectors**.

2. Postal Sector Cooperation

- Enhancing **logistics, postal connectivity, and digital postal services** between the two countries.

3. MSME Entrepreneurship

- Joint initiatives to support **small and medium enterprises**, innovation, and start-up ecosystems.

4. Pharmaceutical Regulations

- Collaboration in **regulatory frameworks for pharmaceutical trade and healthcare products**.

Strategic Importance

- Reduces dependency on **concentrated global supply chains (especially in critical minerals)**.
- Strengthens **industrial and technological cooperation**.

3. Digital Partnership for the Future

India and Brazil adopted a **Joint Declaration and Action Plan for Digital Cooperation**.

Focus Areas

- Digital public infrastructure
- Cybersecurity collaboration
- Artificial Intelligence and emerging technologies
- Data governance and digital innovation ecosystems

Relevance

India's **Digital Public Infrastructure (DPI)** such as:

- **UPI**
- **Aadhaar**
- **Digital governance platforms**

could serve as **models for digital transformation in Global South countries**, including Brazil.

4. Visa Facilitation and People-to-People Contact

To enhance mobility and exchanges:

- Validity of **multiple-entry tourist and business visas** increased from **5 years to 10 years**.
- The change applies **reciprocally** to citizens of both countries.

Expected Impact

- Increased **tourism flows**
- Stronger **business interactions**
- Greater **academic and cultural exchanges**

India–Brazil Relations: Background and Evolution

1. Diplomatic Foundations

- Diplomatic relations established in **1948**.
- Upgraded to a **Strategic Partnership in 2006**.

Brazil is one of India's **key partners in Latin America**.

2. Cooperation in Multilateral Forums

India and Brazil collaborate extensively in **global governance institutions**, including:

Forum	Purpose
BRICS	Economic cooperation among emerging economies
BASIC	Climate negotiations group (Brazil, South Africa, India, China)
G-20	Global economic governance
G-4	Advocacy for UN Security Council reform
IBSA	South–South cooperation platform

They also work together in organizations such as:

- **United Nations**
- **World Trade Organization**
- **UNESCO**
- **World Intellectual Property Organization (WIPO)**

Strategic Significance

Both countries advocate:

- **Multilateralism**
- **Reform of global governance institutions**
- **Greater representation for developing countries**

3. Trade and Economic Cooperation

India engages with Brazil through the **India–MERCOSUR Preferential Trade Agreement**.

Key Trade Items

India exports

- Pharmaceuticals
- Automobiles
- Chemicals
- Textiles

India imports

- Crude oil
- Agricultural commodities (such as soy products)
- Gold and minerals

Brazil is **India's largest trading partner in Latin America**.

4. Renewable Energy Cooperation

Energy transition is a major pillar of India–Brazil cooperation.

Key Initiatives

Global Biofuel Alliance

- Brazil became a **co-founding member** alongside India and other partners.
- Focus on **sustainable biofuels and ethanol-based energy systems**.

International Solar Alliance (ISA)

- Brazil ratified the **ISA agreement in 2022**.
- Collaboration focuses on **solar energy deployment and climate action**.

Strategic Importance

- Supports **global climate commitments**
- Promotes **clean energy technologies**
- Strengthens **energy security**

Broader Strategic Significance of the Visit

Dimension	Implication
Geopolitical	Strengthens Global South cooperation

Economic	Expands trade and investment opportunities
Technological	Boosts digital innovation partnerships
Energy Transition	Enhances renewable and biofuel collaboration
Multilateral Diplomacy	Reinforces joint stance on UN reforms

Challenges in India–Brazil Relations

Despite growing cooperation, certain issues remain:

- **Geographical distance and logistics costs**
- **Limited trade diversification**
- **Regulatory barriers in agricultural and industrial sectors**
- **Underdeveloped connectivity between South America and South Asia**

Addressing these constraints is essential for achieving the **$30 billion trade target by 2030**.

Way Forward

To deepen India–Brazil partnership, the following measures are crucial:

- **Expansion of Trade Agreements**
  - Upgrading the **India–MERCOSUR trade agreement**.
- **Supply Chain Collaboration**
  - Joint development of **critical mineral supply chains**.
- **Technology Partnerships**
  - Collaboration in **AI, digital infrastructure, and space technologies**.
- **Green Energy Cooperation**
  - Scaling up **biofuel and solar energy projects**.
- **Strengthening Global South Platforms**
  - Enhanced cooperation in **BRICS, G-20, and IBSA** to advocate equitable global governance.

Conclusion

The **2026 state visit of Brazil's President to India** has reinforced the **strategic partnership between two major emerging economies**. With enhanced cooperation in **trade, digital technology, critical minerals, and renewable energy**, the partnership reflects a broader effort to strengthen **South–South cooperation and multipolar global governance**. Achieving the **$30 billion trade target by 2030** will require sustained policy engagement, improved connectivity, and deeper economic integration.

Keywords: *Strategic Partnership, Global South Cooperation, Trade Expansion, Digital Partnership, Renewable Energy Diplomacy.*

Mains Practice Question

India–Brazil relations have evolved into a multidimensional strategic partnership in recent years. Examine the key areas of cooperation and assess their significance for India's foreign policy and Global South diplomacy.

India–Israel Relations: Outcomes of the Prime Minister's Visit

📌 **Syllabus Mapping:**
✅ **GS Paper II – International Relations**

- **India and its relations with West Asian countries**
- **Bilateral agreements affecting India's strategic and economic interests**

Introduction

The **recent visit of the Prime Minister of India to Israel** marks an important milestone in strengthening bilateral ties between the two countries. During the visit, both nations agreed to upgrade their relationship to a **"Special Strategic Partnership for Peace, Innovation and Prosperity."** The agreements reached during the visit highlight expanding cooperation in **defence, emerging technologies, agriculture, cybersecurity, and economic collaboration**, reflecting the growing strategic convergence between India and Israel.

Key Outcomes of the Visit

The visit resulted in several initiatives aimed at expanding **strategic, technological, and economic cooperation**.

1. Upgradation to a Special Strategic Partnership

India and Israel decided to elevate their bilateral relationship to a **"Special Strategic Partnership."**

Significance

- Reflects deepening **strategic trust and cooperation**
- Strengthens **long-term institutional collaboration**
- Expands cooperation across **innovation, defence, and economic sectors**

2. Cooperation in Critical and Emerging Technologies (CET)

A new initiative on **Critical and Emerging Technologies (CET)** was launched.

Leadership

The initiative will be led by the **National Security Advisors of both countries**.

Key Areas of Cooperation

- **Artificial Intelligence**
- **Cybersecurity**
- **Semiconductors**
- **Quantum computing**
- **Biotechnology**
- **Space technologies**

Importance

These technologies are essential for **future economic growth and national security**.

3. Artificial Intelligence Collaboration

India and Israel signed a **Memorandum of Understanding (MoU) on Artificial Intelligence**.

Additional Initiative

Horizon Scanning / Strategic Foresight Mechanism

- Identifies **future technological trends and risks**
- Supports **strategic policy planning**

Impact: Enhances **innovation ecosystems and research collaboration**.

4. Labour Mobility Agreement

The two countries agreed to facilitate **labour mobility from India to Israel**.

Key Provision

- Israel will allow **up to 50,000 Indian workers over the next five years**.

Significance

- Expands **employment opportunities for Indian workers**
- Strengthens **people-to-people connections**

5. Cybersecurity Cooperation

Both countries agreed to strengthen **cybersecurity collaboration**.

Key Initiatives

- Development of a **multi-year cybersecurity roadmap**
- Establishment of an **India–Israel Centre of Excellence in Cybersecurity in India**

Importance

Enhances capacity to address **cyber threats and digital security challenges**.

6. Agriculture and Water Technology Partnership

Agriculture and water management remain core areas of cooperation.

Major Initiative

India–Israel Innovation Centre for Agriculture (IINCA)

Additional Measures

- **20 joint fellowships in agricultural research**
- Collaboration in **precision agriculture technologies**

Key Areas

- **Drip irrigation**
- **Desalination technologies**
- **Water management systems**

These technologies are particularly important for **water-scarce regions in India**.

7. Financial and Academic Cooperation

Additional initiatives include:

Financial Connectivity: Exploration of **UPI–Israel digital payment linkage**

Academic Collaboration: Launch of **India–Israel Academic Cooperation Forum**

Parliamentary Diplomacy: Establishment of **India–Israel Parliamentary Friendship Group**

These steps promote **institutional dialogue and knowledge exchange**.

Overview of India–Israel Relations

India and Israel share a growing partnership across **political, economic, defence, and technological domains**.

Diplomatic Relations

- India **recognized Israel in 1950**.
- Full diplomatic relations were established in **1992**.

Since then, ties have steadily expanded.

Economic Cooperation

Israel is one of India's important trading partners in West Asia.

Bilateral Trade

- **US$ 3.75 billion (FY 2024–25)**

Key Trade Sectors

Sector	Importance
Diamonds	Major component of bilateral trade
Chemicals	Industrial inputs
Technology products	Growing collaboration

Israel is also **India's second-largest trading partner in Asia in merchandise trade**.

Defence Cooperation

Defence cooperation forms a central pillar of the relationship.

Key Aspects

- Israel is among **India's largest defence suppliers**.
- Collaboration includes **defence technologies, surveillance systems, and missile systems**.

This partnership enhances **India's defence capabilities and strategic autonomy**.

Technological and Innovation Cooperation

India and Israel have strong collaboration in **innovation and research**.

Major Initiative

India–Israel Industrial R&D and Innovation Fund (I4F)

Purpose

- Promote **joint research and technological innovation**
- Support **startups and technology development**

Regional Connectivity and Multilateral Cooperation

India and Israel also cooperate through regional initiatives.

Important Platforms

I2U2 Group

- Includes **India, Israel, United States, and United Arab Emirates**
- Focuses on **economic and technological cooperation**

India–Middle East–Europe Economic Corridor (IMEC)

- A major initiative aimed at strengthening **trade connectivity between India, the Middle East, and Europe**.

Strategic Significance of India–Israel Relations

Dimension	Significance
Defence Security	Access to advanced defence technology
Technology & Innovation	Collaboration in emerging technologies
Agriculture	Improved irrigation and water management
Economic Cooperation	Trade diversification
Geopolitical Strategy	Strengthening partnerships in West Asia

Challenges in the Partnership

Despite strong relations, certain challenges remain.

1. Regional Geopolitical Sensitivities

India must balance relations with **Israel and Arab countries**.

2. Political Instability in West Asia

Regional conflicts may influence diplomatic dynamics.

3. Trade Imbalances

Expanding trade diversification remains necessary.

Way Forward

1. Expanding Technology Partnerships: Strengthen collaboration in **AI, semiconductors, and space technology**.

2. Enhancing Trade and Investment: Promote **innovation-driven economic partnerships**.

3. Deepening Agricultural Cooperation: Use Israeli expertise in **precision agriculture and water management**.

4. Strengthening Strategic Dialogue: Maintain regular **high-level diplomatic and security consultations**.

Conclusion

The **Prime Minister's visit to Israel** marks a significant step in elevating the bilateral relationship to a **Special Strategic Partnership**. With expanding cooperation in **defence, emerging technologies, cybersecurity, agriculture, and economic connectivity**, India and Israel are strengthening a partnership based on **innovation, security cooperation, and shared strategic interests**. This evolving relationship plays an important role in **India's West Asia policy and broader global engagement strategy**.

Keywords: *Strategic Partnership, Critical and Emerging Technologies, Defence Cooperation, Innovation Diplomacy, West Asia Policy.*

Mains Practice Question

India–Israel relations have evolved into a multidimensional strategic partnership. Examine the major areas of cooperation and evaluate their significance for India's foreign policy.

INTERNAL SECURITY & DEFENCE

PRAHAAR: India's National Counter-Terrorism Policy and Strategy

📌 **Syllabus Mapping:**
✅ **GS Paper III – Internal Security**

- **Challenges to internal security through terrorism**
- **Role of external state and non-state actors in creating challenges to internal security**
- **Security agencies and their mandate**

✅ **GS Paper II – Governance and International Relations**

- **International cooperation in counter-terrorism**
- **Policies and mechanisms for maintaining national security**

Introduction

The **Ministry of Home Affairs (MHA)** has unveiled **PRAHAAR**, India's first comprehensive **National Counter-Terrorism Policy and Strategy**. The framework reflects India's **zero-tolerance approach to terrorism** and aims to build a **coordinated, intelligence-driven, and legally robust system** to prevent, respond to, and recover from terrorist threats. The policy integrates **law enforcement modernization, intelligence sharing, community engagement, and international cooperation** to tackle the evolving nature of terrorism.

The PRAHAAR Counter-Terrorism Framework

The strategy operates through multiple pillars designed to address the **entire lifecycle of terrorism — from prevention to recovery**.

1. Prevention of Terror Attacks

The strategy emphasizes **proactive and intelligence-led prevention**.

Key Mechanisms

1. **Multi Agency Centre (MAC)** – facilitates **real-time intelligence sharing among security agencies**.
2. **Joint Task Force on Intelligence (JTFI)** – ensures coordination between **central and state intelligence agencies**.

Importance

1. Enhances **inter-agency coordination**.
2. Allows **early identification of terrorist threats**.
3. Enables **preemptive security actions**.

2. Response Mechanism

The framework establishes a **multi-layered response system**.

Operational Structure

1. **Local Police** act as the **first responders**.
2. **State and Central Anti-Terror Forces** provide operational support.
3. **National Security Guard (NSG)** functions as the **nodal counter-terror force under the MHA**.

Investigation and Prosecution

1. **National Investigation Agency (NIA)** leads major terror investigations.
2. State agencies assist in ensuring **effective evidence gathering and prosecution**.

Outcome

Aims to achieve **high conviction rates**, strengthening deterrence against terrorism.

3. Aggregating Institutional Capacities

The PRAHAAR framework stresses **institutional strengthening of law enforcement agencies**.

Major Measures

1. **Modernization of police forces**
2. Standardization of **anti-terror operational structures across states**
3. Advanced training programs for security personnel

Institutional Support

Training and research support will be provided by the **Bureau of Police Research and Development (BPR&D)**.

Impact

1. Improves **operational readiness**
2. Enhances **inter-state coordination**
3. Builds **specialized counter-terror expertise**

4. Human Rights and Rule of Law

A distinctive feature of PRAHAAR is the emphasis on **legal safeguards and democratic accountability**.

Key Principles

1. Anti-terror operations must **respect fundamental rights**.
2. Legal procedures must follow **constitutional safeguards**.

Legal Redress Mechanisms

Citizens have access to **multiple levels of judicial review**:

1. **District Courts**
2. **High Courts**
3. **Supreme Court**

Significance

Ensures that **counter-terrorism efforts remain consistent with democratic values and rule of law**.

5. Addressing Conditions Conducive to Terrorism

The strategy recognizes that **radicalization and social vulnerabilities** can fuel extremism.

Preventive Measures

1. **Community engagement programs**
2. Collaboration with **NGOs and local leaders**
3. Involvement of **moderate religious scholars**

Target Group: Special attention to **vulnerable youth susceptible to radicalization**.

Outcome: Helps prevent **terror recruitment and ideological extremism**.

6. Strengthening International Cooperation

Terrorism is a **transnational threat**, requiring global collaboration.

Key Instruments

1. **Mutual Legal Assistance Treaties (MLATs)**
2. **Extradition treaties**

Objectives

- Prevent terrorists from finding **safe havens abroad**
- Track and disrupt **global terror financing networks**
- Improve **cross-border intelligence cooperation**

7. Recovery and Resilience

The policy adopts a **whole-of-society approach** to post-terror recovery.

Measures

- Rapid restoration of **public infrastructure**
- Psychological and economic support to **affected communities**
- Partnerships between **government, private sector, and civil society**

Goal: Build **societal resilience against terrorism**.

Evolving Terrorism Challenges Faced by India

India faces multiple and increasingly complex forms of terrorism.

1. State-Sponsored and Cross-Border Terrorism

1. Persistent threats from **state-supported terror networks across borders**.
2. Continued attempts to destabilize regions through **proxy groups**.

Global terror groups such as **Al-Qaeda and ISIS** have also attempted to establish **sleeper cells in South Asia**.

2. Crime–Terror Nexus

There is growing collaboration between:

- **Terrorist organizations**
- **Organized crime networks**
- **Illegal arms traffickers**

Implications

- Increased **terror funding channels**
- Enhanced logistical support for extremist groups.

3. Technological and Cyber Terrorism

Modern terrorist organizations increasingly rely on **digital technologies**.

Tools Used

- Social media propaganda
- Encrypted messaging platforms
- Dark web communication
- Cryptocurrency for financing

Impact

Facilitates **online radicalization and recruitment**.

4. CBRNED Threats

Security agencies are concerned about access to **CBRNED materials**:

- **Chemical**
- **Biological**
- **Radiological**
- **Nuclear**
- **Explosive**
- **Digital threats**

Challenge

Preventing extremist groups from obtaining **weapons of mass destruction or advanced digital attack tools**.

Significance of PRAHAAR

Dimension	Impact
Internal Security	Strengthens national counter-terror architecture
Institutional Coordination	Improves intelligence sharing among agencies
Legal Accountability	Ensures counter-terror actions respect constitutional rights
Community Engagement	Reduces radicalization risks
Global Cooperation	Enhances international counter-terror partnerships

Way Forward

1. Strengthening Intelligence Infrastructure: Use **AI-driven analytics and big data tools** for early threat detection.

2. Enhancing Cybersecurity: Develop specialized units to counter **online radicalization and cyber-terrorism**.

3. International Collaboration: Expand cooperation through platforms such as:

- **Interpol**
- **United Nations Counter-Terrorism Committee**

4. Police Modernization: Accelerate modernization programs under **police reform initiatives**.

Conclusion

The **PRAHAAR National Counter-Terrorism Policy** marks a significant step toward establishing a **comprehensive and integrated security framework in India**. By combining **intelligence-driven prevention, strong legal enforcement, community engagement, and international cooperation**, the policy addresses the evolving challenges of modern terrorism. If effectively implemented, PRAHAAR could significantly enhance India's **national security architecture while preserving democratic principles and human rights**.

Keywords: *Zero Tolerance Policy, Counter-Terror Strategy, Intelligence Coordination, Terror Financing Control, National Security Framework.*

Mains Practice Question

India's counter-terrorism strategy must adapt to evolving technological and transnational threats. Examine the key features of the PRAHAAR framework and evaluate its potential in strengthening India's internal security architecture.

Cybersecurity Framework for Space and Satellite Communication (SatCom) in India

📌 **Syllabus Mapping:**
✅ **GS Paper III – Science and Technology**

- **Space technology and satellite systems**
- **Cybersecurity and emerging technological challenges**

✅ **GS Paper III – Internal Security**

- **Cybersecurity challenges and security infrastructure**

Introduction

With the rapid expansion of **satellite-based communication, navigation, and space-based services**, cybersecurity has become a critical concern for the space sector. In this context, the **Indian Computer Emergency Response Team (CERT-In)**, under the **Ministry of Electronics and Information Technology (MeitY)**, in collaboration with the **SatCom Industry Association (SIA-India)**, has released **Cyber Security Framework and Guidelines for Space and Satellite Communication (SatCom)**. These advisory guidelines aim to strengthen the **cyber resilience of India's space ecosystem** and complement key policy frameworks such as the **Indian Space Policy 2023, IN-SPACe regulatory norms, and the Digital Personal Data Protection Act, 2023**.

Need for Cybersecurity in Space Systems

Modern space infrastructure relies heavily on **digital networks and satellite communication systems**.

Importance

Satellites support critical services such as:

- **Telecommunications**
- **Navigation (e.g., GPS/NavIC)**
- **Weather forecasting**
- **Disaster management**
- **Defence and national security**

Cyber attacks on satellites or ground infrastructure can lead to:

- Communication disruptions
- Navigation errors
- Data theft
- National security risks

Hence, **robust cybersecurity frameworks are essential for safeguarding space infrastructure**.

Key Highlights of the SatCom Cybersecurity Guidelines

The guidelines propose **comprehensive security controls across all components of the satellite communication ecosystem**.

1. Segment-wise Cybersecurity Controls

The framework addresses cybersecurity risks across **four major segments of the space communication system**.

Segment	Description
Space Segment	Includes satellites and onboard payload systems
Ground Segment	Mission control centers and ground stations
User Segment	Satellite terminals, communication devices, and end-user equipment
Communication Links	Uplink and downlink transmission pathways

Objective

To ensure **end-to-end protection of satellite communication systems**.

2. Mandatory Incident Reporting

SatCom operators must **report cybersecurity incidents promptly**.

Reporting Requirement: Any cybersecurity breach or anomaly must be reported to **CERT-In within 6 hours of detection**.

Importance

- Enables **rapid threat response**
- Prevents escalation of cyber incidents

3. Cybersecurity Monitoring and Risk Management

The guidelines emphasize continuous monitoring and risk mitigation.

Key Practices

- **Regular cybersecurity audits**
- Maintenance of **updated threat intelligence**
- **Hazard and Damage Mitigation (HDM)** planning

Technological Tools

Advanced technologies such as:

- **Artificial Intelligence (AI)**
- **Machine Learning (ML)**

are recommended for **real-time monitoring and anomaly detection**.

Core Cybersecurity Principles for the Space Ecosystem

The guidelines outline several foundational principles for strengthening cybersecurity.

1. Security-by-Design and Security-by-Default

Security considerations must be integrated from the **initial stages of system design and development**.

Approach

- Incorporate security in **hardware, software, and communication architecture**
- Avoid adding security measures **only after system deployment**

2. Defence-in-Depth Strategy

The framework adopts a **multi-layered cybersecurity approach**.

Key Idea

Multiple layers of protection are implemented across:

- Space systems
- Ground infrastructure
- Communication networks
- User interfaces

Benefit

If one security layer fails, **other layers continue to protect the system**.

3. Zero-Trust Architecture (ZTA)

The guidelines recommend adopting the **Zero-Trust security model**.

Principle: No entity is automatically trusted, even within internal networks.

Key Features

- Continuous identity verification
- Strict access control mechanisms

This approach helps prevent **insider threats and unauthorized access**.

4. Secure Communication and Encryption

Satellite communication must employ **strong encryption mechanisms**.

Security Measures

- End-to-end encryption for:
  - **Telemetry**
  - **Tracking**
  - **Command (TT&C) signals**
  - **Data payload transmission**

Outcome: Protects sensitive data from **interception and manipulation**.

5. Governance and Accountability

The guidelines emphasize institutional responsibility for cybersecurity.

Key Recommendation

Organizations operating satellite systems must appoint a:

Chief Satellite Security Officer (CSSO)

Responsibilities

- Oversee **cybersecurity governance**
- Ensure compliance with **security protocols**

6. Incident Preparedness and Resilience

The framework stresses preparedness for potential cyber incidents.

Key Measures

- **Incident Response Procedures (IRP)**
- **Business Continuity Plans (BCP)**
- Crisis management strategies specific to **SatCom operations**

Objective

Ensure rapid recovery and minimize operational disruption.

Institutional Framework Supporting Space Cybersecurity

Several policy frameworks support cybersecurity in India's space sector.

Indian Space Policy 2023: Encourages **private sector participation in space activities** while ensuring regulatory oversight.

IN-SPACe (Indian National Space Promotion and Authorization Centre): Acts as the **regulatory authority for private space sector activities**.

Digital Personal Data Protection Act, 2023: Ensures **protection of personal data and privacy in digital ecosystems**, including space-based data services.

Significance of the Cybersecurity Guidelines

Dimension	Importance
National Security	Protects strategic satellite infrastructure
Digital Economy	Secures satellite-based communication services
Space Sector Growth	Builds trust for private sector participation
Global Competitiveness	Aligns India with international space cybersecurity standards

Challenges in Space Cybersecurity

Despite these measures, several challenges remain.

1. Increasing Cyber Threats: Satellite systems are vulnerable to **advanced cyber attacks and electronic warfare**.

2. Rapid Growth of Private Space Sector: The expansion of private satellite operators increases **cybersecurity complexity**.

3. Technological Sophistication of Attacks: Attackers may exploit **software vulnerabilities or signal interference**.

4. Lack of Skilled Cybersecurity Workforce: Space cybersecurity requires **highly specialized expertise**.

Way Forward

1. Strengthening Cybersecurity Infrastructure

Develop advanced **space-specific cyber defence systems**.

2. Capacity Building

Train experts in **space cybersecurity and satellite system protection**.

3. International Cooperation

Collaborate with global partners to address **cross-border cyber threats in space systems**.

4. Continuous Technological Upgradation

Adopt emerging technologies such as:

- AI-driven threat detection
- Quantum encryption systems

Conclusion

The **Cyber Security Framework for Space and Satellite Communication (SatCom)** marks a significant step toward securing India's rapidly expanding **space-based communication infrastructure**. By emphasizing **security-by-design, zero-trust architecture, encryption, and robust incident response mechanisms**, the guidelines aim to enhance the **resilience of India's space ecosystem**. As space technology becomes increasingly central to **national security, economic growth, and digital connectivity**, strengthening cybersecurity will remain essential for ensuring **safe and sustainable space operations**.

Keywords: *Space Cybersecurity, Satellite Communication Security, Zero-Trust Architecture, Space Infrastructure Protection, Digital Security.*

Mains Practice Question

Discuss the importance of cybersecurity in the space sector. Examine the key features of India's Cyber Security Framework for Satellite Communication (SatCom) and its significance for national security.

Bihar Declared Naxal-Free: Progress in India's Fight Against Left Wing Extremism

📌 **Syllabus Mapping:**
✅ **GS Paper III – Internal Security**

Left Wing Extremism and insurgency in India

Role of the State in maintaining internal security

Introduction

Bihar has recently been declared **Naxal-free** following the **surrender of the last active armed Maoist operative in the state**. This development marks a significant milestone in India's ongoing campaign to eliminate **Left Wing Extremism (LWE)**. The **Union Government has set March 31, 2026 as the target date for the complete eradication of LWE across the country**, reflecting intensified security and development initiatives in affected regions.

Understanding Left Wing Extremism (LWE)

Definition

Left Wing Extremism (LWE), commonly referred to as **Naxalism or Maoism**, represents a form of armed insurgency that seeks to overthrow the **democratic state through revolutionary violence**.

Ideological Basis

- The movement is inspired by **Maoist ideology**, advocating:
- Establishment of a **classless society**
- Armed revolution against **state institutions**
- Mobilization of marginalized communities

Historical Origins of Naxalism

The movement traces its roots to the **Naxalbari uprising of 1967 in West Bengal**.

Key Features of the Naxalbari Movement

- Peasant revolt led by **radical communist leaders**
- Demand for **land redistribution and agrarian reforms**
- Inspired by **Mao Zedong's revolutionary model**
- Over time, the movement expanded into a wider **insurgency across several Indian states**.

The "Red Corridor"

The region affected by LWE is often referred to as the **Red Corridor**.

States Historically Affected

- **Chhattisgarh**
- **Jharkhand**
- **Odisha**
- **Maharashtra**
- **West Bengal**
- **Madhya Pradesh**
- **Kerala**
- **Andhra Pradesh**
- **Telangana**

These areas typically have:

High levels of **poverty**

Tribal populations: Limited **infrastructure and governance presence**

Reasons for the Rise of Left Wing Extremism

Scholars and policymakers often link LWE to **structural socio-economic issues**.

1. Socio-Economic Inequality

Large sections of rural and tribal populations historically faced:

Landlessness

- Lack of **basic services**
- Economic marginalization

2. Governance Deficits

Weak administrative presence in remote regions created **spaces for insurgent influence**.

3. Tribal Displacement

Development projects such as mining and infrastructure have led to **displacement of tribal communities**, contributing to local grievances.

4. Ideological Mobilization

Maoist groups used:

Propaganda

Grassroots mobilization

to attract support from marginalized communities.

Measures Taken by the Government to Combat LWE

The government has adopted a **multi-dimensional strategy combining security operations with development initiatives**.

1. Security-Based Measures

- **Strengthening Security Forces:** Deployment of specialized forces such as:
  - **Central Reserve Police Force (CRPF)**: **CoBRA (Commando Battalion for Resolute Action)**
- **Intelligence and Surveillance:** Improved intelligence networks and use of **technology-based surveillance**.

2. Development Initiatives

Recognizing that security operations alone cannot address LWE, the government has emphasized **development in affected regions**.

Key Programmes

- **Aspirational Districts Programme**
- **Road Connectivity Projects in LWE areas**
- **Skill development initiatives**

These programmes aim to address **root causes such as poverty and lack of opportunities**.

3. Rehabilitation and Surrender Policies

Governments offer **rehabilitation packages to surrendered militants**.

Components

- Financial assistance

- Skill training
- Integration into mainstream society
- This policy has encouraged many insurgents to **abandon armed struggle**.

Significance of Bihar Becoming Naxal-Free

The declaration of Bihar as Naxal-free carries several important implications.

1. Improvement in Internal Security

Reduced Maoist presence strengthens **law and order in the region**.

2. Development Opportunities

- Improved security conditions encourage:
- Infrastructure development
- Investment and economic growth

3. Model for Other States

Bihar's experience may provide lessons for **other LWE-affected states**.

Challenges Remaining in Eliminating LWE

Despite progress, LWE continues to persist in some regions.

1. Difficult Terrain: Dense forests and remote areas provide **safe havens for insurgents**.

2. Socio-Economic Backwardness: Persistent poverty and inequality continue to fuel discontent.

3. Cross-State Mobility of Maoists: Insurgents often operate across **state borders**, complicating enforcement.

Way Forward

1. Strengthening Governance in Remote Areas: Improve access to **education, healthcare, and infrastructure**.

2. Inclusive Development: Focus on **tribal welfare and livelihood opportunities**.

3. Enhanced Inter-State Coordination: Improve cooperation among **state governments and central agencies**.

Conclusion

The declaration of **Bihar as Naxal-free** represents a significant milestone in India's efforts to eliminate **Left Wing Extremism**, one of the country's major internal security challenges since independence. However, long-term success will depend not only on **security operations but also on addressing socio-economic grievances, strengthening governance, and promoting inclusive development** in vulnerable regions. Achieving the **government's target of eliminating LWE by March 31, 2026** will require sustained efforts across security, development, and governance dimensions.

Keywords: *Left Wing Extremism, Naxalism, Internal Security, Red Corridor, Inclusive Development.*

Mains Practice Question

Left Wing Extremism in India has both security and socio-economic dimensions. Examine the causes of the movement and evaluate the strategies adopted by the government to address it.

ECONOMY

Namo Bharat RRTS: Transforming Regional Mobility in NCR

📌 **Syllabus Mapping:**
✅ **GS Paper III – Infrastructure**

- **Infrastructure: Energy, Ports, Roads, Airports, Railways**
- **Urbanisation, Urban Infrastructure and Transport**

Introduction

India has taken a major step toward modernizing regional transport with the inauguration of the **Namo Bharat Regional Rapid Transit System (RRTS)**. The project aims to significantly improve connectivity within the **National Capital Region (NCR)** by enabling seamless travel between major urban centers and Delhi. By integrating **high-speed regional mobility with city transport networks**, the system seeks to transform commuting patterns, reduce travel time, and support sustainable urban development.

About Namo Bharat Regional Rapid Transit System (RRTS)

The **Namo Bharat RRTS** is a **rail-based, semi-high-speed commuter transit system** designed to connect cities in the **National Capital Region** through fast and frequent services.

Key Features

- **Maximum Speed:** Up to **180 km per hour**
- **Purpose:** High-speed regional commuting between major urban centers
- **Dedicated Corridors:** Trains operate on **exclusive tracks** to ensure reliability and efficiency.

Implementing Agency

The project is being implemented by the **National Capital Region Transport Corporation (NCRTC)**.

This entity is a **joint venture between the Central Government and the governments of:**

- **Delhi**
- **Uttar Pradesh**
- **Haryana**
- **Rajasthan**

How RRTS Differs from Existing Transport Systems

Feature	Metro Rail	Conventional Rail	RRTS
Travel Distance	Short urban trips	Long-distance travel	Regional intercity travel
Speed	Moderate	Moderate	**Semi-high-speed (up to 180 km/h)**
Stops	Frequent	Few	**Limited stops for faster travel**
Frequency	High	Lower	**High-frequency regional service**
Infrastructure	Urban corridors	Shared rail network	**Dedicated regional corridor**

Thus, RRTS fills the **mobility gap between metro systems and conventional railways**.

Significance of the Namo Bharat RRTS

1. Addressing Urban Congestion

India is undergoing rapid urbanization.

- By **2030, more than 40% of India's population is expected to live in urban areas**.
- Metropolitan cities face increasing **traffic congestion and infrastructure pressure**.

The RRTS offers **fast regional commuting**, enabling people to live in surrounding towns while working in metropolitan centres.

2. Reduction in Travel Time

One of the key advantages of the system is **dramatic travel time reduction**.

Example:

- **Delhi–Meerut RRTS Corridor**
- Travel time reduced from **around 3 hours to nearly 60 minutes**

Impact

- Improved **daily commuting efficiency**
- Increased **labour productivity**
- Better **quality of life for workers**

3. Balanced Regional Development

RRTS supports the idea of **polycentric urban development**.

Polycentric Growth Model

Instead of concentrating economic activities in a single city, development spreads across multiple urban centers.

Benefits

- Growth of **satellite towns and suburban areas**
- Reduced pressure on **mega cities**
- Creation of **regional economic hubs**

This aligns with the concept of **integrated regional planning**.

4. Environmental Sustainability

Transport is one of the major contributors to **urban pollution and greenhouse gas emissions**.

The RRTS contributes to sustainability through:

- **Electric-powered train systems**
- Reduced dependence on **private vehicles**
- Lower **carbon emissions**

Environmental Impact

- Reduced **traffic congestion**
- Lower **fuel consumption**
- Improved **urban air quality**

5. Social Empowerment and Gender Inclusion

A notable feature of the project is its contribution to **women's participation in the workforce**.

Nari-Shakti Initiative

- Women constitute the **majority of train operators and station control staff**.

Significance

- Promotes **gender inclusivity in technical sectors**
- Enhances **women's visibility in public transport operations**
- Strengthens the narrative of **women-led development**

Broader Economic and Urban Development Impacts

Dimension	Impact
Economic Growth	Faster commuting improves productivity
Urban Planning	Encourages planned suburban expansion
Real Estate Development	Growth along transit corridors
Employment Generation	Infrastructure construction and operations
Regional Integration	Stronger connectivity between NCR cities

Challenges in Implementation

Despite its transformative potential, certain challenges remain:

1. **High Capital Costs:** Large infrastructure projects require substantial investment and financial sustainability.

2. **Land Acquisition Issues:** Urban infrastructure projects often face delays due to land procurement challenges.
3. **Multimodal Integration:** Effective coordination with **metro, bus, and local transport networks** is essential.
4. **Institutional Coordination:** The project requires collaboration among **multiple state governments and central agencies**.

Way Forward

To maximize the benefits of RRTS, the following steps are essential:

1. Strengthen Multimodal Connectivity: Integrate RRTS with **metro systems, buses, and last-mile transport**.

2. Transit-Oriented Development (TOD): Promote urban planning around transit corridors to enhance economic activity.

3. Expansion to Other Regions: Similar regional rapid transit systems can be developed in:

- **Mumbai Metropolitan Region**
- **Bengaluru Metropolitan Region**
- **Chennai region**

4. Sustainable Financing: Use **public-private partnerships (PPP)** and innovative financing models.

Conclusion

The **Namo Bharat Regional Rapid Transit System (RRTS)** represents a significant advancement in India's urban transport infrastructure. By enabling **high-speed regional mobility, reducing congestion, and supporting sustainable development**, it has the potential to reshape the urban landscape of the National Capital Region. With effective integration, strong governance, and expansion to other metropolitan regions, RRTS could become a **model for future regional transport systems in India**.

Keywords: *Regional Connectivity, Sustainable Transport, Polycentric Urban Development, Infrastructure Modernization, Urban Mobility.*

Mains Practice Question

Discuss the significance of the Regional Rapid Transit System (RRTS) in addressing urban congestion and promoting balanced regional development in India. Evaluate its potential role in transforming urban mobility.

India–France Protocol to Amend Double Taxation Avoidance Convention (DTAC)

📌 **Syllabus Mapping:**
✅ **GS Paper III – Indian Economy**

- **Taxation and international economic relations**
- **Investment climate and economic reforms**

✅ **GS Paper II – International Relations**

- **Bilateral agreements and economic diplomacy**

Introduction

India and France have signed a **Protocol to amend the Double Taxation Avoidance Convention (DTAC)** originally concluded in **1992**. The amendment aims to modernize the tax treaty by incorporating **global anti-tax avoidance measures** and removing interpretational ambiguities. The revised framework reflects evolving global standards on **tax transparency, fair taxation, and prevention of corporate profit shifting**, particularly in the context of the **OECD–G20 Base Erosion and Profit Shifting (BEPS) initiative**.

Understanding DTAC and DTAA

Double Taxation Avoidance Agreement (DTAA)

A **DTAA** is a bilateral agreement between two countries designed to **prevent the same income from being taxed in both jurisdictions**.

Purpose

- Promote **cross-border trade and investment**
- Provide **tax certainty to individuals and businesses**
- Prevent **tax evasion and double taxation**

DTAC vs DTAA

- **DTAC (Double Taxation Avoidance Convention)** is simply a **formal legal term used for certain tax treaties**.
- Both essentially serve the same objective of **avoiding double taxation on income**.

Example

Without DTAA: A company earning income in **France** could be taxed both in **France and India**.

With DTAA: Tax liability is **allocated or credited between the two countries**, avoiding double taxation.

Key Amendments in the India–France DTAC

1. Removal of the Most-Favoured-Nation (MFN) Clause

The amendment removes the **MFN clause** to address interpretational issues in treaty benefits.

Purpose

- Eliminate **ambiguities in applying treaty provisions**
- Prevent **unintended extension of tax benefits**

Background

In several Indian tax treaties, MFN provisions allowed benefits granted to **third countries** to automatically extend to other treaty partners.

Impact

- Enhances **clarity and predictability in tax rules**
- Prevents misuse of **treaty provisions by multinational companies**

2. Incorporation of BEPS Multilateral Instrument (MLI) Provisions

The protocol integrates provisions from the **BEPS Multilateral Instrument (MLI)**.

Purpose

- Strengthen measures against **tax avoidance by multinational corporations**
- Align the treaty with **global tax governance standards**

Key Features

- Anti-abuse provisions
- Prevention of **artificial profit shifting**
- Enhanced **tax transparency**

Understanding the Most-Favoured-Nation (MFN) Principle

The **MFN principle** is a core concept in international trade.

Meaning

Under the **World Trade Organization (WTO)** framework:

- A country must **treat all trading partners equally**.
- If a country grants **special trade benefits to one nation**, it must extend the same benefits to all other WTO members.

Application in Tax Treaties

In some tax agreements: If one country offers **lower tax rates to another country**, MFN clauses may require extending similar benefits to existing treaty partners.

Issues

- Creates **legal disputes and interpretation challenges**
- Can lead to **unintended tax concessions**

Base Erosion and Profit Shifting (BEPS)

Concept

Base Erosion and Profit Shifting (BEPS) refers to **tax avoidance strategies used by multinational corporations**.

How BEPS Works

Companies shift profits to jurisdictions with:

- **Low tax rates**
- **Minimal regulatory oversight**

Result

1. Reduction in **overall corporate tax liabilities**
2. Loss of **tax revenue for countries where economic activity occurs**

BEPS Multilateral Instrument (MLI)

The **BEPS Multilateral Instrument** is an international treaty designed to **quickly update existing bilateral tax treaties**.

Key Characteristics

- Enables countries to **modify multiple tax treaties simultaneously**
- Avoids lengthy **bilateral renegotiations**

Timeline

Year	Development
2018	BEPS MLI entered into force
2019	Provisions began implementation

Objectives

- Implement recommendations of the **OECD–G20 BEPS Project**
- Prevent **tax avoidance strategies**
- Strengthen **international tax cooperation**

Significance of the India–France DTAC Amendment

1. Strengthening Tax Transparency

The updated treaty improves **clarity in taxation rules** and reduces potential disputes.

2. Preventing Corporate Tax Avoidance

Incorporating **BEPS provisions** ensures multinational companies cannot easily shift profits to low-tax jurisdictions.

3. Aligning with Global Tax Standards

The amendment brings India–France tax arrangements in line with **international taxation reforms led by OECD and G20**.

4. Improving Investment Climate

Clear tax rules enhance **investor confidence** and support **bilateral economic cooperation**.

France is already a **major investor in India**, particularly in sectors such as:

- **Defence and aerospace**
- **Infrastructure**
- **Energy**
- **Technology**

India–France Economic Relations

India and France maintain strong economic ties.

Key Areas of Cooperation

Sector	Cooperation
Defence	Rafale aircraft and strategic partnerships
Energy	Civil nuclear cooperation and renewable energy
Technology	Space and digital innovation
Infrastructure	Urban transport and smart cities

The tax treaty update further strengthens **economic and financial cooperation between the two countries**.

Way Forward

1. Strengthening Global Tax Governance: Countries must cooperate through **OECD and G20 frameworks** to combat tax avoidance.

2. Enhancing Treaty Transparency: Regular updates to bilateral tax treaties can prevent **legal ambiguities and disputes**.

3. Digital Economy Taxation

Future reforms should address **tax challenges arising from digital companies and cross-border digital services**.

Conclusion

The **amendment of the India–France Double Taxation Avoidance Convention** reflects the evolving global effort to create a **fair and transparent international tax system**. By removing the **MFN clause and incorporating BEPS Multilateral Instrument provisions**, the agreement strengthens safeguards against tax avoidance while improving regulatory clarity. Such reforms not only enhance **bilateral economic cooperation** but also align India's taxation framework with **emerging global standards of international tax governance**.

Keywords: *Double Taxation Avoidance, BEPS, MFN Clause, International Tax Governance, Economic Diplomacy.*

Mains Practice Question

Discuss the significance of Double Taxation Avoidance Agreements (DTAAs) in international economic relations. How do BEPS measures strengthen global tax governance?

National Monetisation Pipeline (NMP) 2.0: Expanding Asset Monetisation in India

📌 **Syllabus Mapping:**
✅ **GS Paper III – Indian Economy**

- **Infrastructure development and financing**
- **Public–Private Partnerships (PPP) and investment models**

Introduction

The **Union Finance Minister** has launched the **National Monetisation Pipeline 2.0 (NMP 2.0)**, a major initiative aimed at unlocking the economic value of **existing public infrastructure assets**. Prepared by **NITI Aayog**, the pipeline is based on the **Asset Monetisation Plan for 2025–2030** announced in the **Union Budget 2025–26**. The programme seeks to generate resources by leveraging **operational or under-utilized public infrastructure**, without increasing fiscal pressure on the government.

Understanding Asset Monetisation

Asset monetisation refers to the process of **leasing or transferring revenue rights of public infrastructure assets to private entities** for a specified period while retaining ownership with the government.

Key Characteristics

- Ownership **remains with the government**.
- Private sector is allowed to **operate and maintain the asset**.
- Revenue generated from the asset is used to **fund new infrastructure projects**.

Purpose

- Mobilize **financial resources for infrastructure development**
- Improve **efficiency and asset utilization**

- Reduce **government's fiscal burden**

National Monetisation Pipeline (NMP) 2.0

The **second phase of the NMP** provides a **medium-term roadmap for asset monetisation between FY2026 and FY2030**.

Key Objective

- Provide **clear visibility of monetisable public assets**
- Encourage **private sector participation**
- Support **infrastructure expansion without excessive public borrowing**

Key Highlights of NMP 2.0

1. Monetisation Potential

The estimated **aggregate monetisation potential** under NMP 2.0 is:

₹16.72 lakh crore (FY26–FY30)

This includes:

- **₹5.8 lakh crore from private sector investments**

Significance

- Strengthens **capital mobilization for infrastructure**
- Reduces **dependence on government borrowing**

2. Sectoral Coverage

NMP 2.0 includes **assets from 12 major infrastructure sectors**.

Major Sectors Involved

Sector	Share in Monetisation
Highways (including Multi-Modal Logistics Parks and ropeways)	**26%**
Power	**17%**
Railways	**16%**
Ports	**16%**
Petroleum and Natural Gas	—
Civil Aviation	—
Warehousing and Storage	—
Urban Infrastructure	—
Coal and Mines	—
Telecommunications	—
Tourism Infrastructure	—

These sectors represent **core infrastructure assets critical to economic growth**.

3. Distribution of Monetisation Proceeds

Revenue generated from monetisation is distributed across multiple channels.

Allocation Pattern

- **Consolidated Fund of India (largest share)**
- **Private sector direct investments**
- Allocation to **Public Sector Undertakings (PSUs) or Port Authorities**
- **State Consolidated Funds**

Impact

- Supports **public expenditure on infrastructure**
- Encourages **federal fiscal coordination**

Guiding Principles for Asset Monetisation

The framework follows certain guiding principles to ensure **transparent and efficient monetisation**.

1. Focus on Core Assets

Similar to **NMP 1.0**, the second phase focuses primarily on **core infrastructure assets** that support government service objectives.

Examples include:

- Highways
- Railways
- Power transmission networks
- Ports

2. Inclusion of Non-Core Assets

The policy also allows monetisation of **non-core assets**, particularly when development potential exists.

Examples include:

- Government land
- Buildings
- Real estate assets linked to infrastructure development

Such assets can be used for **urban infrastructure projects and commercial development**.

3. Private Sector Participation through PPP Models

NMP 2.0 encourages investment through **Public–Private Partnership (PPP) frameworks**.

Key Model Used

Design–Build–Finance–Operate–Transfer (DBFOT)

Key Features

- Private entity finances and builds infrastructure
- Operates the asset for a concession period
- Ownership eventually transfers back to the government

Benefits

- Mobilizes **private capital**
- Improves **project efficiency**
- Reduces **public financial burden**

Stages of Asset Monetisation

The estimation of monetisation potential follows a **structured multi-stage process**.

Five Stages

- **Identification of assets**
- **Assessment of revenue potential**
- **Selection of monetisation models**
- **Private sector participation and bidding**
- **Monitoring and evaluation**

This systematic approach ensures **transparent implementation and accountability**.

Performance of National Monetisation Pipeline 1.0

The **first phase of the National Monetisation Pipeline (NMP 1.0)** covered **FY2022–FY2025**.

Key Highlights

- Target: **₹6 lakh crore monetisation**
- Achievement: **Around 90% of the target achieved**

Major Contributing Sectors

- **Highways**
- **Railways**
- **Power sector**
- **Petroleum and natural gas pipelines**
- **Telecommunications**

These sectors accounted for **approximately 72% of the total monetisation target**.

Significance of NMP 2.0

1. Boost to Infrastructure Financing

Infrastructure requires massive investments to achieve India's growth targets. NMP helps mobilize **long-term capital without raising public debt**.

2. Improved Asset Utilization

Many government assets remain **under-utilized**. Monetisation allows them to generate **economic value**.

3. Private Sector Efficiency

Private operators can introduce:

- **Better management practices**
- **Technological innovation**
- **Operational efficiency**

4. Economic Growth and Employment

Infrastructure expansion promotes:

- **Industrial growth**
- **Logistics efficiency**
- **Job creation**

Challenges in Asset Monetisation

Despite its benefits, the monetisation framework faces several challenges.

1. Valuation Challenges: Accurate valuation of infrastructure assets is complex.

2. Investor Confidence: Private investors require **stable regulatory frameworks** and predictable returns.

3. Public Perception Issues: Asset monetisation is sometimes misunderstood as **privatization**, which can create political resistance.

4. Institutional Coordination: Successful implementation requires coordination among:

- **Central government**
- **State governments**
- **Public sector enterprises**

Way Forward

1. Transparent Monetisation Process: Clear bidding procedures and disclosure of valuation methods.

2. Strengthening Regulatory Frameworks: Stable policy environment to attract **long-term investors**.

3. Expanding Infrastructure Financing Tools: Use of **Infrastructure Investment Trusts (InvITs)** and **Real Estate Investment Trusts (REITs)**.

4. Strong Monitoring Mechanisms: Continuous oversight to ensure **efficient asset utilization and service delivery**.

Conclusion

The **National Monetisation Pipeline 2.0** represents a strategic shift in India's infrastructure financing strategy. By unlocking the value of **existing public assets and leveraging private investment**, the initiative aims to accelerate infrastructure development while maintaining fiscal discipline. If implemented

effectively, NMP 2.0 can play a crucial role in achieving **sustainable economic growth, improved infrastructure quality, and enhanced public service delivery**.

Keywords: *Asset Monetisation, Infrastructure Financing, Public–Private Partnership, Fiscal Sustainability, Economic Growth.*

Mains Practice Question

What is asset monetisation? Discuss the significance of the National Monetisation Pipeline (NMP) in strengthening infrastructure financing in India. Evaluate the challenges associated with its implementation.

Free Trade Agreements and India's Expanding Global Trade Access

📌 **Syllabus Mapping:**
✅ **GS Paper III – Indian Economy**

- **International trade and economic relations**
- **Trade policy, globalization, and economic growth**

✅ **GS Paper II – International Relations**

- **Bilateral and regional agreements affecting India's interests**

Introduction

Free Trade Agreements (FTAs) have emerged as an important instrument of **India's trade policy and economic diplomacy**. As of **2025**, India's network of FTAs provides **preferential trade access to nearly two-thirds of global trade**, enabling Indian industries to integrate more effectively with international markets. These agreements reduce trade barriers, promote economic cooperation, and strengthen India's role in the **global trading system**.

Understanding Free Trade Agreements (FTAs)

Definition

A **Free Trade Agreement (FTA)** is a **legally binding treaty between two or more countries** that aims to facilitate trade by reducing or eliminating barriers.

Major Trade Barriers Addressed

- **Tariffs** on goods
- **Import quotas**
- **Regulatory restrictions**
- **Trade facilitation barriers**

Additional Provisions in FTAs

Modern FTAs also include provisions on:

- **Investment protection**
- **Intellectual property rights**
- **Services trade**
- **Digital trade regulations**

These agreements aim to create **stable and predictable trade environments** for businesses.

India's Free Trade Agreement Partners

India has established FTAs with a wide range of countries and regional blocs.

Major Bilateral Partners

- **United States**
- **United Kingdom**
- **Australia**
- **United Arab Emirates (UAE)**
- **Oman**
- **New Zealand**
- **Japan**
- **Singapore**
- **South Korea**
- **Sri Lanka**

- **Nepal**
- **Bhutan**
- **Thailand**
- **Malaysia**

These partnerships facilitate **preferential market access for Indian goods and services**.

Regional Trade Groupings Associated with India

India also participates in trade arrangements with several regional groupings.

Regional Bloc	Significance
European Union (EU)	Major market for Indian exports
European Free Trade Association (EFTA)	Trade partnership with advanced economies
ASEAN	Key partner in Asia-Pacific trade
SAARC	Regional economic cooperation in South Asia

These frameworks help strengthen **regional economic integration**.

Ongoing FTA Negotiations

India continues to expand its trade partnerships through ongoing negotiations.

Key Negotiating Partners

- **Gulf Cooperation Council (GCC)**
- **Israel**
- **Chile**
- **Canada**
- **Peru**
- **Bangladesh**
- **Maldives**
- **Qatar**
- **Bahrain**
- **Eurasian Economic Union (EAEU)**

These negotiations aim to **expand India's export markets and deepen economic partnerships**.

Significance of FTAs for India

FTAs play a critical role in strengthening India's economic growth and global integration.

1. Trade Diversification

FTAs enable India to **diversify its export and import markets geographically**.

Benefits

- Reduced dependency on **limited trading partners**
- Expansion into **new international markets**
- Lower tariffs for Indian exports

This diversification improves **economic resilience in global trade**.

2. Integration into Global Supply Chains

FTAs help integrate India into **global production networks**.

Impact

- Improved **access to developed markets**
- Increased **competitiveness of Indian industries**
- Encouragement of **foreign investment**

Global value chain integration is essential for sectors such as:

- Electronics
- Automobiles
- Pharmaceuticals
- Textiles

3. Employment Generation

Expanded exports and investment under FTAs can create **new employment opportunities**.

Key Sectors

- Manufacturing
- Services
- Agriculture exports

This contributes to **inclusive economic growth**.

4. Geopolitical and Strategic Benefits

FTAs are not only economic instruments but also tools of **strategic diplomacy**.

Role in Foreign Policy

- Strengthen **bilateral trust and cooperation**
- Support India's **multi-aligned foreign policy approach**
- Enhance India's role in **regional economic governance**

5. Efficient Resource Utilization

FTAs allow countries to specialize in producing goods where they have **comparative advantage**.

Concept: According to economist **David Ricardo's theory of comparative advantage**, countries benefit when they focus on producing goods where they are most efficient.

Result

- Higher **global economic efficiency**
- Lower **production costs**
- Increased **consumer welfare**

Challenges Associated with FTAs

Despite their advantages, FTAs also present several challenges.

1. Trade Deficits

India has experienced trade deficits with certain FTA partners.

Example

Higher imports in sectors such as **electronics and machinery**.

2. Impact on Domestic Industries

Some domestic industries may face **increased competition from cheaper imports**.

Affected Sectors

- Dairy
- Agriculture
- Small-scale manufacturing

3. Rules of Origin Issues

Weak enforcement of **rules of origin** can allow third-country goods to enter markets through FTA partners.

4. Implementation and Compliance Challenges

Complex regulatory standards can affect the **utilization rate of FTAs by exporters**.

Way Forward

1. Strategic FTA Negotiations

Ensure balanced agreements that protect **sensitive domestic sectors**.

2. Strengthening Export Competitiveness

Invest in:

- Manufacturing capacity
- Technology adoption
- Logistics infrastructure

3. Enhancing FTA Utilization

Provide exporters with better information about **rules of origin and tariff concessions**.

4. Aligning Trade with Industrial Policy

Integrate FTAs with initiatives such as:

- **Make in India**
- **Production Linked Incentive (PLI) schemes**

Conclusion

Free Trade Agreements have become a crucial component of India's strategy for **expanding global trade access and strengthening economic diplomacy**. By providing **preferential market access and integrating Indian industries into global supply chains**, FTAs contribute to economic growth, employment generation, and geopolitical partnerships. However, to maximize their benefits, India must pursue **balanced trade negotiations, strengthen domestic competitiveness, and ensure effective implementation of trade agreements**.

Keywords: *Free Trade Agreements, Trade Diversification, Global Supply Chains, Economic Diplomacy, Comparative Advantage.*

Mains Practice Question

Free Trade Agreements have become an important instrument of India's trade policy. Discuss their significance for India's economic growth and examine the challenges associated with their implementation.

Industrial Corridors: Catalysts for Strengthening India's Industrial Ecosystem

📌 **Syllabus Mapping:**
✅ **GS Paper III – Indian Economy**

- **Infrastructure development and industrial growth**
- **Industrial policy and economic development**

Introduction

The **Union Budget 2026–27** emphasized the development of **industrial corridors**, particularly announcing plans for an **integrated East Coast Industrial Corridor with a major node at Durgapur**. Industrial corridors are emerging as a key strategy to promote **manufacturing growth, regional development, and global supply chain integration**. Through integrated infrastructure and investment clusters, these corridors aim to transform India into a **major global manufacturing hub**.

Understanding Industrial Corridors

Meaning: Industrial corridors are **linear development zones connecting major economic centres through integrated infrastructure networks**.

Infrastructure Components

Industrial corridors typically include:

- **Highways and expressways**
- **Rail networks**
- **Ports and logistics hubs**
- **Airports and industrial clusters**

Key Objective

To facilitate **industrial agglomeration and economic activity along transport corridors**.

Key Features of Industrial Corridors

Industrial corridors are designed to create **globally competitive industrial ecosystems**.

Major Characteristics

- **World-class infrastructure**
- Integrated **transport and logistics systems**
- Promotion of **industrial clusters**
- Attraction of **domestic and foreign investments**

Economic Impact

They help utilize **regional comparative advantages** through targeted investments.

National Industrial Corridor Development Programme (NICDP)

The development of industrial corridors in India is primarily driven by the **National Industrial Corridor Development Programme (NICDP)**.

Key Features

- Development of **multiple industrial corridors across the country**
- Promotion of **sustainable urban-industrial ecosystems**
- Focus on **Low-Carbon Cities (LCCs)** and environmentally sustainable development.

Corridors Covered

Currently, **11 industrial corridors** are being implemented under this programme.

Institutional Framework for Industrial Corridor Development

Several institutional bodies oversee the planning and implementation of corridor projects.

1. National Industrial Corridor Development Corporation (NICDC)

Background

- Originally established as the **Delhi–Mumbai Industrial Corridor Development Corporation (DMICDC)**.
- Incorporated in **January 2008**.

Administrative Control

Operates as an **autonomous organization under the Ministry of Commerce and Industry**.

Role

- Planning and implementing **industrial corridor projects**
- Facilitating **infrastructure development and investment promotion**

2. National Industrial Corridor Development and Implementation Trust (NICDIT)

Purpose

NICDIT provides **financial and institutional support** for corridor development.

Budget Allocation

- **₹3,000 crore allocated under Budget Estimates 2026–27**

Role

- Ensures **efficient implementation of corridor projects**
- Supports **project financing and coordination**

Major Industrial Corridors in India

Several industrial corridors are under development to promote **regional economic integration**.

Examples

Industrial Corridor	Key Regions
Delhi–Mumbai Industrial Corridor (DMIC)	North and Western India
Chennai–Bengaluru Industrial Corridor (CBIC)	Southern India
Amritsar–Kolkata Industrial Corridor (AKIC)	Northern and Eastern India
East Coast Economic Corridor (ECEC)	Eastern coastal regions

These corridors aim to enhance **connectivity, manufacturing capacity, and export competitiveness**.

Significance of Industrial Corridors

Industrial corridors contribute to **economic transformation and industrial modernization**.

1. Promotion of Manufacturing Growth

Industrial corridors support the **expansion of manufacturing sectors**.

Impact

- Increased **industrial production**
- Support for initiatives such as **Make in India**

2. Integration with Global Supply Chains

Improved logistics and infrastructure enable Indian industries to integrate with **global value chains**.

Benefits

- Increased **export competitiveness**
- Attraction of **foreign direct investment (FDI)**

3. Balanced Regional Development

Corridors stimulate **industrial development in multiple regions**.

Outcome

- Reduced regional economic disparities
- Development of **new urban-industrial hubs**

4. Employment Generation

Industrial corridor projects generate employment across sectors.

Employment Areas

- Manufacturing
- Construction
- Logistics and services

5. Sustainable Urban Development

The NICDP promotes **Low-Carbon Cities (LCCs)**.

Focus

- Energy-efficient infrastructure
- Sustainable urban planning

Challenges Associated with Industrial Corridors

Despite their potential, industrial corridor projects face several challenges.

1. Land Acquisition Issues

Large-scale industrial projects require **significant land for development**.

Example

The **Delhi–Mumbai Industrial Corridor (DMIC)** requires extensive land for **greenfield industrial zones**.

Problem

- Smaller states often face **land availability constraints**.

2. Lack of Institutional Coordination

Multiple agencies are involved in industrial corridor development.

Example

In the **Chennai–Bengaluru Industrial Corridor (CBIC)**:

- Industrial estates such as the **Tumakuru Industrial Township** operate independently of local authorities.

Impact

- Administrative inefficiencies
- Delays in project implementation

3. Limited State-Level Support

Effective corridor development requires **strong coordination between central and state governments**.

Issues

- Differences in policy priorities
- Delays in approvals

4. Skill and Capacity Constraints

Industrial projects require **skilled manpower and administrative capacity**.

Problem

- Lack of trained staff for managing complex projects.

5. Environmental Concerns

Environmental Impact Assessments (EIA) sometimes fail to adequately incorporate **local community perspectives**.

Consequences

- Environmental degradation
- Public opposition to projects

Way Forward

1. Strengthening Centre–State Coordination

Establish better coordination mechanisms between **central agencies, state governments, and local bodies**.

2. Transparent Land Acquisition

Adopt fair compensation and **community engagement mechanisms**.

3. Skill Development

Promote **industrial training programs aligned with corridor projects**.

4. Sustainable Infrastructure Development

Integrate **green technologies and environmental safeguards**.

Conclusion

Industrial corridors represent a crucial strategy for transforming India's **industrial ecosystem and enhancing manufacturing competitiveness**. Through improved infrastructure, investment attraction, and regional integration, these corridors can drive **economic growth, employment generation, and global supply chain participation**. However, addressing challenges related to **land acquisition, institutional coordination, and environmental sustainability** will be essential to ensure the **long-term success of India's industrial corridor initiatives**.

Keywords: *Industrial Corridors, Infrastructure Development, Manufacturing Growth, Global Supply Chains, Regional Economic Integration.*

Mains Practice Question

Industrial corridors are crucial for strengthening India's manufacturing ecosystem. Discuss their significance and examine the challenges associated with their implementation.

New GDP Series (Base Year 2022–23): Enhancing Measurement of India's Economy

📌 **Syllabus Mapping:**
✅ **GS Paper III – Indian Economy**

- **National Income Accounting and Economic Growth**
- **Government policies and statistical systems in economic planning**

Introduction

The **Ministry of Statistics and Programme Implementation (MoSPI)** has released a **new series of Annual and Quarterly National Accounts Estimates**, including revised estimates of **Gross Domestic Product (GDP)**. The new series updates the **base year to 2022–23 from the earlier 2011–12**, incorporating improved data sources, refined estimation techniques, and updated economic structures. The revision reflects **structural changes in the Indian economy**, such as the expansion of digital services, platform-based employment, and evolving consumption patterns.

Understanding GDP and Base Year Revision

What is GDP?

Gross Domestic Product (GDP) represents the **total monetary value of all final goods and services produced within a country during a specific period**.

Importance

GDP is widely used to:

- Measure **economic growth**
- Assess **economic performance**
- Guide **policy planning and fiscal decisions**

What is a Base Year?

The **base year** is the reference year used for calculating **real GDP**, allowing economists to compare economic growth after adjusting for price changes.

Purpose of Revising the Base Year

- Reflect **current economic structure**
- Incorporate **new data sources and sectors**
- Improve **accuracy of national income estimates**

Key Changes in the New GDP Series

The updated GDP series introduces several methodological improvements.

1. New Base Year: 2022–23

The base year has been shifted from **2011–12 to 2022–23**.

Reason for Selection

FY **2022–23** was considered the most recent **"normal economic year" after COVID-19 disruptions during 2019–2021**.

Importance

The revision ensures that GDP estimates better reflect **current economic realities**.

2. Integration of New Data Sources

The new GDP series incorporates **high-frequency and administrative data**.

Major Data Sources Used

- **GST collections**
- **e-Vahan portal** (vehicle registration data)
- **Public Financial Management System (PFMS)**

Impact

- Improves **accuracy and timeliness of economic data**
- Better captures **formal and digital economic activities**

3. Improved Deflation Techniques

The new series adopts **double deflation** instead of the earlier **single deflation** method.

Single Deflation (Earlier Method)

- Adjusted only the **output price index**.

Double Deflation (New Method)

- Adjusts both:
  - **Input prices**
  - **Output prices**

Application

Used in **manufacturing and agriculture sectors**.

Benefit

Provides **more precise measurement of real economic value added**.

4. Integration of Supply and Use Tables (SUT)

The revised series aligns **Supply and Use Tables with national accounts**.

Purpose

- Reduce discrepancies between:
  - **Production-based GDP**
  - **Expenditure-based GDP**

Outcome

Improves **consistency and reliability of GDP estimates**.

5. Improved Estimation of Private Final Consumption Expenditure (PFCE)

PFCE represents **household consumption expenditure**, which is a major component of GDP.

New Estimation Methods

- Direct estimation from **production data**
- Use of **administrative datasets**

- **Commodity flow approach**

Impact

Provides a **more realistic estimate of consumption demand**.

6. Adjustments in Government Accounts

Government estimates now incorporate **pension system changes**.

Key Inclusion

Integration of:

- **National Pension System (NPS)**
- **Old Pension Scheme (OPS)**

Importance

Ensures better representation of **public sector financial obligations**.

7. Inclusion of Emerging Economic Activities

The revised GDP series captures previously underrepresented sectors.

Newly Included Activities

- **Hired domestic workers**
- **Digital and gig economy platforms**

New Data Sources

- **Annual Survey of Unincorporated Sector Enterprises (ASUSE)**
- **Periodic Labour Force Survey (PLFS)**

Benefit

Improves measurement of **informal and household sector contributions**.

Reasons for Revising the GDP Base Year

Periodic revisions are necessary due to structural changes in the economy.

1. Structural Transformation of the Economy

Over the past decade, India's economy has seen rapid growth in:

1. **Digital services**
2. **Renewable energy**
3. **E-commerce and gig economy**

The new base year better captures these changes.

2. Alignment with International Best Practices

The **United Nations Statistical Commission** recommends periodic updates to national accounts to ensure **comparability and accuracy**.

Implications of the New GDP Series

The revised estimates have important macroeconomic implications.

1. Revision in GDP Size

Under the new series:

- The **nominal GDP size for FY 2025–26 is revised downward by around 3.3–3.8%**.

- Estimated at **₹345.47 lakh crore**.

Real Growth

However, the **real GDP growth rate increased to around 7.6% for FY 2025–26**.

2. Higher Fiscal Deficit Ratio

Due to the lower GDP base: The **fiscal deficit ratio increased from 4.36% to 4.51% of GDP for FY 2025–26**.

Explanation: When GDP decreases while deficit remains unchanged, the **deficit-to-GDP ratio rises**.

3. Increase in Debt-to-GDP Ratio

The **central government's debt-to-GDP ratio** has also increased.

New Estimate: 57.5% for FY 2026–27

Earlier Target: 55.6%

Policy Challenge

This may complicate the government's objective of **reducing central debt to 50% of GDP by 2031**.

Significance of the New GDP Series

Dimension	Importance
Statistical Accuracy	More reliable economic estimates
Policy Planning	Better macroeconomic policy formulation
Global Comparability	Alignment with international statistical standards
Economic Representation	Captures digital and informal economy

Challenges and Concerns

1. Interpretation Complexity: Frequent revisions may create confusion in **economic comparisons over time**.

2. Fiscal Policy Implications: Lower GDP estimates can increase **fiscal deficit and debt ratios**.

3. Data Reliability: Reliance on administrative datasets requires **strong data governance and transparency**.

Way Forward

1. Strengthening Statistical Systems: Enhance data collection mechanisms through **digital governance and real-time datasets**.

2. Improving Transparency: Provide clear explanations to ensure **public understanding of GDP revisions**.

3. Integrating Emerging Sectors: Continue improving methods to capture **digital economy, gig work, and services sector growth**.

Conclusion

The **new GDP series with base year 2022–23** represents an important step toward modernizing India's **national income accounting framework**. By integrating improved data sources, adopting advanced deflation techniques, and capturing emerging economic activities, the revision provides a **more accurate picture of India's evolving economy**. While the new estimates may affect fiscal indicators in the short term, they strengthen the **credibility and robustness of India's economic statistics**, which is crucial for informed policymaking and global economic comparisons.

Keywords: *GDP Base Year Revision, National Accounts, Double Deflation, Economic Measurement, Fiscal Indicators.*

Mains Practice Question

Why are GDP base years periodically revised? Discuss the key features and implications of India's new GDP series with base year 2022–23.

SOCIETY & SOCIAL JUSTICE

Rising Organ Donation and Transplantation in India: Institutional and Policy Drivers

📌 **Syllabus Mapping:**
✅ **GS Paper II – Governance and Social Justice**

- **Issues relating to development and management of social sector services relating to health**
- **Government policies and interventions for health sector**

✅ **GS Paper III – Science and Technology**

- **Biotechnology and medical advancements**

Introduction

India has witnessed a **significant surge in organ donation and transplantation in recent years**, reflecting improvements in healthcare infrastructure, public awareness, and institutional mechanisms. According to the **Ministry of Health and Family Welfare (MoHFW)**, the number of organ transplants in the country has increased **nearly fourfold—from fewer than 5,000 in 2013 to about 20,000 in 2025**. Importantly, around **18% of these transplants involve organs donated by deceased donors**, indicating growing acceptance of **cadaveric organ donation** in India.

Trends in Organ Donation and Transplantation in India

Growth Over the Past Decade

Year	Number of Organ Transplants
2013	Fewer than **5,000**
2025	Nearly **20,000**

Key Observation

- Rising share of **cadaveric donations (about 18%)**
- Expansion of **organ transplant infrastructure**

This growth indicates progress in **public awareness, institutional capacity, and medical technology**.

Factors Behind the Rise in Organ Donation

Several policy interventions and institutional reforms have contributed to the growth of organ donation in India.

1. Strengthening Institutional Capacity

India has developed a **coordinated national system for organ transplantation**.

National Organ and Tissue Transplant Organization (NOTTO)

- Functions as the **national coordination authority**.
- Maintains **organ donation registries and transplant databases**.
- Facilitates coordination among hospitals and transplant centers.

Supporting Institutions

- **Regional Organ and Tissue Transplant Organizations (ROTTOs)**
- **State Organ and Tissue Transplant Organizations (SOTTOs)**

Impact

- Improved **organ allocation and matching**
- Better **coordination among transplant centers**

2. Development of Green Corridors

A key innovation in organ transplantation logistics is the **creation of Green Corridors**.

What are Green Corridors?

- **Special traffic-free routes** created to transport harvested organs rapidly between hospitals.

Importance

- Minimizes **transportation time**
- Preserves **organ viability**
- Improves **transplant success rates**

Green corridors have played a crucial role in **efficient organ transportation in major cities**.

3. Increasing Public Awareness and Participation

Public awareness regarding organ donation has increased significantly.

Key Development

Since **September 17, 2023**, more than **4.8 lakh citizens have registered for organ and tissue donation** through an **Aadhaar-based verification system**.

Impact

- Expands the **national donor pool**
- Encourages **voluntary organ donation**

This reflects a gradual shift in **societal attitudes toward organ donation**.

4. Improved Healthcare Infrastructure

Advancements in healthcare systems have strengthened transplantation capabilities.

Key Improvements

- Enhanced **donor identification systems**
- Improved **organ retrieval mechanisms**
- Better **coordination between hospitals**

Institutional Collaboration

Coordination among:

- **Central government**
- **State governments**
- **Medical institutions**
- **Civil society organizations**

has significantly improved **transplant efficiency**.

Organ Transplantation Framework in India

India has established a comprehensive legal and institutional framework to regulate organ transplantation.

1. Legal Framework

Transplantation of Human Organs and Tissues Act (THOTA), 1994

This law was enacted to regulate **organ donation and transplantation in India**.

Key Objectives

- Prevent **commercial trading of human organs**
- Establish **ethical guidelines for organ donation**
- Promote **cadaveric organ donation**

The Act has been amended several times to improve regulatory oversight.

2. Three-Tier Institutional Structure

The transplantation system operates through a **three-tier regulatory mechanism**.

Institution	Role
NOTTO	Apex national body coordinating organ donation and transplantation
ROTTO	Regional coordination between states
SOTTO	State-level implementation and monitoring

This structure ensures **efficient coordination and transparency in organ allocation**.

3. National Organ Transplant Programme (NOTP)

The **National Organ Transplant Programme** is a **Central Sector Scheme** aimed at improving access to transplantation.

Objectives

- Strengthen **organ transplant infrastructure**
- Promote **cadaveric organ donation**
- Improve **training and capacity building of medical professionals**

Outcome

Expands **equitable access to life-saving organ transplants**.

Challenges in Organ Donation in India

Despite significant progress, several challenges remain.

1. Low Cadaveric Donation Rate

Compared to developed countries, India still has a **relatively low deceased donor rate**.

2. Awareness and Cultural Barriers

Social myths and misconceptions continue to discourage **organ donation in certain communities**.

3. Infrastructure Gaps

Many hospitals lack the **specialized facilities required for organ retrieval and transplantation**.

4. Illegal Organ Trade

Despite regulations, **illegal organ trafficking networks** remain a concern.

Way Forward

1. Strengthening Awareness Campaigns

Public education programs to promote **voluntary organ donation**.

2. Expanding Transplant Infrastructure

Develop more **organ transplant centers across states**.

3. Improving Organ Sharing Networks

Use **digital platforms and national registries** for faster organ matching.

4. Ethical Oversight

Strict enforcement of **THOTA regulations** to prevent organ trafficking.

Conclusion

India's progress in organ donation and transplantation reflects the success of **policy reforms, institutional strengthening, and public awareness initiatives**. The nearly **fourfold increase in organ transplants over the past decade**demonstrates growing capacity within the healthcare system. However, sustaining this momentum will require **greater public participation, improved infrastructure, and strict regulatory oversight** to ensure ethical and equitable access to life-saving organ transplants.

Keywords: *Cadaveric Donation, Organ Transplant Infrastructure, NOTTO Framework, Public Awareness, Ethical Healthcare Governance.*

Mains Practice Question

Discuss the institutional and policy measures that have contributed to the growth of organ donation and transplantation in India. What challenges remain in strengthening the organ transplantation ecosystem?

AI and Gender Empowerment: Casebook on Gender-Responsive AI Solutions

📌 **Syllabus Mapping:**
✅ **GS Paper II – Governance and Social Justice**

- **Women empowerment and gender equality**
- **Government policies and interventions for vulnerable sections**

✅ **GS Paper III – Science and Technology**

- **Artificial Intelligence and emerging technologies**
- **Technology for inclusive development**

Introduction

A **Casebook on Artificial Intelligence and Gender Empowerment** has been launched as a collaborative initiative of the **Ministry of Electronics and Information Technology (MeitY)** and **UN Women**, with support from the **Ministry of Women and Child Development (MoWCD)**. The publication highlights **gender-responsive AI innovations emerging from the Global South**, demonstrating how artificial intelligence can help address **structural gender inequalities in healthcare, legal access, education, and public safety**.

Concept of Gender-Responsive Artificial Intelligence

Gender-responsive AI refers to the design and deployment of AI systems that:

- Address **gender-specific challenges**
- Promote **women's empowerment**
- Reduce **gender biases in technology and governance**

Importance

Historically, technological systems have sometimes reinforced **existing gender biases** due to unequal representation in datasets and decision-making structures. Gender-responsive AI aims to **ensure equitable outcomes in digital innovation**.

Role of Artificial Intelligence in Gender Empowerment

AI technologies can support women's empowerment across multiple sectors.

1. Healthcare and Menstrual Health

AI-driven healthcare systems can improve **diagnostic accuracy and accessibility of health information**, especially for women.

Example

Smart Kojin

- Uses **Natural Language Processing (NLP)**.
- Provides **confidential and judgment-free information about menstrual health** through chat-based interfaces.

Impact

- Enhances **health awareness among women**

- Reduces stigma around **reproductive health issues**

2. Prevention of Gender-Based Violence

Artificial Intelligence can strengthen mechanisms to address **gender-based violence and legal barriers**.

Example

NyayaSakhi–SWATI

- An AI-based system assisting **domestic violence survivors**.
- Provides **estimates of statutory reliefs and expected legal timelines**.

Significance

- Enables **informed legal decisions**
- Supports **pre-litigation counselling and planning**

3. Access to Justice and Legal Services

AI platforms can empower women by providing **digital awareness and legal assistance**.

Example

YASHODA AI

- Helps women identify **AI-driven harms and digital threats**.
- Promotes **digital hygiene practices**.
- Provides access to **legal remedies and support services**.

Outcome

- Strengthens **digital rights awareness**
- Improves **legal empowerment of marginalized women**

4. Education and Skill Development

AI can transform education systems by providing **personalized learning opportunities**.

Example

AtenIA

- AI-powered platform offering **interactive mentorship for young girls**.
- Enables conversations with **STEM role models**.

Impact

- Encourages **female participation in STEM fields**
- Challenges **traditional gender stereotypes in education**

5. Women's Safety in Public Spaces

AI technologies can enhance **urban safety and emergency response mechanisms**.

Example

NariRaksha

- Uses **geospatial analytics, computer vision, and NLP**.
- Identifies potential safety risks in urban environments.

Benefits

- Enables **faster institutional response**
- Enhances **women's confidence in public spaces**

Significance of the Casebook Initiative

The casebook serves as an important platform to showcase **innovative solutions from the Global South**.

1. Promoting Inclusive Technology

Encourages development of AI solutions that **address social inequalities**.

2. Knowledge Sharing

Provides **case studies and best practices** for policymakers and researchers.

3. Supporting Digital Gender Equality

Highlights how technology can support **Sustainable Development Goal (SDG) 5 – Gender Equality**.

4. Strengthening Global South Leadership

Demonstrates the role of developing countries in creating **socially inclusive AI innovations**.

Challenges in AI-driven Gender Empowerment

Despite its potential, several challenges remain.

1. Algorithmic Bias: AI systems trained on biased data may reproduce **gender stereotypes and discrimination**.

2. Digital Divide: Limited access to digital technologies in rural areas can restrict **women's participation in the digital economy**.

3. Data Privacy Concerns: AI applications handling sensitive personal data require strong **data protection frameworks**.

4. Limited Female Representation in Technology: Women remain underrepresented in **AI research and technology sectors**.

Policy Measures to Promote Gender-Responsive AI

1. Inclusive Data Practices: Ensure datasets represent **diverse gender and social groups**.

2. Strengthening Digital Literacy: Promote **digital and AI literacy programs for women and girls**.

3. Ethical AI Governance: Adopt frameworks ensuring **transparency, fairness, and accountability in AI systems**.

4. Encouraging Women in STEM: Support initiatives promoting **women's participation in science and technology education**.

Conclusion

The **Casebook on AI and Gender Empowerment** highlights the transformative potential of artificial intelligence in addressing **gender inequalities and empowering women**. By showcasing innovative solutions in **healthcare, legal services, education, and public safety**, the initiative demonstrates how **technology can contribute to inclusive development**. However, ensuring ethical AI governance, reducing digital divides, and promoting gender-inclusive technological ecosystems will be crucial for realizing the full potential of **AI-driven gender empowerment**.

Keywords: *Gender-Responsive AI, Women Empowerment, Digital Inclusion, Ethical AI, Social Innovation.*

Mains Practice Question

Artificial Intelligence has the potential to transform gender empowerment in developing societies. Discuss the role of AI in promoting gender equality while highlighting the challenges associated with its implementation.

Rice Fortification under PMGKAY: Policy Pause and Nutritional Implications

📌 **Syllabus Mapping:**
✅ **GS Paper II – Governance and Social Justice**

- **Government policies and interventions for vulnerable sections**

- **Food security and nutrition programs**

✅ **GS Paper III – Indian Economy**

- **Public Distribution System (PDS) and food security**

Introduction

The Government of India has **temporarily discontinued rice fortification under the Pradhan Mantri Garib Kalyan Anna Yojana (PMGKAY)** following findings from a study conducted by **IIT Kharagpur**. The study revealed that **prolonged storage conditions affect the stability and shelf life of fortified rice**, potentially reducing the intended nutritional benefits. This development has renewed debate regarding the **implementation challenges of large-scale food fortification programmes in India's food security framework**.

Understanding Food Fortification

Definition: Food fortification refers to the **deliberate addition of essential micronutrients (vitamins and minerals) to food products** to improve their nutritional quality.

Purpose

- Address **micronutrient deficiencies**
- Improve **public health outcomes**
- Enhance the **nutritional value of commonly consumed foods**

Food fortification is considered a **cost-effective public health intervention**.

Rice Fortification in India

Rice fortification involves blending **Fortified Rice Kernels (FRK)** with regular rice.

Fortified Rice Composition

FRK typically contains added nutrients such as:

- **Iron**
- **Vitamin B12**
- **Folic Acid**

These kernels are mixed with regular rice in a ratio during processing and distributed through government welfare schemes.

Reason for Temporary Discontinuation

The decision to pause rice fortification under PMGKAY was influenced by research findings.

Key Findings of the IIT Kharagpur Study

The study highlighted that **storage conditions significantly affect the stability of fortified rice**.

Major Factors Affecting Shelf Life

- **Moisture content**
- **Storage conditions**
- **Temperature variations**
- **Relative humidity**
- **Packaging materials**

These factors can reduce the **nutritional stability of Fortified Rice Kernels**, thereby limiting the expected health benefits.

Food Fortification Regulatory Framework in India

India has established regulatory standards to guide food fortification practices.

FSSAI Fortification Regulations (2018)

The **Food Safety and Standards Authority of India (FSSAI)** introduced:

Food Safety and Standards (Fortification of Foods) Regulations, 2018

Objectives

- Establish **standards for fortified food products**
- Ensure **quality and safety of fortified foods**

Fortified Foods in India

Several food products distributed through welfare schemes are fortified with micronutrients.

Major Fortified Foods

Food Item	Nutrients Added
Rice and Wheat Flour	Iron, Vitamin B12, Folic Acid
Milk and Edible Oil	Vitamins A and D
Double Fortified Salt	Iodine and Iron

These foods are distributed through **government nutrition and food security programmes**.

Integration of Fortified Rice in Food Safety Net Programs

The government had planned a large-scale rollout of fortified rice.

Implementation Plan

- All **custom-milled rice under PMGKAY and other food safety programmes** was to be replaced with **fortified rice by March 2024**.
- Distribution was planned to continue **until December 2028**.

Coverage

Fortified rice was intended for:

- **Public Distribution System (PDS)**
- **Pradhan Mantri Garib Kalyan Anna Yojana**
- **PM-POSHAN (Mid-Day Meal) Scheme**

Significance of Food Fortification

Food fortification plays a crucial role in addressing **malnutrition and micronutrient deficiencies**.

1. Addressing Micronutrient Deficiencies

India faces a significant burden of **hidden hunger**, caused by deficiencies in essential vitamins and minerals.

Major Deficiencies

Nutrient	Health Impact
Vitamin A	Night blindness
Iodine	Goitre and thyroid disorders
Iron	Anaemia
Folic Acid	Birth defects and developmental issues

Food fortification helps address these deficiencies in **large populations at low cost**.

2. Improving Public Health Outcomes

Fortified foods contribute to:

- Better **maternal and child health**
- Reduced **anaemia prevalence**
- Improved **cognitive development among children**

3. Economic Benefits

According to the **Copenhagen Consensus**, food fortification provides substantial economic returns.

Estimate

- **Every ₹1 spent on fortification generates approximately ₹9 in economic benefits.**

Reasons

- Increased **workforce productivity**
- Reduced **healthcare expenditure**

Challenges in Large-Scale Food Fortification

Despite its benefits, several operational challenges exist.

1. Storage and Supply Chain Issues

As highlighted by the IIT Kharagpur study, improper storage conditions can affect the **stability of fortified nutrients**.

2. Quality Control

Ensuring consistent nutrient levels across large-scale food distribution systems is difficult.

3. Public Awareness

Limited awareness among beneficiaries about the **importance of fortified foods** may affect acceptance.

4. Logistical Constraints

Fortified rice production requires **specialized processing infrastructure**, which may not be uniformly available.

Way Forward

1. Improving Storage and Packaging Systems

Use advanced **moisture-resistant packaging and temperature-controlled storage**.

2. Strengthening Monitoring Mechanisms

Enhance **quality control and nutrient stability testing**.

3. Research and Innovation

Invest in **improved fortification technologies** to increase shelf life.

4. Nutrition Awareness Campaigns

Educate beneficiaries about the **health benefits of fortified foods**.

Conclusion

Food fortification remains an important strategy for addressing **micronutrient deficiencies and improving public health outcomes in India**. While the temporary discontinuation of rice fortification under PMGKAY highlights operational challenges related to **storage and nutrient stability**, it also underscores the need for **better supply chain management, technological improvements, and stronger monitoring systems**. With appropriate reforms, food fortification can continue to play a vital role in strengthening **India's nutrition security framework**.

Keywords: *Food Fortification, Micronutrient Deficiency, Public Distribution System, Nutrition Security, Hidden Hunger.*

Mains Practice Question

Food fortification is considered an effective strategy for addressing micronutrient deficiencies in India. Discuss its significance and examine the challenges associated with its implementation in food security programmes.

ENVIRONMENT & ECOLOGY

Supreme Court Transfers River Pollution Monitoring to the National Green Tribunal

📌 **Syllabus Mapping:**
✅ **GS Paper III – Environment and Ecology**

- **Conservation, environmental pollution and degradation**
- **Environmental impact assessment and pollution control**

✅ **GS Paper II – Polity and Governance**

- **Role of judiciary and environmental institutions**
- **Environmental governance and regulatory mechanisms**

Introduction

The **Supreme Court of India** has recently decided to **transfer the responsibility of monitoring river pollution cases to the National Green Tribunal (NGT)**, closing its **2021 suo motu proceedings** on polluted rivers after observing limited progress over five years. The Court reiterated that the **right to live in hygienic conditions with dignity and a clean environment forms an integral part of the Right to Life under Article 21 of the Constitution**. This move aims to strengthen **institutional oversight and expedite environmental adjudication** through specialized tribunals.

River Pollution in India: Current Status

The **Central Pollution Control Board (CPCB)** periodically assesses water quality across rivers in India.

Definition: Polluted River Stretch (PRS)

A river stretch is categorized as polluted when:

- **Biochemical Oxygen Demand (BOD) exceeds 3 mg/L**

Understanding BOD

Biochemical Oxygen Demand (BOD) is a key indicator of water quality.

- It measures the **amount of dissolved oxygen required by microorganisms to decompose organic matter in water**.

Implication

Higher BOD levels indicate **higher organic pollution and lower water quality**.

Extent of River Pollution (CPCB Report 2025)

The CPCB assessment reveals significant levels of pollution in Indian rivers.

Key Findings

Indicator	Status
Rivers assessed	645 rivers
Polluted river stretches	296 stretches
Rivers affected	271 rivers
States/UTs affected	32 states and Union Territories

State with Highest Polluted Stretches

- **Maharashtra – 54 polluted stretches**

Examples of Polluted Rivers

Several major rivers across India have been identified as polluted.

River	Location

Yamuna	Delhi
Sabarmati	Ahmedabad
Chambal	Madhya Pradesh
Tungabhadra	Karnataka
Sarabanga	Tamil Nadu

These rivers are crucial for **urban water supply, agriculture, and ecological balance**, making pollution a serious concern.

Major Sources of River Pollution

River pollution in India arises from multiple anthropogenic activities.

1. Untreated Sewage

Sewage discharge is the **largest contributor to river pollution**.

Data

According to **CPCB estimates**, **more than 60% of untreated sewage is released into rivers daily**.

Causes

- Inadequate **sewage treatment plants (STPs)**
- Rapid **urbanization and population growth**
- Poor municipal waste management

2. Industrial Effluents

Industries discharge **toxic wastewater containing chemicals and heavy metals** into rivers.

Major Polluting Industries

- Chemical manufacturing
- Sugar mills
- Paper and pulp industries
- Tanneries

Impact

- Contamination of **drinking water sources**
- Damage to **aquatic ecosystems**

3. Other Contributing Factors

Additional causes include:

- **Municipal solid waste dumping**
- **Agricultural runoff containing fertilizers and pesticides**
- **Illegal sand mining**
- **Encroachment of riverbanks**

These activities degrade **river ecology and water quality**.

Role of Judiciary in Environmental Protection

Indian courts have played a significant role in strengthening **environmental jurisprudence**.

Article 21 Interpretation

The Supreme Court has expanded the meaning of **Right to Life under Article 21** to include:

- Right to **clean air**
- Right to **safe drinking water**
- Right to **a pollution-free environment**

This interpretation is rooted in the principle of **environmental justice**.

National Green Tribunal (NGT)

The **National Green Tribunal** is a specialized judicial body dealing with environmental matters.

Establishment

- Created under the **National Green Tribunal Act, 2010**

Key Functions

- Adjudication of **environmental disputes**
- Enforcement of **environmental laws**
- Providing **speedy environmental justice**

Jurisdiction

Covers laws such as:

- Water (Prevention and Control of Pollution) Act
- Environment Protection Act
- Forest Conservation Act

The transfer of river pollution oversight to NGT ensures **specialized monitoring and faster dispute resolution**.

Government Initiatives for River Rejuvenation

The government has launched multiple programmes to address river pollution.

1. Namami Gange Programme (2014)

A flagship programme aimed at **cleaning and rejuvenating the Ganga river**.

Key Components

- Wastewater treatment
- Solid waste management
- Riverfront development
- Biodiversity conservation

2. Yamuna Action Plan (1993)

A dedicated initiative to improve **water quality of the Yamuna river**, particularly in urban stretches.

Focus Areas

- Construction of **sewage treatment plants**
- Pollution control measures

3. National River Conservation Plan (NRCP)

A **centrally sponsored scheme** for pollution abatement in rivers outside the **Ganga basin**.

Objectives

- Improve **water quality**
- Reduce **sewage and industrial discharge**

Use of Technology in River Monitoring

Advanced technologies are increasingly used for pollution monitoring.

Technologies Used

- **LiDAR (Light Detection and Ranging)** technology
- **Drone-based surveys**

Purpose

- Identify **drains discharging waste into rivers**
- Map **pollution sources**
- Support **data-driven policy interventions**

Challenges in River Pollution Control

Despite multiple initiatives, several challenges remain.

1. Inadequate Sewage Infrastructure

Many cities lack sufficient **sewage treatment capacity**.

2. Weak Enforcement

Environmental regulations often face **poor compliance and monitoring**.

3. Fragmented Institutional Coordination

Multiple agencies are involved, leading to **coordination challenges**.

4. Rapid Urbanization

Urban expansion increases **waste generation and pollution load**.

Way Forward

1. Strengthening Sewage Treatment Infrastructure

Expand capacity of **sewage treatment plants (STPs)**.

2. Integrated River Basin Management

Adopt **holistic watershed and basin-level planning**.

3. Stronger Enforcement Mechanisms

Ensure strict implementation of **pollution control laws**.

4. Community Participation

Encourage public awareness and **community-based river conservation initiatives**.

Conclusion

The **Supreme Court's decision to transfer river pollution monitoring to the National Green Tribunal** highlights the need for **specialized institutional oversight in environmental governance**. With **296 polluted river stretches across India**, river pollution remains a critical environmental challenge affecting **public health, biodiversity, and water security**. Strengthening **regulatory enforcement, infrastructure development, technological monitoring, and community participation** will be essential to ensure the **sustainable rejuvenation of India's rivers**.

Keywords: *River Pollution, Environmental Governance, Article 21, National Green Tribunal, River Rejuvenation.*

Mains Practice Question

River pollution remains one of the major environmental challenges in India. Examine the causes of river pollution and evaluate the role of institutional mechanisms such as the National Green Tribunal in addressing this issue.

Scientific River Ranching for Restoring Indigenous Fish Stocks in the Ganga

📌 **Syllabus Mapping:**
✅ **GS Paper III – Environment and Ecology**

- **Conservation of biodiversity and aquatic ecosystems**
- **Sustainable management of natural resources**

✅ **GS Paper III – Agriculture and Allied Sectors**

- **Fisheries sector and blue economy**

Introduction

The **River Ganga**, one of India's most ecologically and culturally significant rivers, has witnessed a decline in **native fish species due to pollution, habitat degradation, and overfishing**. To address this issue, the **ICAR–Central Inland Fisheries Research Institute (ICAR-CIFRI)** has implemented **scientific river ranching under the Namami Gange Programme**. This initiative aims to **replenish indigenous fish populations, restore riverine biodiversity, and support sustainable fisheries livelihoods**.

Understanding River Ranching

Definition

River ranching is a **sustainable aquaculture practice** where fish are bred and raised in controlled environments during their early life stages and later released into natural water bodies.

Process

- **Breeding and hatchery rearing** of fish larvae.
- **Raising juveniles in captivity** until they reach a viable stage.
- **Releasing them into rivers** to grow naturally.
- Fish are later **harvested after reaching maturity**.

Conservation Approach

River ranching represents an **ex-situ conservation strategy**, meaning species are conserved outside their natural habitat during early life stages before being reintroduced into the ecosystem.

Significance of Scientific River Ranching

River ranching plays an important role in restoring **riverine ecosystems and fisheries resources**.

1. Restoration of Indigenous Fish Species

Many native fish species in the Ganga have declined due to **habitat loss and environmental stress**.

River ranching helps:

- Replenish **threatened indigenous species**
- Maintain **genetic diversity of fish populations**

2. Revival of Riverine Fisheries

Declining fish stocks directly affect the livelihoods of **traditional fishing communities**.

Impact

- Increased fish populations
- Improved **fishery productivity**
- Enhanced **income opportunities for fishermen**

3. Ecological Balance in River Systems

Healthy fish populations contribute to maintaining **ecological balance in aquatic ecosystems**.

Benefits

- Stabilization of **food chains**
- Improved **river ecosystem health**
- Protection of **aquatic biodiversity**

4. Sustainable Fisheries Management

River ranching promotes **scientific fisheries management**.

Outcomes

- Reduced **overexploitation of natural fish stocks**
- Improved **long-term sustainability of fisheries**

Namami Gange Programme (NGM)

The river ranching initiative operates under the broader **Namami Gange Programme**, which focuses on restoring the ecological health of the Ganga.

Background

- Approved in **2014 as an Integrated Conservation Mission**
- Initially planned until **March 2021**
- Later extended until **March 2026 under Namami Gange Mission 2.0**

Objective

The programme aims to ensure:

- **Pollution abatement**
- **Ecological rejuvenation of the Ganga River**

Major Pillars of the Namami Gange Programme

The mission is based on a comprehensive approach addressing multiple dimensions of river conservation.

Pillar	Focus Area
Sewage Treatment	Construction of sewage treatment plants
Riverfront Development	Infrastructure along riverbanks
River Surface Cleaning	Removal of floating waste
Afforestation	Plantation along riverbanks
Biodiversity Conservation	Protection of aquatic species
Public Awareness	Community participation
Effluent Management	Industrial pollution control
Ganga Gram Initiative	Sustainable development of villages along the river

Implementation Mechanism

Nodal Agency: National Mission for Clean Ganga (NMCG)

Administrative Framework

- Operates under the **Ministry of Jal Shakti**
- Supported by **state and district-level agencies**

This structure ensures **coordinated action across multiple stakeholders**.

Status of Inland Fisheries in India

India has emerged as a major global player in fisheries production.

Global Position

1. **Second-largest fish-producing country in the world**

Contribution to Global Production

- Approximately **8% share in global fish production**

Importance of Inland Fisheries

Inland fisheries form the backbone of India's fisheries sector.

Contribution

- Over **75% of India's total fish production** comes from **inland water bodies**.

Key Sources

- Rivers
- Lakes
- Reservoirs
- Ponds

This highlights the importance of **river ecosystem conservation for fisheries sustainability**.

Government Initiatives for Fisheries Development

India has launched several schemes to strengthen the fisheries sector.

1. Fisheries and Aquaculture Infrastructure Development Fund (FIDF)

Objective

Provide financial support for:

- Creation of **fisheries infrastructure**
- Development of **modern fish processing facilities**

2. Pradhan Mantri Matsya Sampada Yojana (PMMSY)

PMMSY aims to transform India's fisheries sector through:

- Increased **fish production**
- Adoption of **modern technologies**
- Strengthening **post-harvest infrastructure**

3. Other Policy Initiatives

Additional programmes supporting fisheries include:

- **National Marine Fisheries Policy (2017)**
- **Blue Revolution Scheme**

These initiatives collectively promote **sustainable fisheries development and livelihood security**.

Challenges in Riverine Fish Conservation

Despite these initiatives, several challenges persist.

1. River Pollution: water temperature and flow patterns affect **fish breeding cycles**.

Way Forward

1. Integrated River Basin Management: Adopt ecosystem-based approaches for **river conservation and fisheries management**.

2. Strengthening Hatchery Infrastructure: Expand scientific fish breeding and **river ranching programmes**.

3. Community Participation: Involve **local fishing communities in conservation efforts**.

4. Pollution Control Measures: Improve sewage treatment and enforce **strict industrial effluent regulations**.

Conclusion

Scientific **river ranching under the Namami Gange Programme** represents an innovative approach to restoring **indigenous fish populations and ecological balance in the River Ganga**. By combining **aquatic biodiversity conservation with sustainable fisheries management**, the initiative supports both **environmental protection and socio-economic development of fishing communities**. Continued investment in scientific research, pollution control, and community participation will be essential for ensuring the **long-term health of India's river ecosystems**.

Keywords: *River Ranching, Aquatic Biodiversity, Sustainable Fisheries, Namami Gange, Inland Fisheries.*

Mains Practice Question

Discuss the concept of river ranching and evaluate its role in restoring aquatic biodiversity and promoting sustainable fisheries in India.

SCIENCE & TECHNOLOGY

India–Brazil Strategic Partnership: Outcomes of the Brazilian President's State Visit (2026)

📌 **Syllabus Mapping:**
✅ **GS Paper II – International Relations**

- India and the World
- Bilateral, regional and global groupings involving India and affecting India's interests
- India's relations with key global partners

Introduction

The **state visit of the President of Brazil to India (February 2026)** marked an important milestone in strengthening **India–Brazil bilateral relations**. The visit concluded with a series of agreements and policy initiatives aimed at expanding cooperation in **trade, digital technology, strategic minerals, renewable energy, and people-to-people connectivity**. Both nations also decided to **raise their bilateral trade target to $30 billion by 2030**, highlighting the growing economic and strategic convergence between two major **Global South powers**.

Key Outcomes of the Visit

1. Expansion of Bilateral Trade Targets

- India and Brazil revised their **bilateral trade goal from $20 billion to $30 billion by 2030**.
- This reflects the steady growth of economic engagement between the two emerging economies.

Trade Trends

Year	Bilateral Trade
2024	Moderate growth
2025	**USD 15.21 billion (25% growth)**
Target 2030	**USD 30 billion**

Significance

- Strengthens **South–South economic cooperation**.
- Diversifies India's trade partnerships beyond traditional Western markets.
- Promotes **agricultural trade, energy cooperation, and mineral supply chains**.

2. Strategic Agreements and Memorandums of Understanding

During the visit, **10 Memorandums of Understanding (MoUs)** were signed across key sectors.

Major Areas Covered

1. Rare Earth and Critical Minerals: Cooperation in exploration and supply of **critical minerals essential for clean energy technologies, electronics, and defence sectors**.

2. Postal Sector Cooperation: Enhancing **logistics, postal connectivity, and digital postal services** between the two countries.

3. MSME Entrepreneurship: Joint initiatives to support **small and medium enterprises**, innovation, and start-up ecosystems.

4. Pharmaceutical Regulations: Collaboration in **regulatory frameworks for pharmaceutical trade and healthcare products**.

Strategic Importance

- Reduces dependency on **concentrated global supply chains (especially in critical minerals)**.
- Strengthens **industrial and technological cooperation**.

3. Digital Partnership for the Future

India and Brazil adopted a **Joint Declaration and Action Plan for Digital Cooperation**.

Focus Areas

- Digital public infrastructure
- Cybersecurity collaboration
- Artificial Intelligence and emerging technologies
- Data governance and digital innovation ecosystems

Relevance

India's **Digital Public Infrastructure (DPI)** such as:

- **UPI**
- **Aadhaar**
- **Digital governance platforms**

could serve as **models for digital transformation in Global South countries**, including Brazil.

4. Visa Facilitation and People-to-People Contact

To enhance mobility and exchanges:

- Validity of **multiple-entry tourist and business visas** increased from **5 years to 10 years**.
- The change applies **reciprocally** to citizens of both countries.

Expected Impact

- Increased **tourism flows**
- Stronger **business interactions**
- Greater **academic and cultural exchanges**

India–Brazil Relations: Background and Evolution

1. Diplomatic Foundations

- Diplomatic relations established in **1948**.
- Upgraded to a **Strategic Partnership in 2006**.

Brazil is one of India's **key partners in Latin America**.

2. Cooperation in Multilateral Forums

India and Brazil collaborate extensively in **global governance institutions**, including:

Forum	Purpose
BRICS	Economic cooperation among emerging economies
BASIC	Climate negotiations group (Brazil, South Africa, India, China)
G-20	Global economic governance
G-4	Advocacy for UN Security Council reform
IBSA	South–South cooperation platform

They also work together in organizations such as:

- **United Nations**
- **World Trade Organization**
- **UNESCO**
- **World Intellectual Property Organization (WIPO)**

Strategic Significance

Both countries advocate:

- **Multilateralism**
- **Reform of global governance institutions**

- **Greater representation for developing countries**

3. Trade and Economic Cooperation

India engages with Brazil through the **India–MERCOSUR Preferential Trade Agreement**.

Key Trade Items

India exports

- Pharmaceuticals
- Automobiles
- Chemicals
- Textiles

India imports

- Crude oil
- Agricultural commodities (such as soy products)
- Gold and minerals

Brazil is **India's largest trading partner in Latin America**.

4. Renewable Energy Cooperation

Energy transition is a major pillar of India–Brazil cooperation.

Key Initiatives

Global Biofuel Alliance

- Brazil became a **co-founding member** alongside India and other partners.
- Focus on **sustainable biofuels and ethanol-based energy systems**.

International Solar Alliance (ISA)

- Brazil ratified the **ISA agreement in 2022**.
- Collaboration focuses on **solar energy deployment and climate action**.

Strategic Importance

- Supports **global climate commitments**
- Promotes **clean energy technologies**
- Strengthens **energy security**

Broader Strategic Significance of the Visit

Dimension	Implication
Geopolitical	Strengthens Global South cooperation
Economic	Expands trade and investment opportunities
Technological	Boosts digital innovation partnerships
Energy Transition	Enhances renewable and biofuel collaboration
Multilateral Diplomacy	Reinforces joint stance on UN reforms

Challenges in India–Brazil Relations

Despite growing cooperation, certain issues remain:

- **Geographical distance and logistics costs**
- **Limited trade diversification**
- **Regulatory barriers in agricultural and industrial sectors**
- **Underdeveloped connectivity between South America and South Asia**

Addressing these constraints is essential for achieving the **$30 billion trade target by 2030**.

Way Forward

To deepen India–Brazil partnership, the following measures are crucial:

- **Expansion of Trade Agreements**

  - Upgrading the **India–MERCOSUR trade agreement**.
- **Supply Chain Collaboration**
  - Joint development of **critical mineral supply chains**.
- **Technology Partnerships**
  - Collaboration in **AI, digital infrastructure, and space technologies**.
- **Green Energy Cooperation**
  - Scaling up **biofuel and solar energy projects**.
- **Strengthening Global South Platforms**
  - Enhanced cooperation in **BRICS, G-20, and IBSA** to advocate equitable global governance.

Conclusion

The **2026 state visit of Brazil's President to India** has reinforced the **strategic partnership between two major emerging economies**. With enhanced cooperation in **trade, digital technology, critical minerals, and renewable energy**, the partnership reflects a broader effort to strengthen **South–South cooperation and multipolar global governance**. Achieving the **$30 billion trade target by 2030** will require sustained policy engagement, improved connectivity, and deeper economic integration.

Keywords: *Strategic Partnership, Global South Cooperation, Trade Expansion, Digital Partnership, Renewable Energy Diplomacy.*

Mains Practice Question

India–Brazil relations have evolved into a multidimensional strategic partnership in recent years. Examine the key areas of cooperation and assess their significance for India's foreign policy and Global South diplomacy.

U.S. Shift from ALARA: Implications for Global Radiation Safety

📌 **Syllabus Mapping:**
✅ **GS Paper III – Science and Technology**

- **Nuclear Technology and Radiation Safety**
- **Awareness in emerging technologies and safety frameworks**

✅ **GS Paper III – Environment and Disaster Management**

- **Environmental protection and risk management associated with nuclear energy**

Introduction

The **United States Department of Energy (DOE)** has announced the removal of the **"As Low As Reasonably Achievable (ALARA)" principle** from its regulatory directives governing radiation protection. This marks a major shift in radiation safety policy, replacing the long-standing precautionary approach with a **risk-informed framework that prioritizes operational efficiency and cost considerations**. The decision has raised concerns among scientists and regulatory bodies because it may allow **higher radiation exposure for workers**, potentially challenging the globally accepted radiation protection regime.

Foundations of Global Radiation Protection

The international framework for radiation safety has historically been built on **two core principles** that guide nuclear operations, medical radiation use, and research activities.

1. ALARA Principle

ALARA (As Low As Reasonably Achievable) is a fundamental safety principle in radiation protection.

Key Features

- Radiation exposure must be **minimized as much as reasonably possible**.
- Optimization balances **health risks, technological feasibility, and economic considerations**.
- Even when exposure remains within legal limits, efforts must still be made to **reduce radiation doses further**.

Importance

- Protects **workers, the public, and the environment**.
- Encourages continuous **safety improvements in nuclear operations**.
- Forms the **cornerstone of modern radiation safety policies**.

2. LNT (Linear No-Threshold) Model

The **Linear No-Threshold (LNT) model** provides the scientific foundation behind ALARA.

Core Assumption

- **Any level of radiation exposure carries some risk of cancer**.
- The risk **increases linearly with the radiation dose**.

Implications

- There is **no completely safe threshold** for radiation exposure.
- Therefore, **minimizing exposure becomes essential**, even if doses are small.

Recent Policy Shift in the United States

The **U.S. Department of Energy (DOE)** has decided to eliminate ALARA requirements from certain directives.

Key Elements of the Change

- Adoption of a **risk-informed regulatory framework**.
- Greater emphasis on **operational efficiency and cost-effectiveness**.
- Compliance based mainly on **statutory radiation dose limits**, rather than continuous dose reduction.

Concerns Raised

- Workers may receive **higher radiation doses**, although still within legal limits.
- Weakening of the **precautionary safety culture** that has guided radiation protection for decades.
- Potential divergence from **globally accepted safety standards**.

Global Radiation Safety Framework

Radiation protection worldwide is guided by international organizations that establish **scientific recommendations and regulatory frameworks**.

1. International Commission on Radiological Protection (ICRP)

The **ICRP** provides globally recognized recommendations for radiation safety.

Key Functions

- Develops **radiation protection guidelines**
- Advises governments and regulatory bodies
- Supports **scientific research on radiation risks**

ICRP strongly advocates the **optimization principle similar to ALARA**.

2. International Atomic Energy Agency (IAEA)

The **IAEA** promotes safe and peaceful use of nuclear technologies.

Key Role in Radiation Safety

- Establishes **Basic Safety Standards (BSS)**.
- Provides guidance on **radiation protection and nuclear safety**.
- Ensures **international harmonization of safety practices**.

The **IAEA plans to update its 2014 Basic Safety Standards** incorporating the latest recommendations from the ICRP to maintain global acceptance of radiation safety norms.

3. Global Regulatory Approach

Most countries adopt a **two-tier radiation protection system**.

Components

- **Dose Limits**
- **Optimization (ALARA-type principles)**

This approach ensures that exposure remains **both legally limited and practically minimized**.

Radiation Safety Framework in India

India follows a **strict and precautionary radiation protection regime** aligned with global standards.

Regulatory Authority

The **Atomic Energy Regulatory Board (AERB)** regulates radiation safety across all nuclear and radiation facilities.

Key Responsibilities

- Licensing and regulation of **nuclear facilities**
- Monitoring **radiation exposure levels**
- Enforcing **safety standards and compliance**

ALARA in Indian Regulations

India continues to **strictly enforce the ALARA principle** in all nuclear operations.

Key Features

- Worker exposure limit: **20 millisieverts (mSv) per year**
- Despite this limit, facilities must ensure **actual doses remain far below the permitted threshold**.

Areas Where ALARA is Applied

- **Nuclear power plants**
- **Medical radiation facilities**
- **Industrial radiography**
- **Research institutions**

Implications of the U.S. Policy Shift

1. Impact on Global Safety Norms

If widely adopted, the change may:

- Weaken **international consensus on radiation protection**
- Encourage countries to adopt **less precautionary approaches**

2. Worker Safety Concerns

Without ALARA:

- Exposure may approach **maximum permissible limits**
- Long-term health risks could increase.

3. Regulatory Divergence

Differences between the **U.S. regulatory framework and international guidelines** could create inconsistencies in global nuclear governance.

Broader Context: Radiation Use in Modern Society

Radiation technologies are widely used in multiple sectors.

Major Applications

Sector	Application
Energy	Nuclear power generation
Medicine	Radiotherapy and diagnostic imaging
Industry	Non-destructive testing
Agriculture	Food irradiation and crop improvement

Given these widespread applications, **robust radiation safety frameworks are essential**.

Way Forward

To maintain effective radiation protection globally, several measures are necessary.

1. Strengthening International Cooperation: Global institutions like **IAEA and ICRP** must continue harmonizing radiation safety standards.

2. Scientific Review of Radiation Models: Continuous evaluation of **LNT and alternative models** through scientific research.

3. Reinforcing Safety Culture: Nuclear institutions should prioritize **worker protection and precautionary approaches**.

4. Capacity Building: Developing countries must strengthen **regulatory institutions and monitoring capabilities**.

Conclusion

The decision by the **U.S. Department of Energy to remove the ALARA principle** represents a significant shift in radiation protection philosophy. While the move aims to enhance **operational efficiency and cost-effectiveness**, it also raises important questions regarding **worker safety and global regulatory consistency**. As radiation technologies continue to expand across energy, medicine, and industry, maintaining a **robust and precautionary international safety framework** remains essential to protect both human health and the environment.

Keywords: *ALARA Principle, Radiation Protection, Linear No-Threshold Model, Nuclear Safety Governance, Global Radiation Standards.*

Mains Practice Question

Discuss the role of the ALARA principle in global radiation safety frameworks. Examine the implications of the United States' decision to move away from this approach for international nuclear governance.

Artificial Intelligence as a Catalyst for Inclusive Rural Development in India

📌 **Syllabus Mapping:**
✅ **GS Paper III – Science and Technology**

- **Artificial Intelligence and emerging technologies**
- **Applications of technology in governance and development**

✅ **GS Paper II – Governance**

- **E-governance initiatives and service delivery**
- **Government policies for rural development and inclusive growth**

Introduction

Artificial Intelligence (AI) is increasingly emerging as a **transformative tool for governance and development** in India. By integrating **advanced data analytics, predictive modelling, and digital platforms**, AI can significantly enhance **inclusive rural development**. India's approach combines a **national AI strategy focused on inclusive growth with a robust governance architecture**, making it particularly suitable for addressing **rural development challenges and socially sensitive contexts**.

Role of Artificial Intelligence in Inclusive Rural Development

AI technologies can support rural development by enabling **data-driven decision-making, efficient resource allocation, and targeted service delivery**.

1. Identifying Underserved Villages

AI systems can analyze large datasets to identify **development gaps in rural areas**.

Key Data Source

- **Mission Antyodaya database**

Areas Assessed

- Healthcare facilities
- Education access
- Sanitation coverage

Impact: Helps policymakers **prioritize villages with the greatest development deficits**, ensuring targeted intervention.

2. Predictive Planning for Future Development

AI can generate **predictive insights about future development needs**.

Variables Considered

- Population growth
- Economic activity
- Migration trends
- Infrastructure usage patterns

Benefits

- Enables **long-term planning for rural infrastructure**
- Improves **resource allocation efficiency**

3. Infrastructure Gap Identification

AI tools can help locate villages lacking **critical infrastructure services**.

Example

Using data from **Pradhan Mantri Gram Sadak Yojana (PMGSY)**, AI can identify:

- Villages without all-weather roads
- Connectivity gaps between rural and urban markets

Outcome

Supports **evidence-based infrastructure development**.

Government Initiatives Promoting AI in Rural Development

India has introduced several digital initiatives that integrate **AI technologies with rural governance frameworks**.

1. Decentralised Rural E-Governance

AI-enabled tools are strengthening **local governance and participatory democracy**.

Key Platforms

SabhaSaar: AI-powered platform that **automatically generates minutes of Gram Sabha and Panchayat meetings**.

eGram Swaraj: Digital platform for **planning, monitoring, and implementation of Panchayat projects**.

Gram Manchitra: GIS-based tool to support **village-level development planning**.

Impact

- Improves **administrative transparency**
- Enhances **data-driven decision-making at the grassroots level**

2. Infrastructure and Asset Monitoring

AI tools are also used for monitoring **public infrastructure assets**.

Major Platforms

BhuPRAHARI: Tracks and monitors **assets created under government schemes**.

Digital Shram Setu Mission: Focuses on improving welfare and support systems for **informal sector workers**.

Significance

- Ensures **efficient utilization of public resources**
- Improves **accountability in rural infrastructure projects**

Sectoral Applications of AI in Rural Development

AI is increasingly applied across multiple sectors critical for rural livelihoods.

1. Agriculture and Food Security

AI technologies are helping farmers make **better decisions regarding crop production and pest management**.

Key Initiatives

Kisan e-Mitra: AI-powered **virtual assistant** providing information on government schemes.

National Pest Surveillance System: Uses AI for **real-time pest detection and monitoring**.

Crop Health Monitoring: Satellite and AI-based systems track **crop conditions and yield potential**.

Precision Farming: AI helps optimize **water use, fertilizers, and crop management practices**.

Impact

- Improves **agricultural productivity**
- Reduces **crop losses**

2. Education

AI is transforming access to **quality education in rural areas**.

Major Platforms

DIKSHA (Digital Infrastructure for Knowledge Sharing)

- Developed by **NCERT**
- Provides **digital learning resources for teachers and students**.

YUVAI (Youth for Unnati and Vikas with AI)

- Program designed to develop **AI literacy and socio-technical skills among students in grades 8–12**.

Outcome

- Bridges **digital learning gaps**
- Builds **future-ready skills among rural youth**

3. Healthcare

AI-driven innovations are improving **healthcare delivery in rural regions**.

Example

Suman Sakhi WhatsApp Chatbot (Madhya Pradesh)

- Provides **maternal and newborn health information** to rural women.
- Uses **digital messaging platforms to reach remote populations**.

Benefits

- Enhances **maternal and child health awareness**
- Improves **access to healthcare information**

Multilingual Governance through AI

Language diversity has often been a barrier in digital governance. AI tools are addressing this challenge.

1. BHASHINI

BHASHINI is an AI-enabled language platform providing:

- Translation services
- Speech-to-text tools
- Voice-based interfaces

Coverage

Supports **more than 36 Indian languages**.

Impact

- Enables **inclusive digital governance**
- Improves access to government services for **non-English speakers**

2. BharatGen

BharatGen is India's **first government-funded sovereign Large Language Model (LLM)**.

Features

- Multilingual
- Multimodal AI capabilities

Purpose

- Strengthen **India's indigenous AI ecosystem**
- Support **public sector AI applications**

3. Adi Vaani

Adi Vaani focuses on addressing **communication barriers faced by tribal communities**.

Significance

- Enhances **inclusion of marginalized communities**
- Preserves **linguistic diversity**

Societal Benefits of AI in Rural Development

Dimension	Impact
Governance	Data-driven rural planning
Agriculture	Improved crop productivity
Education	Expanded digital learning access
Healthcare	Better health awareness and service delivery
Social Inclusion	Multilingual digital services

Challenges in Using AI for Rural Development

Despite its potential, several challenges remain.

1. Digital Divide: Limited internet connectivity in remote rural regions.

2. Data Availability: Reliable datasets are essential for effective AI models.

3. Skill Gaps: Lack of digital literacy among rural populations.

4. Ethical Concerns: Issues related to **data privacy and algorithmic bias**.

Way Forward

1. Expanding Digital Infrastructure: Improve **internet connectivity and broadband penetration** in rural areas.

2. Capacity Building: Enhance **digital literacy and AI skills among rural communities**.

3. Strengthening Public Data Systems: Develop reliable datasets for **AI-driven policymaking**.

4. Ethical AI Governance: Ensure transparency, accountability, and protection of **citizen data rights**.

Conclusion

Artificial Intelligence holds immense potential to become a **foundational driver of inclusive rural development in India**. By enabling **data-driven governance, efficient infrastructure planning, improved agricultural productivity, and multilingual service delivery**, AI can help bridge development gaps between urban and rural regions. However, its success will depend on **strengthening digital infrastructure, building human capacity, and ensuring ethical use of technology**.

Keywords: *Artificial Intelligence, Rural Development, Digital Governance, Precision Agriculture, Inclusive Technology.*

Mains Practice Question

Artificial Intelligence has the potential to transform rural development in India. Discuss its applications in governance, agriculture, education, and healthcare while highlighting the challenges associated with its implementation.

Blockchain-Based Digital Governance in India

📌 **Syllabus Mapping:**

✅ **GS Paper III – Science and Technology**

- **Emerging technologies such as Blockchain and their applications**
- **Indigenization of technology and digital innovation**

✅ **GS Paper II – Governance**

- **E-governance initiatives and service delivery**
- **Transparency, accountability and citizen-centric governance**

Introduction

Blockchain technology is increasingly emerging as a **transformative tool in digital governance**, offering secure, transparent, and tamper-proof systems for managing public records and services. In this direction, the **Ministry of Electronics and Information Technology (MeitY)** along with the **Centre for Development of Advanced Computing (C-DAC)** launched the **"Blockchain India Challenge."** The initiative encourages **Indian startups to develop innovative blockchain-based solutions for governance and public service delivery**, aiming to strengthen transparency and efficiency in government systems.

Understanding Blockchain Technology

Blockchain is a **decentralized and distributed digital ledger technology** that records transactions across multiple nodes in a secure and transparent manner.

Core Features of Blockchain

Feature	Explanation
Decentralization	Data is stored across multiple systems rather than a single central authority
Immutability	Once recorded, data cannot be altered or deleted
Transparency	Transactions can be verified by authorized participants
Cryptographic Security	Uses encryption to ensure data integrity and security
Consensus Mechanism	Transactions are validated collectively by network participants

These features make blockchain highly suitable for **governance applications requiring secure record management**.

Role of Blockchain in Digital Governance

Blockchain can significantly enhance **efficiency, transparency, and accountability** in public administration.

1. Secure Certificates and Document Management

One major governance challenge is **document fraud and verification delays**.

Government Initiative

Certificate Chain (developed by the National Informatics Centre – NIC)

Key Features

- Secure digital storage of certificates
- Tamper-proof verification mechanism
- Faster document retrieval

Impact

- Prevents **fake certificates**
- Reduces **bureaucratic delays**

2. Logistics and Supply Chain Management

Blockchain can improve **traceability and transparency in supply chains**.

Example

Aushada System – Karnataka

Functions

- Tracks medicines from **manufacturers to hospitals**
- Records **quality checks and distribution stages**

Benefits

- Patients can verify:
  - Manufacturer details
  - Expiry dates
  - Drug authenticity

Outcome

Reduces **spurious medicines and corruption in medical supply chains**.

3. Judicial Administration

Blockchain technology can support **efficient management of judicial records**.

Example

Inter-Operable Criminal Justice System (ICJS)

Features

- Integrates police, courts, prisons, and forensic institutions.
- Provides a **unified digital platform for case records and evidence management**.

Impact

- Improves **case tracking**
- Enhances **data integrity in criminal justice processes**

4. Property and Land Record Management

Land ownership disputes remain a major governance challenge in India.

Blockchain-Based Property Management Systems

These systems record:

- Property ownership
- Transaction history
- Legal rights and liabilities

Benefits

- Reduces **fraudulent property transactions**
- Speeds up **dispute resolution**
- Enhances **transparency in land administration**

5. Other Emerging Blockchain Applications

Several proof-of-concept projects are being explored.

Potential Applications

- **Remote voting systems**
- **GST monitoring and tax compliance**
- **Blood bank management**
- **Public Distribution System (PDS)**

These applications aim to improve **transparency, accountability, and efficiency in public services**.

Government Initiatives Promoting Blockchain

India has developed several institutional frameworks to encourage blockchain adoption.

1. National Blockchain Framework (NBF)

The **National Blockchain Framework**, developed by **MeitY**, provides a **standardized architecture for deploying blockchain solutions in government services**.

Key Components

Component	Function
Vishvasya Stack	National blockchain infrastructure
NBFLite	Lightweight blockchain framework
Praamaanik	Verification and authentication tools

Objective

- Provide **secure and scalable blockchain infrastructure**
- Promote **interoperability between government systems**

2. Centre of Excellence in Blockchain Technology

The government has established a **Centre of Excellence (CoE) in Blockchain Technology**.

Functions

- Provide **Blockchain-as-a-Service (BaaS)** infrastructure
- Support government departments in implementing blockchain applications
- Encourage **research and innovation in blockchain technologies**

3. Blockchain in Land Records

Several states have begun experimenting with **blockchain-based land record systems**.

States Involved

- **Andhra Pradesh**
- **Telangana**
- **Maharashtra**

Purpose

- Digitize property records
- Reduce **land disputes and fraud**
- Improve **efficiency of property registration**

Advantages of Blockchain in Governance

Dimension	Impact
Transparency	Reduces corruption and fraud
Efficiency	Faster service delivery
Data Security	Tamper-proof record management
Trust in Institutions	Enhances citizen confidence
Cost Reduction	Minimizes administrative overhead

Challenges in Implementing Blockchain Governance

Despite its potential, several obstacles remain.

1. Technical Complexity: Blockchain systems require **advanced technical infrastructure and expertise**.

2. Scalability Issues: Handling **large volumes of government data** can be challenging.

3. Legal and Regulatory Framework

Clear regulations are needed for:

- Data protection
- Digital signatures
- Legal recognition of blockchain records

4. Interoperability

Ensuring compatibility between **existing digital governance systems and blockchain platforms**.

Way Forward

1. Strengthening Digital Infrastructure: Improve cloud infrastructure and **secure data networks**.

2. Capacity Building: Train government officials in **blockchain technologies and digital governance**.

3. Developing Regulatory Frameworks: Establish legal guidelines for **blockchain transactions and digital records**.

4. Public–Private Collaboration: Encourage partnerships between **government agencies, startups, and research institutions**.

Conclusion

Blockchain technology has the potential to significantly transform **digital governance in India** by enabling **secure, transparent, and tamper-proof record systems**. Initiatives such as the **Blockchain India Challenge, National Blockchain Framework, and state-level pilots in land records** demonstrate India's growing commitment to adopting this technology. With appropriate **regulatory frameworks, capacity building, and infrastructure development**, blockchain could become a key pillar of **transparent, efficient, and citizen-centric governance**.

Keywords: *Blockchain Governance, Decentralized Ledger, Digital Transparency, Secure Public Records, E-Governance Innovation.*

Mains Practice Question

Discuss the potential of blockchain technology in transforming digital governance in India. Highlight its applications and examine the challenges associated with its implementation.

LIGO-India: Expanding India's Role in Gravitational Wave Astronomy

📌 **Syllabus Mapping:**
✅ **GS Paper III – Science and Technology**

- **Developments in science and technology and their applications**
- **Indigenization of technology and international scientific collaboration**

Introduction

India is taking a significant step in frontier scientific research with the development of **LIGO-India (Laser Interferometer Gravitational Wave Observatory)**. Recently, **Larsen & Toubro (L&T)** secured a contract from the **Department of Atomic Energy (DAE)** to construct the observatory at **Aundha in Hingoli district, Maharashtra**. LIGO-India will become part of the **global network of gravitational wave detectors**, strengthening international efforts to study cosmic phenomena and expanding India's capabilities in **astrophysics, precision engineering, and advanced instrumentation**.

Understanding LIGO (Laser Interferometer Gravitational Wave Observatory)

Objective

LIGO is an **interferometer-based observatory** designed to detect **gravitational waves**, which are extremely small distortions in space-time caused by powerful cosmic events.

Gravitational Waves

Definition: **Gravitational waves** are **ripples in the fabric of space-time** produced by extremely energetic astronomical events.

Examples of Sources

- **Collisions of black holes**
- **Merging neutron stars**
- **Supernova explosions**
- **Orbiting massive celestial bodies**

Characteristics

- Travel at the **speed of light**
- Carry **information about their origin**
- Provide clues about **the nature of gravity and the structure of the universe**

Theoretical Origin

The existence of gravitational waves was first predicted by:

Albert Einstein in 1916, through his **General Theory of Relativity**.

However, they remained undetected for nearly a century.

First Detection

The first direct detection of gravitational waves occurred in **2015 at LIGO-USA**, confirming Einstein's prediction and opening a new field known as **gravitational wave astronomy**.

Working Principle of LIGO

LIGO detects gravitational waves using a highly sensitive technique called **laser interferometry**.

Key Concept

When gravitational waves pass through space, they cause **extremely tiny distortions in space-time**.

LIGO measures these distortions.

Structure of the LIGO Detector

The observatory consists of **two perpendicular vacuum tunnels forming an L-shape**.

Key Features

- **Length of arms:** 4 kilometers each
- **Ultra-high vacuum environment**
- Highly precise mirrors and laser systems

Working Process

- A **laser beam is split into two beams**.
- The beams travel along the **two perpendicular arms**.
- They are **reflected by mirrors** at the ends.
- The beams recombine to form an **interference pattern**.

If a gravitational wave passes:

- One arm slightly **stretches**
- The other slightly **compresses**

This change alters the **interference pattern**, allowing scientists to detect the gravitational wave.

LIGO-India Project

Approval and Background

The **Government of India approved LIGO-India in 2016** to strengthen the **global gravitational wave detection network**.

Location: **Aundha, Hingoli district, Maharashtra**

Institutional Collaboration

LIGO-India is being developed through collaboration between multiple national and international agencies.

Indian Agencies

- **Department of Atomic Energy (DAE)**
- **Department of Science and Technology (DST)**

International Collaboration

- **National Science Foundation (NSF), USA**

This partnership was established through a **Memorandum of Understanding (MoU)**.

Key Indian Research Institutions Involved

Several leading scientific institutions are participating in the project.

Institution	Location
Institute of Plasma Research (IPR)	Gandhinagar
Inter-University Centre for Astronomy and Astrophysics (IUCAA)	Pune
Raja Ramanna Centre for Advanced Technology (RRCAT)	Indore

These institutions contribute expertise in **astrophysics, laser technology, and precision engineering**.

Global Network of Gravitational Wave Observatories

LIGO-India will join a global network of observatories dedicated to gravitational wave detection.

Major Observatories

Observatory	Country
LIGO	United States
VIRGO	Italy
KAGRA	Japan
LIGO-India	India (under development)

Importance of Global Network

Multiple observatories allow scientists to:

- **Locate gravitational wave sources accurately**
- Improve **detection sensitivity**
- Enhance **global scientific collaboration**

Significance of LIGO-India for India

The project holds major scientific, technological, and strategic significance.

1. Advancing Astrophysical Research

LIGO-India will enable Indian scientists to participate directly in **cutting-edge research on cosmic phenomena**, including:

- Black holes
- Neutron stars
- Evolution of the universe

2. Technological Advancement

The project requires extremely advanced technologies such as:

- **Ultra-precision laser systems**
- **High-vacuum engineering**
- **Advanced optics**

This will promote **high-tech manufacturing capabilities in India**.

3. Industrial Collaboration

Companies like **Larsen & Toubro** are involved in building the facility.

Benefits

- Strengthens **industry–research collaboration**
- Encourages development of **advanced engineering technologies**

4. International Scientific Collaboration

LIGO-India strengthens India's participation in **global scientific partnerships**.

Impact

- Enhances India’s role in **international scientific diplomacy**
- Improves collaboration with **leading global research institutions**

5. Capacity Building and Human Resource Development

The project will create opportunities for:

- **Training scientists and engineers**
- Developing expertise in **astrophysics and instrumentation**

Challenges and Considerations

Despite its importance, the project faces certain challenges.

1. High Technological Complexity: Requires extremely precise engineering and infrastructure.

2. Long Project Timeline: Construction and calibration of such facilities can take several years.

3. Funding and Resource Allocation: Large-scale scientific projects require sustained investment.

Conclusion

The **LIGO-India project** represents a major milestone in India’s journey toward becoming a **global leader in frontier scientific research**. By contributing to the international network of gravitational wave observatories, India will play a crucial role in advancing **our understanding of the universe and fundamental physics**. Beyond scientific discovery, the project will drive **technological innovation, industrial growth, and international scientific collaboration**, reinforcing India’s position in the global knowledge economy.

Keywords: *Gravitational Waves, Laser Interferometry, Astrophysics Research, International Scientific Collaboration, Frontier Science.*

Mains Practice Question

Explain the working principle of the Laser Interferometer Gravitational Wave Observatory (LIGO). Discuss the significance of the LIGO-India project for India’s scientific and technological advancement.

Observation of Shock Waves from Coronal Mass Ejections by Indian Scientists

📌 **Syllabus Mapping:**
✅ **GS Paper III – Science and Technology**

- **Space technology and developments in astronomy**
- **Indigenization of technology and scientific research**

Introduction

Indian scientists have recently **observed shock waves generated by Coronal Mass Ejections (CMEs)** using two advanced instruments: the **Gauribidanur Radio Telescope** operated by the **Indian Institute of Astrophysics** and the **Visible Emission Line Coronagraph (VELC)** onboard India’s **Aditya-L1 solar mission**. This observation contributes significantly to the understanding of **solar activity and space weather**, which can directly affect Earth’s technological infrastructure.

About Coronal Mass Ejections (CMEs)

Definition: A **Coronal Mass Ejection (CME)** is a **large-scale expulsion of solar plasma and magnetic fields from the Sun's corona (outer atmosphere)**.

Composition of CMEs

CMEs consist of:

- **Solar plasma**
- **Charged particles (electrons and protons)**
- **Magnetic fields**

These massive clouds of charged particles travel through space at extremely high speeds.

Origin of CMEs

CMEs originate from **magnetic disturbances in the Sun's corona**.

Process

- Magnetic field lines in the corona become **twisted and stressed**.
- Sudden **magnetic reconnection** occurs.
- Large amounts of **energy are released**.
- Solar plasma is **ejected into space**.

Associated Solar Phenomena

CMEs are often associated with:

- **Solar flares** (sudden bursts of radiation)
- **Sunspot activity**

However, CMEs can also occur **independently of solar flares**.

Solar Cycle and CME Activity

CMEs occur more frequently during the **solar maximum phase** of the **sunspot cycle**.

Solar Cycle

- The Sun follows an **approximately 11-year cycle of activity**.
- During solar maximum:
  - Sunspot numbers increase
  - Solar eruptions become more frequent
  - CMEs occur more often

Shock Waves Generated by CMEs

Fast-moving CMEs can generate **shock waves in space**.

Mechanism: When CME particles move faster than the **local speed of plasma waves**, they create **shock fronts similar to sonic booms**.

Impact on Earth: These shock waves can interact with **Earth's magnetosphere**, leading to **geomagnetic storms**.

Effects of CMEs on Earth

CMEs can significantly affect Earth's **space environment and technological systems**.

Major Impacts

Impact Area	Effect
Satellites	Damage to satellite electronics
GPS Systems	Navigation disruptions
Radio Communication	Signal disturbances
Power Grids	Possible electrical outages
Auroras	Intensified northern and southern lights
Astronaut Safety	Increased radiation exposure

These phenomena collectively fall under the domain of **space weather**.

Role of the Gauribidanur Radio Telescope

The discovery involved observations from the **Gauribidanur Solar Radio Observatory**.

Key Features

- Operated by the **Indian Institute of Astrophysics**
- Located in **Karnataka**
- Currently **India's only dedicated low-frequency solar radio observatory**

Function

It monitors **radio emissions from the Sun**, which help detect:

- Solar flares
- Coronal mass ejections
- Solar shock waves

Aditya-L1 Mission

The discovery was also supported by the **Visible Emission Line Coronagraph (VELC)** onboard the **Aditya-L1 mission**.

About Aditya-L1

Objective

Aditya-L1 is **India's first dedicated solar mission** designed to study:

- **Photosphere** (Sun's visible surface)
- **Chromosphere**
- **Corona** (outermost layer of the Sun)

Launch Details

- **Launch Year:** 2023
- **Launch Vehicle: PSLV-C57**

Payloads on Aditya-L1

The mission carries **seven scientific payloads**, all developed indigenously.

Types of Instruments

- Electromagnetic detectors
- Particle analyzers
- Magnetic field sensors

Important Instrument

Visible Emission Line Coronagraph (VELC)

- Observes the **solar corona**
- Helps detect **CMEs and solar wind dynamics**

Location of Aditya-L1

The spacecraft is positioned in a **halo orbit around the Sun–Earth Lagrange Point L1**.

Distance from Earth

Approximately **1.5 million kilometers from Earth**.

Understanding Lagrange Point L1

Definition: A **Lagrange point** is a location where the **gravitational forces of two large bodies balance with the orbital motion of a smaller object**.

L1 Characteristics

- Located between **Earth and the Sun**

- Provides **continuous observation of the Sun**
- Ideal for monitoring **solar activity and space weather**

Significance of the Discovery

The observation of CME-induced shock waves holds major scientific and technological importance.

1. Improved Space Weather Prediction

Better understanding of CMEs helps in predicting **geomagnetic storms**, enabling preventive measures.

2. Protection of Critical Infrastructure

Early warnings can protect:

- Satellites
- Communication systems
- Power grids

3. Advancing Solar Physics Research

The discovery enhances knowledge about:

- Solar magnetic dynamics
- Space plasma physics
- Sun–Earth interactions

4. Strengthening India's Space Research Capabilities

The collaboration between **ground-based telescopes and space missions** demonstrates India's growing capabilities in **solar and astrophysical research**.

Conclusion

The observation of **shock waves triggered by Coronal Mass Ejections using the Gauribidanur radio telescope and the Aditya-L1 mission** marks an important achievement in India's space science research. By improving the understanding of **solar eruptions and space weather**, this discovery contributes to safeguarding critical technological infrastructure on Earth while strengthening India's position in **global astrophysical research and solar observation**.

Keywords: *Coronal Mass Ejection, Space Weather, Solar Physics, Aditya-L1 Mission, Lagrange Point.*

Mains Practice Question

What are Coronal Mass Ejections (CMEs)? Discuss their impact on Earth and explain the significance of India's Aditya-L1 mission in advancing solar research.

Women in Science and Technology: Catalysts for Viksit Bharat

📌 **Syllabus Mapping:**
✅ **GS Paper II – Governance and Social Justice**

- **Women empowerment and gender equality**
- **Government policies and interventions for vulnerable sections**

✅ **GS Paper III – Science and Technology**

- **Human resource development in science and technology**

Introduction

National Science Day 2026 (28 February) is being celebrated with the theme **"Women in Science: Catalyzing Viksit Bharat."** The theme highlights the growing contribution of women in **scientific research, innovation, and technological advancement**, emphasizing their role in achieving India's vision of becoming a **developed nation (Viksit Bharat)**. While women have historically contributed to scientific knowledge, modern policies aim to **increase their participation, leadership, and innovation capacity in STEM fields**.

Historical Contributions of Women in Science

Women have played important roles in scientific knowledge across different historical periods.

1. Contributions in Ancient and Medieval India

Women scholars participated in intellectual and scientific traditions.

Examples

Gargi Vachaknavi – A renowned Vedic philosopher who participated in philosophical debates in the **Brihadaranyaka Upanishad**.

Lilavati – Associated with the famous mathematical text **"Lilavati" by Bhaskaracharya**, reflecting early engagement of women in mathematics.

These examples demonstrate that **scientific curiosity and intellectual engagement among women have deep historical roots in India**.

2. Modern Pioneers in Science and Technology

Modern India has witnessed several women scientists contributing to cutting-edge research.

Notable Examples

Scientist	Field	Contribution
Kalpana Chawla	Space Science	First woman of Indian origin in space
Tessy Thomas	Defence Technology	Project Director of India's missile programme
Ritu Karidhal Srivastava	Space Engineering	Key scientist in ISRO's Mars Orbiter Mission

These pioneers have become **role models inspiring young women to pursue STEM careers**.

Status of Women in STEM in India

India has witnessed gradual progress in women's participation in science and technology.

1. Increasing STEM Enrolment

Women's participation in **STEM education** has steadily increased.

Statistics: Female STEM enrolment increased from **38.4% (2014–15)** to **42.6% (2021–22)**.

Global Significance

- According to the **All India Survey on Higher Education (AISHE)**:
- **42.7% of global female STEM graduates are from India**.
- This indicates India's **strong pipeline of female STEM talent**.

2. Rising Participation in Research

Women's involvement in research and development has also improved.

Key Data

Indicator	Growth
Share in extramural R&D	**13% (2000–01) → 28% (2018–19)**
Female researchers	**13.9% (2015) → 18.7% (2018)**

This shows a **gradual but positive shift toward gender inclusion in scientific research**.

Challenges Faced by Women in Science

Despite progress, women continue to face several structural and institutional challenges.

1. Structural Barriers to Workforce Participation

Although female enrolment in STEM education is high, **workforce participation remains lower**.

Key Data

Only **about 27% of the STEM workforce in India is female**.

Reasons

- Hiring biases
- Limited mentorship opportunities
- Gender stereotypes in technical professions

2. Sectoral Gender Gaps

Women's representation varies significantly across STEM disciplines.

Examples

Field	Female Participation
Engineering	~14.5%
Health Sciences	~24.5%

This indicates persistent **disciplinary imbalances in STEM fields**.

3. Work–Life Balance Challenges

Women often face **disproportionate caregiving responsibilities**.

Impact

- Career breaks
- Slower research progression
- Reduced leadership opportunities
- This phenomenon is sometimes described as the **"leaky pipeline" in STEM careers**.

4. Leadership Underrepresentation

Women remain underrepresented in **decision-making and leadership positions** in scientific institutions.

Example: Low proportion of women in **research leadership roles, academic boards, and innovation councils**.

Concept: This barrier is often referred to as the **"glass ceiling effect."**

Government Initiatives for Women in STEM

The Government of India has launched several programmes to support women scientists and researchers.

1. WISE-KIRAN Scheme

Launched by the **Department of Science and Technology (DST)**.

Full Form: Women in Science and Engineering – Knowledge Involvement in Research Advancement through Nurturing

Objective

- Support **women scientists and technologists**
- Encourage **research participation and innovation**

2. Women Scientists Scheme (WOS)

Purpose: Enable **women scientists to re-enter research careers after career breaks**.

Benefit: Helps address the **career interruption challenge faced by women researchers**.

3. CURIE Programme

Consolidation of University Research for Innovation and Excellence in Women Universities

Objective: Strengthen **research infrastructure in women's universities**.

4. Vigyan Jyoti Programme

Aim: Encourage **girls to pursue higher education and careers in STEM disciplines**.

Coverage: Implemented across **250 districts in India**.

5. GATI Initiative

Gender Advancement for Transforming Institutions

Objective: Promote **gender equality and institutional reforms in STEMM fields**:

- Science
- Technology
- Engineering
- Medicine
- Mathematics

Importance of Women's Participation in Science

Greater participation of women in STEM contributes to broader national development.

1. Innovation and Research Diversity

Diverse teams produce **more innovative and inclusive technological solutions**.

2. Economic Growth

Increasing women's participation in STEM can strengthen **knowledge-based economic growth**.

3. Inclusive Development

Gender-balanced science ecosystems support **equitable access to opportunities**.

Way Forward

1. Strengthening Mentorship and Networks: Develop mentorship programmes connecting **young women researchers with senior scientists**.

2. Flexible Work Policies: Promote policies that support **work–life balance for women scientists**.

3. Institutional Gender Audits: Regularly assess **gender representation in scientific institutions**.

4. Early STEM Education: Encourage **girls' participation in science education from school level**.

Conclusion

Women have made significant contributions to **science and technology throughout history**, and their participation continues to grow in modern India. While increasing STEM enrolment reflects positive progress, challenges such as **workforce participation gaps, leadership underrepresentation, and structural barriers** remain. Strengthening policy support, institutional reforms, and mentorship systems will be essential to unlock the full potential of women in science, enabling them to play a crucial role in achieving the vision of **Viksit Bharat through innovation and knowledge-driven growth**.

Keywords: *Women in STEM, Gender Equality, Scientific Innovation, Human Capital Development, Inclusive Growth.*

Mains Practice Question

Discuss the status of women in science and technology in India. Examine the challenges they face and evaluate the effectiveness of government initiatives aimed at promoting gender equality in STEM fields.