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SC blames NTA for leak of 2026 NEET paper

Bench issues notice to Ministry of Education, and NTA, on plea to 'replace or restructure' the body

NTA to file an affidavit on measures to implement recommendations of the monitoring committee

Plea said the NTA did not answer to Parliament, which shielded it from direct audits by the govt

Krishnadas Rajagopal
NEW DELHI

The Supreme Court on Monday squarely blamed the National Testing Agency (NTA) for the National Eligibility-cum-Entrance Test-Undergraduate (NEET-UG), 2026, paper leak, saying the exam body sadly had not learnt its lesson even two years after the previous security breach in 2024.

The hard work of 23 lakh students came to nothing with the cancellation of the examination after it was learnt that the question paper had been leaked.

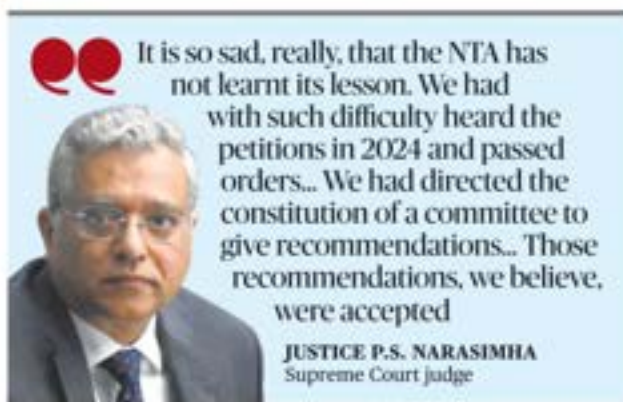
A Central Bureau of Investigation (CBI) probe is under way into the issue and a retest is scheduled on June 21.

"It is so sad, really, that

the NTA has not learnt its lesson. We had with such difficulty heard the petitions in 2024 and passed orders... We had directed the constitution of a committee to give recommendations... Those recommendations, we believe, were accepted... a monitoring/high-powered committee was appointed," Justice P.S. Narasimha, heading a two-judge Bench, observed on Monday while hearing a petition filed by the Federation of All India Medical Association to "replace or fundamentally restructure" the NTA.

Affidavit sought

The Bench directed the NTA to file an affidavit in the next three days on measures taken by it to implement the recommendations of the monitoring/



high-powered committee and listed the case for hearing on an urgent basis later this week.

The top court also issued notices to the Union of India, the Union Ministry of Education, and other respondents arraigned by the petitioners.

A second petition by the United Doctors Front was also heard, which sought the transition of the NTA

from a registered society to a statutory body established by an Act of Parliament to ensure constitutional and parliamentary accountability.

For the Supreme Court, the NEET-UG 2026 paper leak was a repetition from 2024, when over 20 lakh students were affected by a paper leak.

The court had, at the time, taken cognisance of

Pradhan seeks report on CBSE marking glitches

NEW DELHI

Union Minister for Education Dharmendra Pradhan has sought a detailed report on the glitches in the CBSE portal after multiple complaints about the new On Screen Marking system. » PAGE 6

the fiasco and heard petitioners over many days. It had finally not cancelled the 2024 exam, reasoning that the leak had been localised.

However, the apex court had acknowledged the need to reform the exam process. It had directed the constitution of a committee headed by former Indian Space Research Organisation Chairman K.

Radhakrishnan to recommend changes in the way the NTA conducted the crucial annual exam for medical admissions across the country.

The recommendations of the monitoring/high-powered committee included the shift to a computer-based test (CBT) mechanism. Mr. Radhakrishnan has also been asked to file a separate affidavit within the same time period as the NTA on what steps were taken to ensure that the committee's recommendations had been followed.

The petitions have sought sweeping directions to the government to mandate "digital locking" of question papers, and transition to the CBT model to eliminate the physical chain-of-custody risks.

The doctors' body

pointed out that, unlike the Union Public Service Commission or the Staff Selection Commission, the NTA was not directly answerable to Parliament. It operated under the Ministry of Education, shielding it from direct audits by the Comptroller and Auditor General, and mandatory probes by Parliamentary Committees.

"The recurrence proves that cosmetic administrative tweaks and expert committees like the K. Radhakrishnan Committee are inadequate without a fundamental legislative overhaul," the petition has contended.

The doctors' front sought the dissolution of the NTA in its current form and the enactment of a parliamentary Act to create a new testing authority.

- **Key Terms and Explanations**
- **National Testing Agency (NTA)**
 - Established in 2017, the NTA was envisioned as a premier, specialist, and autonomous testing organization to conduct entrance examinations for higher educational institutions. Its primary mandate is to bring responsiveness, error-free delivery, and international standards to large-scale assessments like NEET-UG and JEE Main.
- **Statutory Body vs. Registered Society**
 - **Registered Society:** An entity established under the Societies Registration Act, 1860, typically used for literary, scientific, or charitable purposes. It operates with a high degree of administrative flexibility but lacks direct parliamentary oversight. *Example:* The NTA in its current form.
 - **Statutory Body:** A formal organization created through a specific Act of Parliament. This legislative backing mandates clear lines of accountability, subjects the body to parliamentary scrutiny, and enforces strict statutory rules. *Example:* The University Grants Commission (UGC) or the Union Public Service Commission (UPSC, which is constitutional).
- **Chain-of-Custody Risk**
 - This refers to the vulnerabilities present during the physical handling, storage, and transportation of confidential examination materials. In a paper-and-pencil model, the question paper must travel from secure printing presses to bank vaults, and finally to local examination centers via physical couriers, creating multiple intervention points where security can be breached.
- **Computer-Based Test (CBT) Model**
 - An examination format where questions are delivered and answered digitally on secure computer terminals at designated centers. This model eliminates the need for physical printing and distribution of question papers, replacing it with encrypted digital transmission minutes before the examination commences.
- **Accountability Frameworks (CAG and Parliament)**
 - **Comptroller and Auditor General (CAG):** The constitutional authority responsible for auditing the receipts and expenditures of the government and its bodies, ensuring financial propriety and transparency.
 - **Parliamentary Committees:** Legislative panels (like the Public Accounts Committee) that cross-examine institutional heads, audit administrative failures, and hold organizations directly answerable to the citizens' elected representatives.

- **Main Arguments and Substantive Parts**
- **The Vulnerability of Institutional Agility Without Accountability**
 - The current debate highlights that the administrative flexibility granted to autonomous societies can become an institutional liability if not balanced with stringent oversight. Operating under a ministry rather than a legislative mandate shields an examination body from direct legislative scrutiny, preventing regular performance audits and mandatory parliamentary questioning.
- **The Failure of Cosmetic Administrative Fixes**
 - A recurring crisis reveals that temporary interventions—such as appointing high-powered advisory committees or issuing post-facto guidelines—are fundamentally inadequate. When an institution suffers from deep-rooted operational gaps, structural and legislative overhauls are required rather than minor administrative adjustments.
- **Scale vs. Security in Standardized Testing**
 - Managing examinations for over two million candidates simultaneously presents an unprecedented logistical challenge. The substantive argument here is that the physical model of examination distribution scale introduces systemic vectors of corruption that can only be mitigated by minimizing human intervention through technology.
- **The Erosion of Human Capital and Public Trust**
 - The ultimate consequence of an examination compromise is not merely administrative delay; it is the systemic devaluation of student labor. The cancellation of an exam nullifies months or years of intense preparation, creating a psychological crisis among the youth and diminishing the perceived legitimacy of the state's merit-allocation systems.

- **Historical Evolution of the Issue**
- **Pre-Independence Foundation (1854–1947)**
 - The concept of a centralized, merit-based competitive examination in India dates back to the Macaulay Committee report of 1854, which replaced patronage with open competition for the Civil Services. This established the philosophical precedent that public allocation of positions must be governed by uniform, competitive assessments.
- **Post-Independence Fragmentation (1947–2010s)**
 - Following independence, professional education admissions were highly decentralized. States conducted their own Common Entrance Tests (CETs), alongside national-level exams like the All India Pre-Medical Test (AIPMT). This fragmented landscape was plagued by varying evaluation standards, multiple application fees, and localized institutional corruption.
- **The Era of Centralization (2013–2017)**
 - To curb commercialization, capitation fees, and malpractice in private medical colleges, the central government pushed for a single, unified national examination. Despite initial legal challenges regarding federal autonomy, the Supreme Court mandated the implementation of the National Eligibility-cum-Entrance Test (NEET). In 2017, the Union Cabinet approved the setting up of the NTA to relieve bodies like the CBSE from conducting these massive tests.
- **The Modern Crisis of Institutional Vulnerability (2024–Present)**
 - While centralization resolved the issue of fragmented standards, it created a single point of failure. Recent vulnerabilities exposed in large-scale examinations have shifted the policy discourse from *whether* exams should be centralized to *how* the centralizing agency can be structurally insulated from administrative and security failures.
- **Way Forward**
- **Statutory Restructuring through Parliament**
 - The government should enact a comprehensive "National Testing Authority Act." This law should clearly define the body's powers, structural composition, and accountability mechanisms, subjecting it to direct review by a Parliamentary Standing Committee and mandatory annual auditing by the CAG.
- **Implementation of End-to-End Encrypted Digital Delivery**
 - Transition completely away from the physical distribution of question papers. Implement a multi-layered digital locker system where encrypted exam papers are sent directly to centers via secure virtual private networks (VPNs). These papers should remain locked until unlocked simultaneously nationwide via dynamic, multi-factor authentication keys generated just prior to the start of the exam.
- **Strict Enforcement of the Public Examinations Act**
 - Utilize the legal provisions of the Public Examinations (Prevention of Unfair Means) framework to deter malpractices. This includes imposing severe financial penalties and mandatory prison sentences on institutional heads, coaching syndicates, and third-party vendors found complicit in paper leaks or cheating networks.
- **Decentralized Logistics under Central Digital Supervision**
 - Adopt a hub-and-spoke model where regional university centers share logistical responsibilities, reducing reliance on private schools and outsourced third-party centers. This administrative decentralization should be paired with centralized digital monitoring, utilizing AI-driven proctoring and real-time CCTV feeds to secure the examination environment.

COMPREHENSIVE UPSC ANALYSIS: REFORMING INDIA'S EXAMINATION ARCHITECTURE

AXIA IAS ACADEMY PRESENTS:

[2024: NEET Leak (Localized Breach)]

[2026: NTA Blamed by SC (Repeated Crisis)]



[23 Lakh Students Affected]

[CBI Probe Underway]

[Retest: June 21]

KEY THEMES & DEFINITIONS

- **Chain-of-Custody Risk**
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- **CBT**
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- **Statutory Body vs Society**
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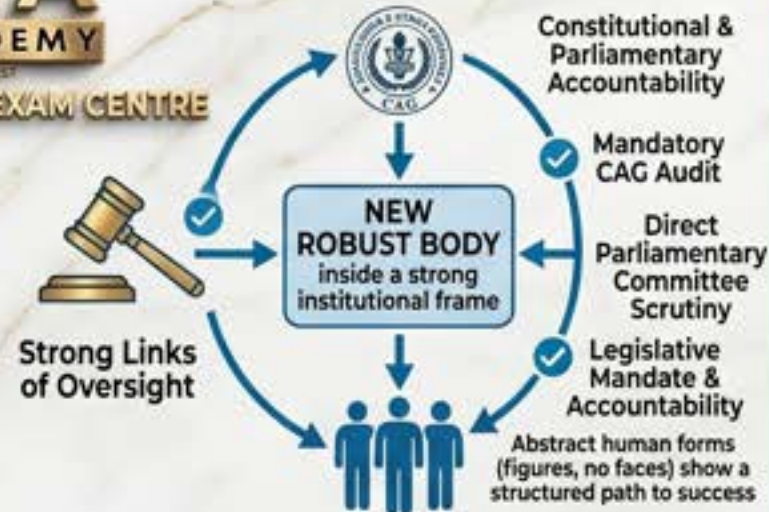


CURRENT NTA MODEL (Society Registration Act)



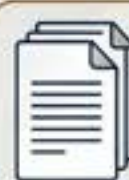
VS

PROPOSED NEW BODY (Statutory Body By Parliamentary Act)



RADHAKRISHNAN COMMITTEE RECOMMENDATIONS

- **Shift to CBT Mechanism**
Destined avittenn roount tewm of CBT and Parliamentary Committees
- **Minimizing Chain-of-Custody Risk**
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- **Decryption Key on Time-Stamp**
Decryption Key of Question Papers are ascete to use and snorean naseepers
- **Digital Locking of Question Papers**
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GS 2: Statutory vs Society Bodies, Institutional Accountability



Parliament Accountability



GS 4: Administrative Accountability & Ethics



Essay: Meritocracy & Public Trust

WAY FORWARD

- Statutory Restructuring Festructuntien Accountability
- Digital Locking in commocent on or paper
- Strict Enforcement in ritioss

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Assam UCC Bill tabled; seeks ban on polygamy

Opposition parties oppose the Bill and demand consultation with all stakeholders; draft legislation excludes Scheduled Tribes from its purview; makes registration of live-in relationships mandatory

The Hindu Bureau
GUWAHATI

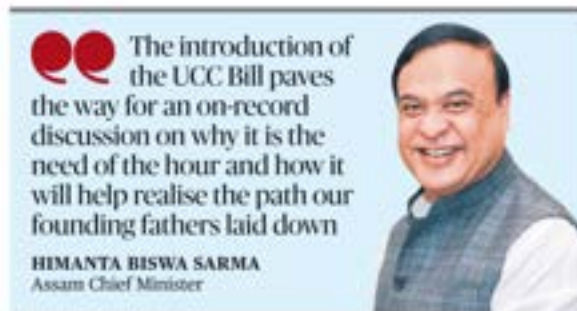
The Assam government on Monday tabled 'The Uniform Civil Code, Assam, 2026 Bill' in the State Assembly, proposing a common law for all residents on matters related to marriage, divorce, succession, and live-in relationships.

Uttarakhand and Gujarat are the two other States that have passed such a law earlier.

Assam Parliamentary Affairs Minister Atul Bora tabled the Bill on behalf of Chief Minister Himanta Biswa Sarma. The MLAs of three Opposition parties opposed the Bill.

"The introduction of the UCC Bill paves the way for an on-record discussion on why it is the need of the hour and how it will help realise the path our founding fathers laid down," the Chief Minister said.

Under the proposed



law, bigamy and polygamy shall invite imprisonment up to seven years under Section 82 of the Bharatiya Nyaya Sanhita, 2023.

The Assam UCC Bill, replacing various religion-based personal laws to ensure "absolute equality and gender justice", excludes Scheduled Tribes from its purview.

The Bill mandates monogamy and sets a standardised legal age of 21 years for grooms and 18 years for brides. The government said the Bill, if passed, would make registration of all marriages and divorces

compulsory to prevent fraud. The Bill codifies uniform grounds for divorce, such as cruelty, desertion, or mutual consent, and ensures the custody of children under five years with the mother.

The Bill creates a uniform, gender-equal order of preference for intestate inheritance among Class-1 heirs, which includes the spouse, children, and parents of the deceased.

The Bill makes the registration of live-in relationships mandatory within a month. "This protects vulnerable individuals by de-

claring that any child born out of a live-in relationship is fully legitimate, and by granting a deserted live-in partner the explicit legal standing to claim financial maintenance through the courts," the statement said. Failure to register a live-in relationship within a month shall attract imprisonment for up to three months or a fine of up to ₹10,000.

The Bill repeals the Assam Compulsory Registration of Muslim Marriages and Divorces Act, 2024, to streamline the State's statutory architecture.

Congress leader Zakir Hussain Sikdar said the "political agenda" of the BJP made the government "bulldoze" the Bill. "The government should have held consultations with political parties and non-political organisations before introducing the Bill in the House," he said. The Bill has been scheduled for discussion on May 27.

- **Key Terms and Explanations**

- **Uniform Civil Code (UCC):** A proposed common set of personal laws governing civil matters such as marriage, divorce, inheritance, adoption, and succession for all citizens, irrespective of their religion, gender, or sexual orientation. Currently, different communities in India are governed by distinct personal laws (e.g., the Hindu Marriage Act, Muslim Personal Law Shariat Application Act).
- **Bigamy and Polygamy:** *Bigamy* is the act of entering into a marriage while still legally married to another person. *Polygamy* is the broader practice of having multiple spouses simultaneously. Under recent state-level UCC legislations, both practices are strictly prohibited across all communities, standardizing criminal penalties.
- **Intestate Succession:** This refers to the distribution of a deceased person's property and assets when they die without leaving a valid legal will. Civil codes establish a uniform statutory hierarchy to determine who inherits the property in such scenarios.
- **Class-1 Heirs:** A primary legal category of immediate relatives who have the first and strongest claim to an individual's property during intestate succession. In a gender-equal code, this group uniformly includes the spouse, children, and parents (including the mother and father equally).
- **Live-in Relationships Registration:** A regulatory mechanism requiring couples residing together in a domestic relationship resembling marriage to officially report their status to a designated state authority within a specified timeframe. Non-compliance results in civil or criminal penalties.
- **Bharatiya Nyaya Sanhita (BNS), 2023:** The primary penal code of India that replaced the colonial-era Indian Penal Code (IPC). State UCC bills cross-reference sections of the BNS to enforce criminal penalties for civil violations like bigamy.
- **Scheduled Tribes (ST) Exemption:** The constitutional and statutory exclusion of indigenous tribal populations protected under the Fifth and Sixth Schedules of the Indian Constitution from the application of uniform civil laws. This preserves their customary community practices and autonomous legal traditions.

- **Main Arguments and Substantive Parts**

- The legislative framework of a state-level Uniform Civil Code centers around standardizing personal laws to achieve equity, balanced against the preservation of cultural federalism.

- **Core Theses and Main Provisions**

- **Absolute Gender Equality:** The primary justification for the code is the elimination of gender-discriminatory practices embedded in traditional personal laws. It guarantees equal rights to women in marriage, divorce, and property inheritance.
- **Standardization of Marriage and Divorce:** The code enforces a strict minimum age of marriage—21 years for grooms and 18 years for brides—and mandates monogamy across all religious denominations. It also establishes identical, codified grounds for divorce (such as mutual consent, desertion, or mental cruelty) for both partners.
- **Compulsory Civil Registration:** It legalizes a mandate for the compulsory registration of all marriages, divorces, and live-in relationships. This serves as a institutional buffer against marital fraud, desertion, and child marriage.
- **Legal Protections in Domestic Partnerships:** By regulating live-in relationships, the legal template ensures that children born from these unions are granted absolute statutory legitimacy. Furthermore, it explicitly empowers deserted live-in partners to claim financial maintenance through family courts.

- **Counterarguments and Institutional Critiques**

- **Procedural Top-Down Implementation:** Critics and opposition factions argue that such sweeping codes are often accelerated through state assemblies without thorough public consultation, cross-party consensus, or deep deliberations with community leaders.
- **Infringement on Cultural Autonomy:** Opponents contend that a single legal template threatens the pluralistic fabric of Indian society by overriding diverse religious rites, shifting the delicate balance between Article 44 (UCC) and Articles 25-26 (Freedom of Religion).
- **Concerns over State Paternalism:** The mandatory registration of live-in relationships under threat of imprisonment is heavily criticized by legal scholars as an overreach of state surveillance, potentially violating the fundamental right to privacy.

- **Historical Evolution of the Issue**

- The journey toward a Uniform Civil Code in India represents a long-standing tension between legal modernization and the preservation of diverse community identities.

- **Colonial Era Foundations**

- **The Lex Loci Report (1840):** The British colonial administration emphasized the importance of uniformity in codifying Indian laws relating to crimes, evidence, and contracts. However, it explicitly recommended leaving the personal laws of Hindus and Muslims completely untouched to avoid triggering widespread social and religious unrest.

- **The B.N. Rau Committee (1941):** Appointed to codify Hindu law, this committee recommended a harmonized civil code that would grant equal rights to women, laying the groundwork for post-independence family law reforms.

- **The Constituent Assembly Debates (1947–1948)**

- **The Compromise of Article 44:** The debate over a common civil code was one of the most polarized in the assembly. Dr. B.R. Ambedkar strongly advocated for a mandatory UCC to ensure gender justice and national integration.

- **Directive Principles:** Due to intense resistance from minority representatives who feared an erosion of their identity, the code was ultimately placed under Article 44 within Part IV of the Constitution as a Directive Principle of State Policy (DPSP), making it aspirational rather than judicially enforceable.

- **Post-Independence Milestones**

- **The Hindu Code Bills (1950s):** Rather than implementing a universal code, the government chose to reform Hindu personal laws sequentially through specific acts covering marriage, succession, and guardianship. This effectively deferred a single uniform code for all citizens.

- **The Shah Bano Case (1985):** The Supreme Court upheld the right of a divorced Muslim woman to claim maintenance under criminal law, observing that a common civil code would help the cause of national integration.

- **The Sarla Mudgal Case (1995):** The apex court re-emphasized that a UCC was necessary to prevent individuals from changing religions solely to circumvent bigamy laws.

- **The Law Commission Consultation (2018):** The 21st Law Commission issued a consultation paper stating that a Uniform Civil Code was "neither necessary nor desirable at this stage," suggesting instead that individual personal laws be systematically reformed from within to remove discriminatory clauses.

- **The Shift to State-Led Legislations (2024–2026):** With the central government deferring a national code, individual states began utilizing Concurrent List powers to enact state-level UCCs. Uttarakhand pioneered this approach, followed by legislative measures in Gujarat and Assam, creating regional templates for uniform civil legislation.

- **Way Forward**

- **1. Phased Consensus-Building and Genuine Consultation**

- Rather than pushing civil codes through state legislatures overnight, governments should launch extensive, transparent consultations with religious scholars, tribal councils, civil society groups, and legal experts from all communities. The focus must be on convincing skeptical groups that a common code aims to secure gender justice and equality, not to erase their unique cultural identity or religious rites.

- **2. De-criminalizing and Reforming Live-in Relationship Rules**

- The punitive sections that mandate jail time for failing to register a live-in relationship should be reconsidered. The state can achieve its goal of protecting women and children by allowing couples to self-declare their relationship to access civil benefits (like joint insurance or maintenance claims) through family courts, removing the heavy-handed threats of police intervention and criminal records.

- **3. Strengthening Local Judicial and Digital Systems**

- Before enforcing mandatory civil registries, states must invest heavily in upgrading their administrative infrastructure:

- Build secure, encrypted online portals to make registering marriages and relationships simple and less prone to local corruption.

- Establish dedicated, well-staffed family courts to handle the anticipated rise in maintenance, child custody, and inheritance cases.

- Conduct continuous gender-sensitization programs for local registrars and police officers to prevent the law from being used for moral policing or harassment.



COMPREHENSIVE ANALYSIS OF THE PROPOSED UNIFORM CIVIL CODE, ASSAM, 2026 BILL



India-U.S. ties, Iran crisis in focus as Quad Foreign Ministers meet today

NEWS ANALYSIS

Sahasini Haidar
NEW DELHI

Foreign Ministers of the Quad will meet for the first time in nearly a year, as External Affairs Minister S. Jaishankar hosts U.S. Secretary of State Marco Rubio, Australian Foreign Minister Penny Wong, and Japanese Foreign Minister Toshimitsu Motegi in Delhi on Tuesday at Delhi's Hyderabad House. The Foreign Ministers will also call on Prime Minister Narendra Modi, an External Affairs Ministry advisory said.

The Ministers last met on July 1, 2025, when they updated the goals for the quadrilateral grouping, simplifying them to four areas: maritime and transnational security, economic prosperity and security, humanitarian assistance and emergency responses, and the launch

of the Quad Critical Minerals Initiative.

However, rapid developments, including the U.S.-Israel strikes on Iran and other actions by the Donald Trump administration, have posed questions over the viability of the grouping, and the Ministers will have their task cut out as they seek to renew their mandate.

In addition, they will discuss whether it is possible to hold the Quad Summit in India later this year, or take a decision to downgrade the grouping by meeting regularly only at the Foreign Minister level, as was the case prior to 2021, given India's difficulties in scheduling the summit in 2024 and 2025.

Trade tensions

In particular, tensions between India and the U.S. in the past year have led to a slowdown in ties, amid differences over the India-Pakistan conflict, strained

trade talks after the U.S. imposed a whopping 50% tariff on Indian goods, Mr. Trump's comments on India being a "dead economy", and immigration restrictions by the U.S. During his four-day visit to India, Mr. Rubio has faced some embarrassment and persistent questions from journalists over the U.S. President reposting an anti-immigrant rant describing India as a "hellhole".

"The President is a big fan of India, a big fan of Prime Minister Modi. I wouldn't be here if the President didn't want me to be here. He wouldn't have sent someone like Sergio [Gor] to be our Ambassador, someone who's very close to the President," Mr. Rubio told journalists on Monday.

"I mean, people say stupid stuff all the time on social media and in every country in the world, unfortunately," he added, in-

dicating "general" comments online.

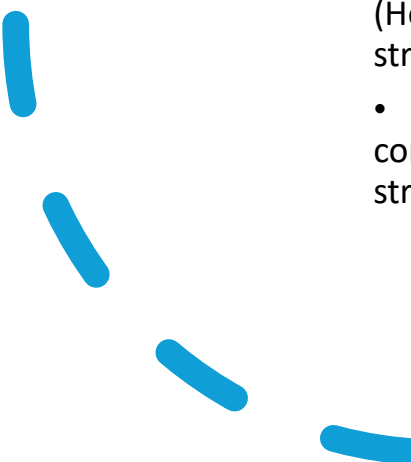
Invitation to PM

Although Mr. Rubio conveyed an invitation to Mr. Modi to visit Washington in the next few months, it is Mr. Trump's turn to visit India, and Mr. Modi is in any case expected to travel to the U.S. for the G-20 Summit in December. Prior to that, his travel schedule has already filled up.

Prioritising the Quad may be more difficult given other engagements. In September, Chinese President Xi Jinping is expected to be in the U.S. to return Mr. Trump's visit to China, which will take precedence. Indications that Washington is seeking a more accommodating position with Beijing could cause concerns for the long-term future of the Indo-Pacific grouping that was set up to counter Chinese actions in the region.



- **Key Terms and Explanations**

- **Quadrilateral Security Dialogue (Quad):** An informal strategic forum comprising India, the United States, Japan, and Australia. It is maintained by semi-regular summits, information exchanges, and joint military drills (such as the Malabar Exercises). It operates not as a military alliance, but as a collaborative platform focused on maintaining a free, open, and rules-based order.
 - **Indo-Pacific Strategic Construct:** A geopolitical concept that integrates the Indian Ocean and the Pacific Ocean into a single, contiguous strategic space. This framework replaces the older "Asia-Pacific" terminology, explicitly elevating India's role as a primary maritime anchor and stabilizer across critical sea lanes of communication.
 - **Quad Critical Minerals Initiative:** A joint functional mechanism designed to map vulnerabilities and secure supply chains for rare earth elements and critical minerals (such as lithium, cobalt, and nickel). The objective is to build collective resilience and reduce near-monopolistic dependencies on single-nation supply chains for green tech and defense manufacturing.
 - **Strategic Autonomy:** A foreign policy doctrine wherein a sovereign nation pursues its national interests and executes external relations without entering into binding, systemic alliances that constrain its independent decision-making. India's simultaneous engagement with the West and its historic partnerships in Eurasia are premier examples.
 - **Functional Downgrading:** The deliberate shift of a multilateral grouping's engagement from the highest political level (Heads of State/Government) to lower bureaucratic or ministerial echelons. This adjustment is typically triggered by structural friction, scheduling gridlocks, or a mutual desire to lower the political visibility of the forum.
 - **Tariff Protectionism:** The economic practice of imposing high import duties on foreign goods to restrict external competition and insulate domestic industries. While serving domestic political mandates, it frequently disrupts bilateral strategic trust by introducing trade volatility between close partners.
- 

- **Main Arguments and Substantive Parts**
 - The structural core of contemporary minilateralism revolves around the tension between shared long-term security anxieties and immediate bilateral frictions. The primary arguments shaping this dynamic include:
 - **The Functional Re-centering of the Quad**
 - The grouping has deliberately narrowed its sprawling agenda down to four core pillars: maritime and transnational security; economic prosperity and infrastructure resilience; humanitarian assistance and disaster relief (HADR); and technology supply-chain security via the Critical Minerals Initiative. This optimization reflects a pragmatic recognition that concrete deliverables in functional niches are more sustainable than sweeping, broad-spectrum political declarations.
 - **Bilateral Protectionism as a Structural Strain**
 - Aggressive economic shifts—such as sudden high-tariff regimes, restrictive immigration postures, and protectionist domestic rhetoric—create acute vulnerabilities within strategic groupings. When a principal partner implements sweeping trade penalties (such as a 50% tariff on a partner's goods) or employs alienating political messaging, it introduces a trust deficit. This economic friction directly threatens the spillover effect needed to sustain high-level security architectures.
 - **Out-of-Region Geopolitical Distractions**
 - Minilateral forums are inherently vulnerable to systemic shocks occurring outside their primary theater. The escalation of conflicts in West Asia, specifically security challenges around the Strait of Hormuz, forces global powers to redirect their diplomatic, military, and financial capital. This diversion dilutes the institutional focus required to maintain momentum in the Indo-Pacific maritime domain.
 - **The Dilemma of Institutional Leveling**
 - A persistent debate exists over whether to sustain the Quad at the Leader-Summit level or return it to a Foreign-Minister-level engagement. While summit-level diplomacy signals maximum political commitment, scheduling bottlenecks and shifting domestic priorities often cause friction. Downgrading to the ministerial level offers operational flexibility and reduces political exposure, but risks signaling institutional fatigue to regional competitors.



- **Way Forward**
- **Institutionalizing the Ministerial and Functional Layers**
 - Diplomats should deliberately de-link the daily progress of working groups from the high-visibility scheduling of Leader Summits. By empowering the Foreign Ministers' Framework and joint technical secretariats, the grouping can sustain momentum on maritime security and critical minerals even during intense domestic political cycles or out-of-theater crises.
- **Constructing a Strategic Economic Carve-Out**
 - Member states must realize that aggressive trade barriers undermine security cooperation. There is an urgent need to negotiate a "Strategic Trade and Technology Carve-Out." This arrangement would insulate critical sectors—such as semiconductor inputs, rare earth processing, and dual-use defense tech—from broader bilateral tariff disputes.
- **Insulating Strategic Statecraft from Domestic Rhetoric**
 - Sophisticated statecraft requires a clear separation between political communication aimed at domestic audiences and official diplomatic engagement. Utilizing quiet, institutional channels to resolve sensitive friction points (such as immigration issues or trade imbalances) prevents public trust deficits and preserves bureaucratic goodwill across partner nations.

- **UPSC CSE Mains (GS Paper II)**
 - "Quadrilateral Security Dialogue (Quad) is transforming itself into a trade and technology partnership from a purely military alliance." Critically analyze the statement. **(2022)**
 - The USA is facing an internal debate between global strategic commitments and domestic economic protectionism. Evaluate its consequences on India-US strategic ties.
 - "Critically examine the aims and objectives of SCO. What importance does it hold for India?" *(Useful for comparing the balancing act between India's membership in Western-heavy groups like the Quad and Eurasian groups like the SCO).* **(2021)**

- **UPSC CSE Prelims**
 - With reference to the "Quadrilateral Security Dialogue (Quad)", consider the following statements:
 - It was first conceptualized as a formal military alliance via a binding treaty.
 - All four member nations participate together in the Malabar naval exercise.
 - Which of the statements given above is/are correct? *(Answer: 2 only)*

COMPREHENSIVE ANALYSIS: THE 2026 QUAD FOREIGN MINISTERS MEETING IN DELHI



- **Key Terms and Explanations**

- **Classical Hall Effect:** Discovered by Edwin Hall in 1879, it occurs when a magnetic field is applied perpendicular to a current-carrying conductor. The magnetic field exerts a transverse Lorentz force on moving charges, pushing them to one side. This creates a measurable voltage across the edges.

- *Analogy:* Think of a crowd of people walking down a hallway when a powerful crosswind suddenly blows, pushing everyone toward the left wall and creating a bottleneck of people on that side.

- **Integer Quantum Hall Effect (IQHE):** Observed at ultra-low temperatures and under massive magnetic fields, the transverse electrical resistance does not increase smoothly as the magnetic field changes. Instead, it changes in discrete, precise "staircase" steps or integers (1, 2, 3, ...). This reveals that electrical resistance can be quantized based on fundamental constants.

- **Landau Levels:** Quantized electronic energy states that occur when charged particles move in a two-dimensional plane under a uniform magnetic field. Instead of having a continuous spectrum of energy, electrons are forced into specific, fixed energy tracks.

- *Analogy:* Moving from a regular sloped ramp where you can stand at any height, to a strict set of bunk beds where you can only sit on the first, second, or third level, with no hovering in between.

- **Fractional Quantum Hall Effect (FQHE):** A highly complex state where quantum resistance steps occur at fractional values ($1/3$, $2/5$, $3/7$, ...). This happens because the electrons interact so intensely with each other that they act collectively, mimicking the existence of particles with only a fraction of an electron's basic charge.

- **Quasiparticles and Anyons:** Quasiparticles are emergent collective excitations that behave like standalone particles within a medium, even though they cannot exist outside it. Anyons are a special type of quasiparticle that exist strictly in two-dimensional systems. Unlike regular particles, anyons possess a unique "topological memory" of their trajectories, making them highly robust for data processing.

- *Analogy:* A wave traveling across an ocean. The individual water droplets only move up and down, but the collective wave pattern moves across miles as a distinct, observable entity.

- **Moiré Superlattice:** A macro-scale geometric interference pattern created when two or more identical crystalline grids are overlaid with a slight relative twist angle.

- **Fractional Quantum Anomalous Hall Effect (FQAHE):** The realization of the fractional quantum Hall state *without* applying a massive external magnetic field. The "Anomalous" designation signifies that internal structural engineering mimics the role of an external force field.

- **Main Arguments and Substantive Parts**

- The core thesis centers on a fundamental shift in material science: transitioning from **force-driven quantum states** to **geometry-driven quantum states**.

- **The Core Paradigm Shift**

- For decades, achieving exotic quantum behaviors like the FQHE required brute-force methods—specifically, placing ultra-pure materials inside massive, energy-intensive superconducting magnets at near absolute zero. The recent breakthrough demonstrates that by stacking five sheets of graphene (pentalayer) at precise twist angles, the material's internal structure can "fake" the physics of an external magnetic field.

- **Mechanism of the Breakthrough**

- **Slowing the Electrons:** In standard materials, electrons zip around with high kinetic energy, largely ignoring each other's electric fields.

- **The Moiré Trap:** When five layers of graphene are stacked with a fractional twist angle relative to one another, the resulting moiré superlattice acts like an atomic-scale egg carton, physically slowing down the electrons.

- **Dominance of Mutual Repulsion:** As kinetic energy drops, the natural electrostatic repulsion between electrons (Coulomb interaction) becomes the dominant force. Confined to a small space and unable to fly apart, the electrons self-organize into a highly synchronized collective quantum fluid, giving rise to fractional quantization naturally.

- **The Scientific Counter-Argument & Validity Testing**

- While private tech companies (such as Microsoft) have claimed the creation of anyonic quantum chips using alternative methods, the broader scientific community remains deeply skeptical due to difficulties in independent verification. In contrast, the 2024 MIT discovery of FQAHE in pentalayer graphene provides verifiable, repeatable metrics (reproducing specific fractional values like $2/3$ and $3/5$) without the masking effect of a massive external magnetic field.

- **Historical Evolution of the Issue**

- The timeline below traces the journey of charge transport discoveries from 19th-century classical observations to the latest frontiers in twistrionics.

- Discovery of the Classical Hall Effect

- 1879

- Edwin Hall discovers that a perpendicular magnetic field creates a transverse voltage in a conductor. This occurs nearly two decades before the electron itself is discovered.

- Discovery of the Electron

- 1897

- J.J. Thomson isolates the electron, establishing it as the fundamental, indivisible carrier of negative electrical charge. This provides the mathematical framework for Hall's discovery.

- Discovery of the Integer Quantum Hall Effect

- 1980

- Klaus von Klitzing discovers that at ultra-low temperatures and high magnetic fields, Hall resistance is quantized in perfect whole numbers, revealing macroscopic quantum states.

- Discovery of the Fractional Quantum Hall Effect

- 1982

- Tsui, Stormer, and Laughlin observe fractional plateaus ($1/3$, $2/5$). This proves that strongly interacting electrons can manifest fractional charges via collective behavior.

- The Graphene Revolution

- 2004

- Andre Geim and Konstantin Novoselov isolate single-atom-thick sheets of carbon (graphene), introducing two-dimensional electron systems to material science.

- Emergence of Magic-Angle Twistrionics

- 2018

- Physicists discover that twisting two layers of graphene at a precise "magic angle" (1.1 DEGREE) completely alters its electronic properties, unlocking native superconductivity.

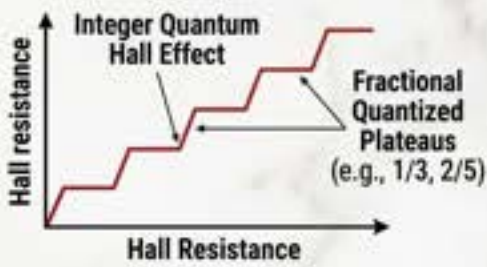
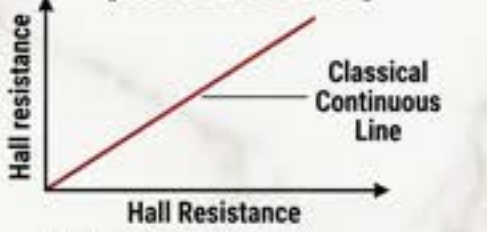
- Observation of FQAHE in Pentalayer Graphene

- 2024

- An MIT team led by Long Ju detects the Fractional Quantum Anomalous Hall Effect in a five-layer graphene stack on a boron nitride substrate, eliminating the need for external magnets.

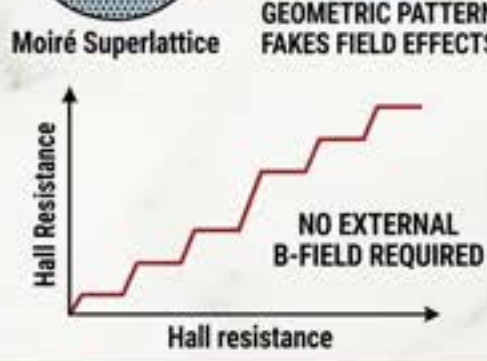
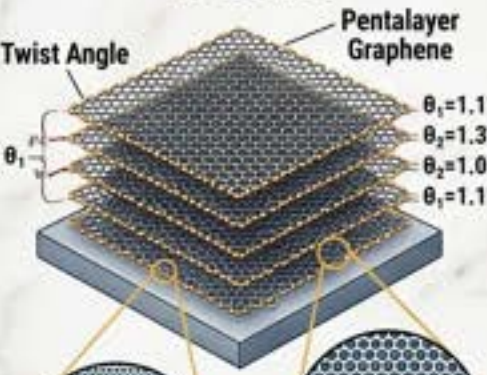
A Deep Dive into FQAHE and Its Revolutionary Potential | UPSC GS PAPER 3: SCIENCE & TECHNOLOGY

THE OLD PROBLEM: FRACTIONAL QUANTUM HALL EFFECT (FQHE) [DISCOVERED 1982]

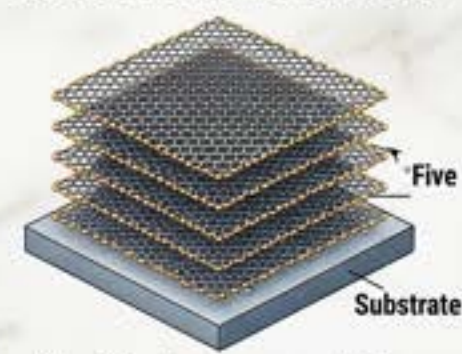


MRI-like B-Field (Indispensable but Impractical)
Required huge external magnetic fields, ultra-cold, and ultra-pure materials

THE BREAKTHROUGH: FQAHE (2024) - QUANTUM HALL WITHOUT EXTERNAL B-FIELDS

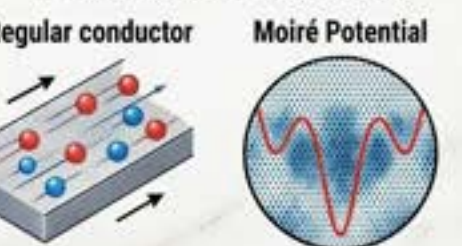


THE KEY INNOVATION: PENTALAYER GRAPHENE & STRONG INTERACTIONS



Those ***five** layers are required to significantly slow electrons

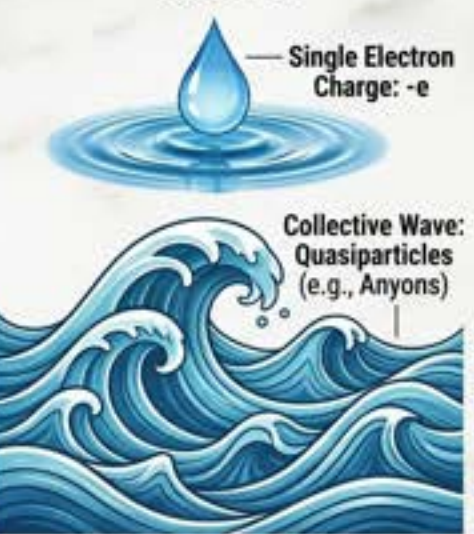
2024 Breakthrough: MIT Team Led by Long Ju in Pentalayer Graphene



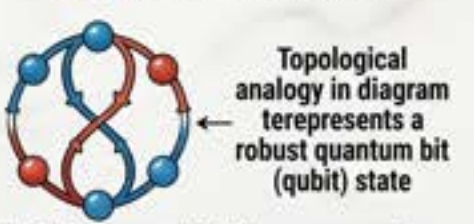
Fasttron: fast, non-interacting electrons
Poer slow: slow, strongly interacting, self-organizing electrons

Creating the Perfect Anomalous Environment

THE INNOVATION'S POWER: ANYONS & COLLECTIVE STATES



Fractional Charges: $1/3e, 2/5e$



'braiding anyons' as the ocean analogy.

Topological Protection for Quantum Information | FAULT-TOLERANT QUBITS OF THE FUTURE

UPSC PERSPECTIVE & WAY FORWARD

1 UPSC GS PAPER 3 RELEVANCE

- ADVANCED MATERIALS (GRAPHENE)
- QUANTUM COMPUTING
- TECHNOLOGICAL SOVEREIGNTY
- NATIONAL QUANTUM MISSION (NQM)

2 CHALLENGES

- ULTRA-CLEAN MATERIAL
- ULTRA-COLD
- ULTRA-PRECISE TWIST ANGLES

3 WAY FORWARD

- PRECISION ENGINEERING
- DEEP-TECH INNOVATION
- DEMOCRATIZING ACCESS TO EXOTIC PHYSICS



BUILDING BLOCKS

The physics of thermometers, temperatures and cold atoms

By two different devices to measure temperature. The science behind them, and concepts such as absolute zero and cold atoms, reveal the complex physics underlying the measurement of heat and temperature

Why humans

People from Bangalore should not be allowed to complain about their weather turning hot. The other day, as a woman friend called to express disappointment over their daytime temperatures reaching as high as 32 degrees, I wondered to what she also would should I believe her about the pleasant 42 degrees seen in Kampala. The Indian south, the normally burning air and the "Monday" bright sunny afternoons are clearly things she would not be missing.

Even while you drink a glass of iced water to cool yourself, have you ever wondered what does a "degree" really mean? Is that 1/100th of some great mathematical, but just the temperature. What have you ever thought how does one even measure it?

Units of temperature

The standard unit of temperature is called Celsius, named after Swedish physicist Anders Celsius who designed some of the early thermometers. But there is a fundamental catch with measuring temperature. While we can feel something hot or depressingly cold depending on the weather or global news, our challenge in measuring temperature is defining the zero for it. After all, unlike the number of gas molecules or total 20-cm, can you really count there are your fingers, and say when you have "one"?

To define this zero – we use one of our common day magical materials – water. So, how does water help decide that? In process, we need to understand what temperature really is.

Temperature is a way of estimating how fast something is. Now where we heat something, what we are really doing is making the atoms and molecules of that material move and vibrate faster. They shake more and more vigorously as we pump in energy. Gradually when we cool something we make the atoms more sluggish than is we take away their energy. Not very different from us, as we are really sensitive to heat or cool something as long as we stand!

Turn out the answer is no. For a while, the material may decide to get heated or cooled. But at some point it may decide to completely change its character. This is called a phase transition. You see this everyday. When water is kept in a refrigerator, it would first cool cooling and appear as just colder water.

But at some point, it won't cool as it is used – but will start forming ice, which as we know is a solid. This "temperature" at which water transforms is now named "zero" degree Celsius. Similarly, when water is heated, it gets better and better until it starts boiling and turning into vapor. After this particular "temperature" after which the water cannot get hot anymore – was marked 100° degrees Celsius.

Remember the aim and aim of temperature was marked and divided into a hundred divisions so that we can measure everything else in their units. It is on this scale that our body temperature is 37 degrees Celsius. There is another popular scale – Fahrenheit, where zero and 100 is marked using a different process. On that scale our body temperature is approximated to be 98.6 degrees Fahrenheit. In 1960s physicists



Finally decided to use Celsius as a standard unit.

They decided to use Celsius as a standard unit. Now that we have defined zero and 100 of temperature, the next question to be asked is measure of them comes another magical essential – mercury, or – not the phase.

Mercury thermometers

Mercury is a metal. The first of absolute zero, which conducts current and shines, but unlike our earthly atoms or spores, it is in a liquid state. How much more expand a bit when heated? This is because the atoms within the material need to get away from each other when they are hot, but one of the most amazing properties of mercury is that it expands only as much as it is heated. Think of it like a rod whose length changes depending on how hot it is, but we have found the thermometer trick.

The idea is simple yet necessary in a glass bulb attached to a tube. Keep the bulb in a bucket of ice. Spin the level of mercury in the tube and mark it as zero. Now put the same bulb in boiling hot water. Mercury will expand and the level will rise in the tube. Mark that one level as 100. On your favorite scale to equally divide the distance between the two marks into 100 divisions, and you have a thermometer. Now you can put this thermometer in your favorite soup, or soil, or your mouth to measure how much

the mercury expands to tell you what the temperature is.

In fact, this is how regular thermometers used to work until a few years ago, when plastics were still new stuff. Most of the school-going students today may not have seen these thermometers. They could easily break for a huge low surface from the subtle melting.

But in any case, mercury thermometers, then, could be found in every household. But as the quality of greenhouse gases, global temperatures, losses, judgments, and governments changed – our thermometers changed too.

Digital thermometers

To measure temperature, one basically needs a material which changes its behavior depending on how hot something is, and whose change of behavior can be measured accurately. After all, measuring something correctly is fundamental in all of science. The branch of physics which specializes in the precise physical measurements is called metrology.

With advances in condensed matter physics – the physics of materials – physicists created a new class of materials called semiconductor in the 1950s. Semiconductor are neither metals like

conductors like aluminum or copper, nor insulators (a thing which do not conduct current) like glass or wood. Between the poles, "semis". They conduct a small amount of current, but the amount of current they carry can increase if the temperature rises.

Like in the case of semiconductors have a rather interesting arrangement of atoms and electrons.

In metals, electrons move freely from atom to atom, like a soup – so they can easily conduct electricity whenever a battery is attached. In insulators, the electrons are tightly bound to the atoms, so even when a battery is put – they refuse to budge. In semiconductors, electrons are loosely bound to the atoms. They mostly stay close to atoms, but when the atoms become agitated due to heat, they shake off their electrons. These "free" electrons can move more and create an electrical current.

Now when a battery is attached to a semiconductor and if the temperature rises, the atoms shake more vigorously and more electrons are made free. In the future the surrounding is, more current will be generated and if we can measure that current we can find what the temperature is.

This is what happens in a digital thermometer which you find in your favorite oven – with 50 years of technological progress, humans have perfected the art of measuring changes in currents and voltages.

Absolute zero and cold atoms

Now, even while water seems to be at zero degree Celsius – the atoms in the ice are still shaking, though more slowly. Now if we continue to take away their energy even further, is there a point where it can eventually have "no" energy? What temperature would that mean?

That temperature is now defined as the absolute zero – in another unit called Kelvin (K), the a metric unit of measuring temperature, in terms of Celsius, this means 273 degrees Celsius.

When temperatures fall to just a few Kelvin, they become even harder to measure. No longer can we measure or understand to measure them, about the properties of these thermometers themselves would change completely.

In fact, even atoms themselves become very funny at these temperatures and we need to use the whole power of quantum mechanics to understand them. Study of such atoms at ultra low temperatures is called atomic physics.

Bose and his condensate

In general, you're considered as one of the two types of particles, like "fermions" type, where they don't like to sit together in one space. And another "boson" where they like to all sit together whenever given a chance. "Boson" is named after Satyendra Nath Bose, an Indian physicist. In 1920s, he first theoretically predicted the existence of behavior of these "bosons".

When cold atoms are brought to rest and where they reach temperatures very close to zero Kelvin they form an exotic phase of matter called the Bose-Einstein Condensate (BEC), named after Bose and Albert Einstein. In 1995, near U.S. scientists Eric A. Cornell, Wolfgang Ketterle and Carl E. Wieman were awarded the Nobel Prize in Physics for achieving the BEC in experiments at a temperature of 20 nanokelvin (nK), 1 in a 100,000,000 Kelvin, just slightly above absolute zero.

In the next time when the hot hot atoms, whether in Bangalore or Kampala, and you call a friend to complain about the rising temperature – don't forget to express gratitude to the long, illustrious line of thermometers that have accurately measured temperatures for you. Ludwig Boltzmann is an Austrian Professor of Physics at 37 degrees.

- **Key Terms and Explanations**

- **Temperature:** At a microscopic level, temperature is a direct measure of the average kinetic energy of the atoms or molecules within a substance. Increased thermal energy manifests as greater atomic agitation and faster molecular movement, whereas cooling induces molecular sluggishness.
- **Phase Transition:** This refers to the transformation of a thermodynamic system from one state of matter to another, such as a solid turning into a liquid or a liquid changing into a gas. These transitions occur at specific, constant temperatures where the structural arrangement of particles changes abruptly.
- **Metrology:** The scientific study of measurement. It establishes common, international frameworks for defining units (such as the SI units for mass, length, and temperature), ensuring accuracy, reliability, and precision across global scientific, industrial, and commercial domains.
- **Semiconductors:** Materials whose electrical conductivity falls between that of conductors (like copper) and insulators (like glass). Their unique atomic structure allows their conductivity to increase with temperature, as thermal energy liberates tightly bound electrons, creating a measurable electrical current.
- **Absolute Zero:** The theoretical lower limit of thermodynamic temperature, defined as 0 K or -273.15 DEGREE C. At this point, the classical motion of atoms ceases entirely, and the system retains only its quantum mechanical zero-point energy.
- **Bosons and Fermions:** All subatomic particles are categorized based on their quantum spin. *Fermions* (like electrons and protons) obey the Pauli Exclusion Principle, meaning no two particles can occupy the identical quantum state. *Bosons* (like photons and certain atoms) prefer to cluster together and can occupy the exact same quantum state simultaneously.
- **Bose-Einstein Condensate (BEC):** Often called the fifth state of matter, a BEC forms when a dilute gas of bosons is cooled to temperatures incredibly close to absolute zero (nano-Kelvins). At this critical threshold, a large fraction of the bosons collapse into their lowest energy quantum state, behaving as a single macroscopic "super-atom."

- **Main Arguments and Substantive Parts**

- The evolution of temperature measurement reveals a fascinating trajectory: humanity's shift from observing macroscopic physical changes to manipulating microscopic quantum states. The core arguments surrounding this theme can be broken down into three main areas:

- **The Kinetic Definition and Calibration of Temperature**

- Temperature is not an arbitrary sensation of hot and cold; it is the physical manifestation of molecular chaos. To measure it objectively, science requires fixed reference points. Historically, the phase transitions of water—its freezing point (0 DEGREE C) and boiling point (100 DEGREE C)—served as the foundational boundaries to divide and standardize thermal scales.

- **The Shift from Mechanical to Solid-State Sensors**

- Traditional thermometry relied on the linear thermal expansion of liquid mercury inside a glass capillary tube. However, modern technology demands higher precision, rapid response times, and digital integration. This drove the transition to semiconductor-based sensors. In these digital devices, temperature variations alter the material's internal electrical resistance, turning a physical thermal state into a clean, measurable electronic signal.

- **The Breakdown of Classical Physics at the Extreme Cold**

- As a system approaches absolute zero, traditional tools like mercury or standard semiconductors become completely obsolete because molecular motion freezes and material properties shift radically. At these extreme cryogenic scales, classical physics fails, and quantum mechanics takes over. Investigating these ultra-low temperatures reveals entirely new physical phenomena, such as the Bose-Einstein Condensates, which open up fresh frontiers in quantum computing, precise metrology, and fundamental atomic research.



- **Historical Evolution of the Issue**

- The history of thermometry and low-temperature physics is a testament to the compounding nature of scientific discovery over the last few centuries.

- **The Era of Calibration (Early 18th Century):** Physicists like Daniel Gabriel Fahrenheit and Anders Celsius designed the first reliable, practical temperature scales. By anchoring their instruments to reproducible natural phenomena—like the freezing and boiling points of water—they transformed temperature from a vague sensation into a quantifiable scientific metric.

- **The Thermodynamic Paradigm (Mid-19th Century):** Lord Kelvin introduced the absolute temperature scale, establishing the concept of Absolute Zero (0 K or -273.15 DEGREE C). This shifted thermometry from relying purely on material properties (like the expansion of mercury) to a deeper framework rooted in fundamental thermodynamics and energy states.

- **The Digital and Solid-State Revolution (Mid-20th Century):** The rise of quantum mechanics and semiconductor physics in the 1950s paved the way for the invention of the transistor and digital sensors. This development rendered glass mercury thermometers largely obsolete in advanced industrial and medical settings, replacing them with thermistors and silicon-based temperature sensors.

- **The Quantum Frontier (Late 20th Century to Present):** In 1924, Indian physicist Satyendra Nath Bose formulated the statistical mechanics for light quanta, which he shared with Albert Einstein, leading to the theoretical prediction of the Bose-Einstein Condensate. It took seventy-one years of technological progress in laser cooling and magnetic trapping for scientists Eric Cornell, Wolfgang Ketterle, and Carl Wieman to finally create a BEC in a laboratory setting in 1995, an achievement recognized with the 2001 Nobel Prize in Physics. Today, this research underpins the development of ultra-precise atomic clocks and quantum technologies.

UPSC CSE COMPREHENSIVE ANALYSIS: THE PHYSICS OF THERMOMETERS, TEMPERATURES AND COLD ATOMS.

UPSC SYLLABUS: SCIENTIFIC INSTRUMENTS AND QUANTUM MECHANICS IN CLIMATE MONITORING.

1. KEY TERMS & EXPLANATIONS.

Temperature

HOT vs **COLD**

At microscopic level... direct measure of average kinetic energy, ...aid microscopy...

Phase Transition

ICE 0°C \rightarrow **100 $^{\circ}\text{C}$**

Transformation of substance... changes character abruptly at specific constant temperatures.

Absolute Zero

0 K

Theoretical limit... Theoretical limit... classical motion ceases... atoms...

Bose-Einstein Condensate (BEC)

Fermions vs **Bosons**

Fifth state of matter... bosons... bosons collapse to lowest energy quantum state.

2. MAIN ARGUMENTS & SUBSTANTIVE PARTS.

A. Kinetic Definition and Calibration

Temperature is direct physical manifestation of molecular agitation... required fixed points for calibration (H₂O phase transitions).

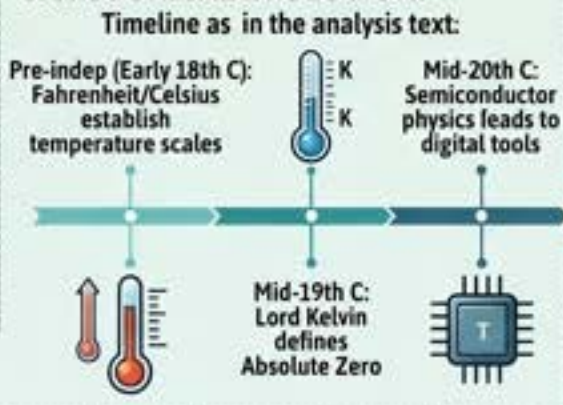
B. Shift from Mechanical to Solid-State Sensors

Driven by need for high precision, rapid response, and digital output... change material's electrical resistance with temperature.

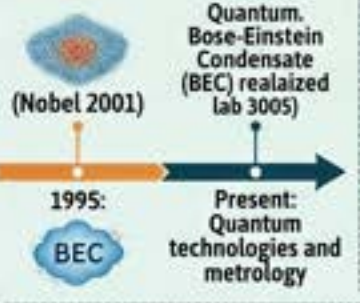
C. Breakdown of Classical Physics

As system approaches absolute zero... classical tools fail... quantum sensor... requires new physics (Quantum Mechanics) for study.

3. HISTORICAL EVOLUTION.



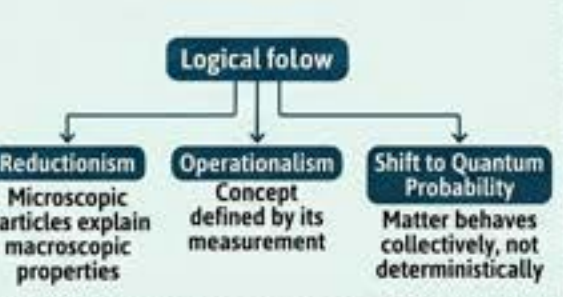
5. NEW FEATURES & UNIQUE IDEAS.



6. SUSTAINABILITY OF THE IDEA. (Assessed factors)

- ✓ Environmental: Phase out toxic mercury (Minamata Convention, etc.)
- ✓ Resources & Material Dependencies: Semiconductor manufacturing (supply chains)
- ✓ Ethical & Societal: Equitable global access to quantum tech (quantum divide)

4. LOGICAL AND PHILOSOPHICAL BASE.



5. NEW FEATURES & UNIQUE IDEAS.

- Quantum Metrology & Sensing** (High precision gravimeters, magnetometers)
 - Optical Lattices** (Simulating complex materials in controlled environments)
- Feasibility assessment: Miniaturization and portability challenges, ...mintermination of makeriers, mesuring and proihred quantum lattices.

7. CHALLENGES RELATED. (Obstacles & Risks)

- Technical** (Isolation, Scalability - isolating from light and sound)
- Implementation** (Costs, Standards - high capital for metrology labs)
- Skills Gap** (interdisciplinary knowledge: quantum physics + systems engineering)

8. MULTIDIMENSIONAL ANALYSIS.



9, 10, 11. UPSC CSE LINKAGES. (Strongest connections)

NCERT Book

- NCERT Science: Cl-9 Science (States of Matter)
- Cl-11 Physics: (Thermal Properties)
- Cl-12 Physics: (Semiconductors, Quantum Dual Nature)

Syllabus Paper

- GS-3: (S&T, Indian contributions - S.N. Bose)
- GS-1: Geography - Climate Monitoring
- Essay

11. Best Linkages: GS-3 (Achievements of Indians - S.N. Bose) and Epistemology (Scientific knowledge evolution via better measurement)

12. WAY FORWARD



13. PYQs & 14. MODEL ANSWER.

- Key Questions in sll hosts (selected PYQ):
- BEC Prelims 2011
 - NQM GS-3 2023
 - NQM GS-3 2023 (Pelims)
 - NQM GS-3 2023 (What scams)
 - NQM GS-3 2023 (Quantum toos)
 - NQM GS-3 2023 (What scams)
- Model Answer Structure (selected PYQ):
- Intro (BEC & NQM scope)
 - Scientific Sig
 - Strategic Autonomy
 - Conclusion

Why is the Indian rupee falling?

How does a falling rupee affect India's economy? How does a currency's exchange rate shape its balance of payments? To what extent does Foreign Portfolio Investment influence demand for the rupee? What strategic role does the Reserve Bank of India play in preventing the rupee's depreciation?

EXPLAINER

Exchange Rates

The graph of the Indian rupee has been making sharply downward. The rupee-to-dollar exchange rate, or the rupee needed to purchase a U.S. dollar, crossed 81 in May this year. That rate was around 61 a year ago, indicating the rupee's decline in value since then.

Exchange rate is the price that a currency, such as the rupee, commands in the market, relative to the dollar or other currencies. Just as the market price of a stock is determined by demand and supply, so is the price of a currency.

What is the impact of trade deficits on the rupee's value?

The demand for the rupee rises with India's exports and falls with imports. When India is a trade-surplus country, the dollar or euros they receive from foreign buyers are exchanged for rupees to pay workers and suppliers, thereby increasing demand for the rupee. On the other hand, India's imports impact it by exchanging rupees for dollars, thereby reducing the demand for the rupee. Rupee demand also declines when we trade abroad and exchange rupees at the airport for the currency of our destination country.

Overall, if India's imports exceed exports, the foreign-currency payments it must make to the rest of the world exceed the foreign-currency payments it receives. That implies more rupees are exchanged for dollars than dollars are exchanged for rupees, leading to declines in the demand for, and the value of, the rupee (requiring more rupees to purchase one dollar).

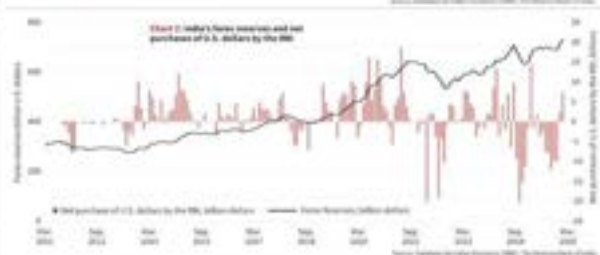
Thus, a country's exchange rate is closely tied to the country's balance of foreign-currency payments to and from the rest of the world. India has consistently run a non-fuel trade deficit, with imports of goods (especially oil) exceeding exports. The deficit in its merchandise trade account is partially offset by a surplus in India's services. That is mainly thanks to foreign-currency inflows from the export of services, particularly software, and to the large remittance inflows from migrant workers, especially in West Asian countries. Overall, India's current account, which is the sum of merchandise trade and the services account, has been in deficit (Table 1).

The gap in the current account between the foreign-currency payments India owes to the rest of the world and the foreign-currency payments it receives, has been bridged by inflows through the capital account, mainly foreign investment and loans. If the current account deficit is more than offset by a surplus in the capital account, the overall foreign-currency received is sufficient to meet the country's foreign exchange or foreign reserves (Table 2).

How do capital inflows stabilize the rupee?

A country's foreign reserves are as valuable as a family's treasure trove. The reserves are tapped to pay for critical imports during periods of insufficient foreign-currency inflows, and to defend the currency's value when capital outflows are too large (discussed below).

Foreign direct investment (FDI) mostly in new or existing factories and businesses and, as a result, has been one leading factor to the host country. In comparison, foreign portfolio investments



FDI, which involves purchases of shares or bonds, is highly stable and drives by speculation. Portfolio investors enter a country seeking quick financial returns and exit at the first sign of risk or when higher returns are offered elsewhere. When FDI receipts, the stock markets are on a roll, when it flows out, it leaves a trail of destruction. Capital outflows imply that investors withdraw their investments in rupee assets and exchange them for dollar assets, leading to a further in demand for the rupee and rise in its foreign rate.

The periods of rapid depreciation of the Indian rupee have each been characterized by worsening of the trade account, FDI outflows, or both. These include April to September 2001 (when the rupee-to-dollar rate fell from 54.4 to 62.6), January to October 2008 (from 62.4 to 72.6), February to April 2022 (from 75.3 to 76.3), January to October 2023 (from 74.4 to 82.3), September 2024 to February 2025 (from 82.1 to 87.3), and the latest phase that began in May 2025 (from 80.2 to 90.8) (Chart 1). The recent losses in the

rupee have mainly been due to foreign investors withdrawing from India as they moved to the safety of their home-born asset-growing prospects of returns and higher U.S. interest rates. The depreciation of the rupee implies a high cost on the Indian economy. To purchase a barrel of oil at \$90, Indian companies now must pay 79,000, compared to 78,200 had the exchange rate remained at 80 per dollar. However, a depressed rupee can help boost exports: a shirt costing \$1,000 can be sold in the U.S. market at \$2.5 now. If the exchange rate were 80 per dollar, the price would have been \$3. The rupee depreciation alone may not help much, given the surge of supply and demand constraints weighing on Indian manufacturing.

What is the role of the RBI? The Reserve Bank of India (RBI) intervenes to prevent the exchange rate from falling to very low levels. When foreign investors rush out by selling their rupee assets for dollars, the RBI prints or

the rupee by selling some of the dollar or treasury bonds from its reserves. This raises the demand for rupee and drives the dollar to a fall. During October 2024-January 2025 and August-December 2025 (Chart 2), India's foreign reserves remain sufficiently large. They stand at around 130-135 billion at the end of March 2025, enough to cover 9-10 months' worth of the country's imports (at the end of December 2024). That is a slightly narrower RBI can deploy to shield the rupee against impending speculative falls.

The ongoing geopolitical tensions and the threat of further oil price increases pose serious challenges. India could be at risk of paying more dollars per barrel of oil and more rupees per dollar. The country must take steps to regulate speculative capital outflows and reduce its dependence on oil imports.

THE GIST

The rupee-to-dollar exchange rate crossed 81 in May this year. A currency's exchange rate refers to the price it commands in the market, relative to the dollar and other currencies.

Exchange rate is closely tied to a country's balance of payments, which has consistently run a merchandise trade deficit, with imports—especially oil—exceeding exports.

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- **Key Terms and Explanations**

- To construct a structurally sound understanding of India's external sector, it is vital to master the foundational vocabulary governing currency markets and international trade.

- **Exchange Rate:** The price of one domestic currency expressed in terms of another foreign currency. It represents the external purchasing power of a nation's money and is determined by the intersection of market demand and supply forces in a floating regime. For instance, an exchange rate of ₹96/\$ implies that ninety-six Indian rupees are required to purchase one United States dollar.

- **Balance of Payments (BoP):** A systematic, comprehensive statistical record of all economic transactions between the residents of a country and the rest of the world over a specific time horizon (typically a financial year). It follows a double-entry bookkeeping system and is structurally divided into the Current Account and the Capital Account:

- Balance of Payments (BoP) = Current Account + Capital Account + Errors and Omissions = 0

- **Current Account Deficit (CAD):** A macroeconomic state occurring when a country's total imports of goods, services, and unilateral transfers exceed its total exports. It indicates that the nation is a net debtor to the rest of the world for that specific period.

- **Merchandise Trade Deficit:** The negative net balance specifically arising from the cross-border trade of tangible, physical goods (e.g., India importing expensive crude oil, gold, and electronic machinery while exporting textiles, gems, and refined petroleum products).

- **Invisibles:** The component of the Current Account that captures trade in non-tangible elements. It includes **Services** (software exports, tourism), **Remittances** (money sent home by migrant workers abroad), and **Income** (interest, profit, and dividends on foreign assets). India historically maintains a structural surplus in invisibles, which acts as a cushion against its merchandise trade deficit.

- **Foreign Direct Investment (FDI):** Long-term capital inflows where foreign entities invest directly in physical plants, asset creation, or joint ventures, acquiring management control (typically defined as a stake of 10% or more in a listed company). FDI is stable, non-speculative, and introduces technology and managerial best practices.

- **Foreign Portfolio Investment (FPI):** Short-term capital inflows into the domestic financial markets (stocks, corporate bonds, government securities) without acquiring direct management control. Highly sensitive to global interest rate differentials and risk perceptions, FPI is often labeled as "**Hot Money**" due to its high volatility and tendency to flee abruptly during global uncertainty.

- **Foreign Exchange (Forex) Reserves:** Assets held by a nation's central bank (the Reserve Bank of India) in foreign currencies, gold, Special Drawing Rights (SDRs), and reserve tranches with the IMF. These reserves act as a shock absorber against sudden capital flight and provide the necessary liquidity to settle international obligations.

- **Main Arguments and Substantive Parts**
- The core structural challenge of the Indian Rupee (INR) lies in its vulnerability to both domestic imbalances and external macroeconomic cross-currents.
- **The Structural Trade Asymmetry**
- India operates under a persistent, structural merchandise trade deficit. This is primarily driven by an inelastic demand for vital industrial inputs—most notably crude oil, coal, electronics, and gold. When global commodity prices spike, India's import bill expands rapidly, creating an elevated demand for foreign currency (primarily the US Dollar) relative to the supply generated by Indian exports.
- **The Invisibles Cushion and Its Limitations**
- While India's structural trade deficit is massive, it is significantly mitigated by a robust surplus in the invisibles account. This surplus is propelled by IT/software services and global remittances from the Indian diaspora (particularly from the Gulf Cooperation Council nations and Western economies). However, this surplus is often insufficient to completely eliminate the deficit, resulting in a persistent Current Account Deficit (CAD) that requires continuous financing via foreign capital inflows.
- **Capital Account Volatility and the "Hot Money" Dilemma**
- To bridge the CAD, India relies on capital inflows. While Foreign Direct Investment (FDI) offers a stable foundation, Foreign Portfolio Investment (FPI) introduces severe volatility. When developed economies—particularly the US Federal Reserve—raise domestic interest rates or when global geopolitical tensions flare up, institutional investors engage in a "flight to safety." They liquidate their Indian portfolio assets, convert their rupees into dollars, and exit the domestic market, causing a sharp, rapid depreciation of the rupee.
- **Central Bank Intervention and Reserve Adequacy**
- The Reserve Bank of India (RBI) does not fix a specific target level for the rupee; instead, it intervenes to check extreme, speculative volatility and ensure orderly market conditions. When the rupee faces heavy downward pressure, the RBI steps in as a seller of US dollars from its accumulated Forex reserves. While this intervention successfully cushions the rupee's decline, it directly reduces the nation's total foreign exchange reserves, requiring a careful calibration of reserve adequacy to ensure there is enough cover for future imports.



- **Historical Evolution of the Issue**

- Understanding the trajectory of the Indian Rupee requires tracing its evolution through distinct policy paradigms from the pre-independence era to the present day.

- **Pre-Independence to the Bretton Woods Era (1947–1971):** Following independence, the Indian rupee was pegged to the British Pound Sterling, and subsequently to the US Dollar under the par value system established by the Bretton Woods agreement. Economic management was highly controlled, with tight foreign exchange regulations to conserve scarce external reserves.


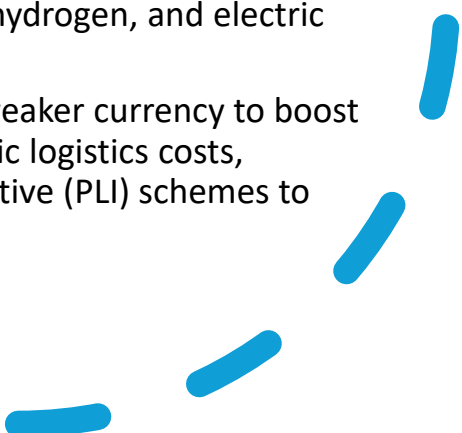
- **The 1966 Devaluation Crisis:** Confronted with severe droughts, consecutive external conflicts (1962 and 1965), and a ballooning fiscal deficit, India faced a severe balance of payments strain. Under pressure from international financial institutions, the government implemented a significant deliberate devaluation of the rupee to restore export competitiveness.

- **The 1991 Balance of Payments Crisis:** A defining watershed moment in Indian economic history. Triggered by the Gulf War oil shock, a sharp decline in remittances, and years of unsustainable fiscal expansionism, India's foreign exchange reserves fell to a level barely sufficient to finance two weeks of essential imports. This existential crisis forced India to pledge its gold reserves and implement deep structural economic reforms.

- **Transition to the Managed Float (1992–1993):** As part of the post-1991 structural adjustment program, India dismantled the administered exchange rate system. It initially introduced the Liberalized Exchange Rate Management System (LERMS) in 1992, transitioning to a full market-determined exchange rate system in 1993. This established the modern "**Managed Float**" or "**Dirty Float**" paradigm, where market forces determine the rate, but the RBI intervenes during periods of speculative stress.

- **The 2013 Taper Tantrum:** When the US Federal Reserve hinted at winding down its quantitative easing program, capital abruptly fled emerging economies. India, grouped under the vulnerable "Fragile Five" economies due to a high CAD and high inflation, saw the rupee depreciate drastically. This led to institutional reforms focused on building massive forex buffers and adopting an explicit flexible inflation-targeting framework.

- **The Contemporary Era (2020s–2026):** The rupee has faced renewed pressures driven by post-pandemic global inflation, aggressive monetary tightening cycles by Western central banks, and heightened geopolitical fragmentation. However, unlike in 1991 or 2013, India's robust forex reserves (hovering near historic highs of around USD 691 billion) have provided a strong defense, demonstrating an evolution from structural vulnerability to resilient macroeconomic management.

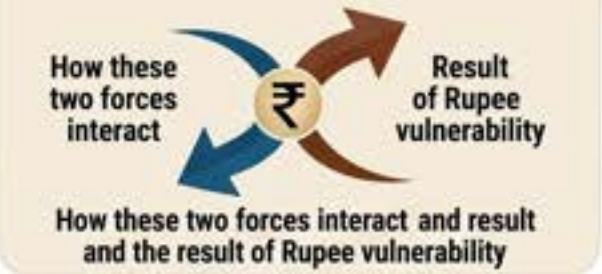
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- **Way Forward**
 - **Short-Term Stabilisation Measures**
 - **Prudential Capital Management:** The RBI should continue using calibrated, non-disruptive interventions to smooth out speculative exchange rate volatility without burning through reserves unnecessarily.
 - **Monitoring Corporate Exposure:** Tightening surveillance on unhedged External Commercial Borrowings (ECBs) is essential to ensure domestic corporations are not overly exposed to sudden currency drops.
 - **Medium-Term Structural Adjustments**
 - **Expanding Local Currency Settlement:** Policymakers should actively build on existing local currency frameworks, expanding rupee-denominated trade invoicing with key regional and energy-exporting partners to reduce transaction reliance on the US dollar.
 - **Deepening Domestic Financial Markets:** Integrating Indian sovereign bonds into global indexes should be managed carefully, alongside efforts to deepen domestic bond markets. This helps attract more stable, long-term institutional capital.
 - **Long-Term Strategic Interventions**
 - **Accelerating Decarbonization:** True long-term stability requires reducing the structural trade deficit by accelerating the transition to renewable energy, green hydrogen, and electric mobility, which compresses the nation's fossil fuel import bill.
 - **Enhancing Core Export Competitiveness:** Rather than relying on a weaker currency to boost trade, India should focus on structural improvements: lowering domestic logistics costs, modernizing infrastructure, and expanding the Production Linked Incentive (PLI) schemes to move up the global value chain into high-tech manufacturing.
- 

THE MACROECONOMIC FRAMEWORK: KEY TERMS & DEFINITIONS

- Exchange Rate:** The external purchasing power of the Rupee (e.g., ₹96/\$), determined by demand-supply forces.
- Balance of Payments (BoP):** Comprehensive statistical record of all economic transactions. Divided into Current & Capital Accounts.
- Current Account Deficit (CAD):** Net debtor status when imports exceed exports.
- Invisibles Surplus:** India's structural cushion from Services (IT), Remittances, and Income. Often insufficient to offset the merchandise gap.

STRUCTURAL DYNAMICS: TRADE ASYMMETRY & CAPITAL FLOWS

- Trade Asymmetry:** Persistent merchandise trade deficit due to inelastic demand for crucial inputs (oil, gold, electronics). Global price spikes expand the import bill.
- Limitations of Invisibles:** Surplus is robust but not enough to eliminate CAD, requiring continuous financing.
- 'Hot Money' Dilemma:** India is dependent on volatile FPI flows. US Fed rate hikes and geopolitical risk trigger sudden capital flight and rapid depreciation.



THE THEORETICAL LOGIC OF EXTERNAL MANAGEMENT



Mercantilism vs Market Realism: Explaining the tension between boosting 'Make in India' exports vs managing 'Imported Inflation' on consumers and raising borrowing costs in aovsnors.

HISTORICAL EVOLUTION OF THE RUPEE: CRITICAL SHIFTS

- 1947-1971:** Pegged system (Bretton Woods). Controlled economy. Scarce reserves.
- 1966:** Severe Devaluation Crisis due to droughts and conflict.
- 1991:** Existential BoP Crisis. Moves gold, shifts to reforms and 'Managed Float' (1992-1993 Transition).
- 2013:** Taper Tantrum, Fragile Five status. Sharp depreciation.
- 2020s-2026:** Contemporary challenges (inflation, geopolitics) with robust robust forex buffers (e.g., USD 691B).

STRATEGIC INNOVATIONS & NEW FEATURES

- De-Dollarization and Local Currency Settlement:** Bilateral mechanisms (Rupee-Dirham/Ruble) for direct trade settlement, bypassing USD. Feasible with energy partners, but scalability hurdles due to liquidity.
- Digital Integration (UPI Linkage):** UPI linkages globally (e.g., Singapore PayNow, UAE), reducing remittance costs and supporting invisibles. Scalable and practical.
- Green Transition for Import Substitution:** Accelerating solar, wind, green hydrogen to structurally compress the inelastic fossil fuel import bill. Sustainable long-term solution.

SYSTEMIC ANALYSIS & ASTRATEGIC WAY FORWARD

- Multi-Dimensional Analysis:**
 - Social:** Imported inflation on essentials
 - Political:** Rupee value visibility
 - Legal:** FEMA, 1999 balances
 - Ethical:** Exporters vs general public interests; generational equity
 - International:** Diversifying USD reliance for strategic autonomy
 - Economic:** IT gains vs expanded subsidy burden
- Way Forward (Integrated solutions):**
 - Balanced middle path
 - Monitor unhedged corporate debt
 - Deepen domestic bond markets
 - Expand local currency settlement
 - Accelerate green transition
 - Target structural export competitiveness (PLI, infrastructure, R&D)
- Syllabus Linkages & PYQ Practice:**
 - Mapping:** GS-3 (Economy, liberalization), GS-2 (Global policies, diaspora), Essay, Ethics
 - Previous Years Questions (PYQs)** List 2-3 examples with model answer structure outlines
 - 2015 GS-3 "Effect of depreciation"
 - 2021 GS-3 "V-shaped vulnerabilities"
 - 2022 Prelims 'RBI actions'



Should RBI defend rupee, or let it find its own level



URV MISHRA

THE SHARP slide in the rupee's exchange rate has sparked a debate on the Indian economy. The urgent policy decision before the government and the Reserve Bank of India (RBI) is whether to prevent the rupee from sliding further against the US dollar or to let it fall and find its true level.

The rupee's exchange rate against the US dollar typically changes depending on the relative demand for the two currencies in the foreign exchange (forex) markets. If Indians demand more dollars (either to buy foreign goods or to invest in other countries) than the rupees demanded by foreigners for their Indian goods or to invest in India, the relative value (exchange rate) moves in favour of the dollar.

The worsening of the rupee's exchange rate is reflective of a weakness of the Indian economy.

How can the rupee's exchange rate be artificially improved?

Indians can't hold dollars with them for regular use within the country; all dollars flow back to RBI. This can be employed by the central bank to artificially boost the rupee's exchange rate when needed.

The RBI can sell the dollars it has in the forex market, thereby increasing the supply. The central bank buys rupees in return for the dollars, thereby increasing the former's demand. This is referred to as the RBI defending the rupee.

How does the RBI decide when to defend?

The RBI's official policy line has always been that it does not target a certain level of rupee. Rather, the RBI's concern is that the movement in the rupee's exchange rate should be orderly. In other words, the RBI would intervene if it thinks the rupee is falling or rising against any currency too fast.

This makes sense, as the RBI is charged with maintaining financial stability in the economy. Imagine how difficult it would be for you as a consumer (say a student planning their graduate studies in the US) or a trader if the rupee's exchange rate changed dramatically every day.

Does defending the rupee work?

In the short term, it can work. The foreign-currency reserves (the main contri-

• Snapshot of India's forex and exchange rate movements



tion of India's total dollar) have stayed roughly at the same level over the past six years as the RBI deployed more and more dollars from its kitty to defend the rupee.

There is a flipside too. Over the medium term, the RBI's strategy to sell all that losses is coming a cropper because eventually the rupee has fallen sharply.

Why can't the RBI defend the rupee like it did earlier?

There are two reasons.

First, policymakers like to have around 10 months of import cover — enough dollars to continue necessary imports for least 10 months. After the RBI hits a certain level of forex reserves, it has to take a pause and reconsider.

Secondly, and this is a less appreciated aspect and perhaps the biggest constraint that India and the RBI face when it comes to defending the rupee: the quality of India's forex.

Most of the forex with the RBI comes to India in the form of investments into the Indian economy, and not so money earned by selling to the rest of the world. As we have seen in the past few years, such money can be pulled out of India if investors take a dim view of growth prospects or if they like some other destination better.

Another way to look at this situation is that the less the RBI holds is more a liability than an asset. For instance, China's re-

Defending the rupee

The RBI can sell the dollars it holds in the forex market, thereby increasing their supply

•

If there's more rupees in return for the dollars, increasing the former's demand. This is called defending the rupee

its flows through a trade surplus. The dollars it gets in return are at least not to be pulled out by any investor. But in India, thanks to our continuing weakness in trade, India spends more dollars importing than it earns exporting.

Why not let the rupee find its level?

Mainstream economists regularly advocate this. They argue that a weaker rupee will help India's exporters. Similarly, as the rupee's exchange rate falls, all imports will become costlier and hence their demand will fall. The net result will be an elimination of the trade deficit (the gap between exports and imports).

However, if the RBI allows the rupee's exchange rate to fall, then neither would the central bank have to draw down India's forex reserves, nor would the Prime Minister be forced to ask Indians to undertake austerity measures.

However, while this recommendation makes sense on paper, in India's case, there are strong arguments that suggest that letting the rupee find its level could end up either not having any impact at all, in the worst case scenario, exacerbate the slide.

Here are some reasons why.

• A large part of India's exports — some analysts estimate as high as 80% — are "re exports". In other words, these exports are essentially based on imported goods. As such, a fall in the rupee's ex-

change rate makes the imports costlier for Indians just as they make the exports cheaper for foreigners. In other words, the effect cancels out.

• Also, in many export goods, India is a price-taker and not a price-setter. Take, for example, steel textile goods. India competes fiercely with other countries such as Bangladesh. India cannot set the price of their goods but they're undercut by their Bangladesh counterparts.

Imagine an Indian exporter selling a T-shirt for ₹1 when one dollar was worth ₹50. Next month the exchange rate falls and becomes ₹100 to a dollar. In such a case, the foreign buyer will likely force the Indian exporter to reduce the price to say ₹0.6 for a T-shirt, since this way the Indian exporter would still earn ₹30 more than what he was earning before the exchange rate fell. The end result is that a falling rupee may not have boosted exports and export earnings for Indians, as the argument goes in economic textbooks.

• There is a good chance that letting the rupee find its level, especially when it has lost a lot of value, could further push down the exchange rate. In other words, depreciation can trigger depreciation.

Even Indian importers balk at the rupee just falling; they are likely to buy more and more dollars from the forex market because they expect the rupee to weaken in the coming weeks and months. But the more they buy dollars, the more the rupee weakens further.

An exactly different thing happens to Indian exporters as well with the same result of exacerbating the rupee's fall. If the rupee has been falling, an importer may defer accepting a payment because he'll be capable of meeting the bill only if he gets more rupees. This slows up the supply of dollars that were otherwise scheduled to come into the market, thus further making the price of dollars.

Something similar happens on the capital account side — with reference to the movement of money for investment purposes, letting the rupee fall may discourage investments.

Suppose the Indian stock markets give 10% returns in a particular year. But during the year, the rupee loses 5% of its exchange rate. This means an investor investing in India would get only about 5% returns in dollar terms.

This would discourage future investments, especially if the foreign investors expect the rupee to slide further. In such a case, they may hold back fresh investments. But this, in turn, will further show up as a deficit in India's overall balance of payment and will further push down the rupee's exchange rate.

Many economists argue that letting the rupee slide further will help India's exporters. But that may exacerbate woes

- **Key Terms and Explanations**

- **Currency Depreciation:** This refers to the fall in the value of a currency in a floating exchange rate system due to market forces of demand and supply. For instance, if the value changes from ₹80 per dollar to ₹88 per dollar, the rupee has depreciated because it now takes more rupees to buy a single US dollar.
- **Foreign Exchange (Forex) Reserves:** These are assets held on reserve by a central bank in foreign currencies. They include foreign currency assets, gold, Special Drawing Rights (SDRs), and the reserve tranche position in the IMF. They act as a cushion against external economic shocks.
- **Foreign Currency Assets (FCA):** The largest component of Forex reserves, consisting of multi-currency assets like US Dollars, Euros, and Pound Sterling held in the form of foreign treasury bills and deposits with foreign central banks.
- **Import Cover:** An essential metric that measures the number of months of imports that can be sustained by a country's forex reserves. For an economy like India, a comfortable import cover is traditionally considered to be around **10 to 12 months** to ensure balance of payments stability.
- **Capital Account vs. Current Account:** The current account records the net flow of liquid cash moving in and out of a country due to trade in goods, services, and net income transfers. The capital account records all international net changes in financial assets and liabilities, such as Foreign Direct Investment (FDI) and Foreign Portfolio Investment (FPI).
- **Price-Taker vs. Price-Setter:** In international trade, a price-taker nation must accept prevailing global market prices for its exports because it lacks monopoly power or distinct product differentiation. A price-setter has enough market share or unique branding to dictate its own prices. India's export basket, being heavily reliant on highly competitive commodities and textiles, often makes it a price-taker.
- **Re-exports and Import Content of Exports:** This occurs when imported raw materials or intermediate goods undergo processing before being exported as finished products. If an export product has a **40%** import content (such as refined petroleum or cut and polished diamonds), any benefit from rupee depreciation is largely offset by the rising cost of importing those raw inputs.



- **Main Arguments and Substantive Parts**

- The core debate centers on a classic macroeconomic dilemma: should a central bank intervene to stabilize its currency, or should it allow market forces to dictate its value?

- **The Mechanism and Limits of Central Bank Intervention**

- When a currency faces sharp depreciation due to global headwinds or domestic imbalances, the central bank can artificially support it by selling foreign currencies (dollars) from its forex kitty and buying domestic currency (rupees). This intervention increases the demand for the rupee, temporarily arresting its slide. However, this strategy faces absolute structural limits:

- **Depletion of Reserves:** Selling dollars drains the nation's forex reserves, reducing its capacity to handle future external crises.

- **The Quality of Forex Reserves:** Unlike export-surplus nations like China, India's forex reserves are largely built on capital account inflows (FDI and volatile FPI) rather than trade surpluses. This means a significant portion of India's reserves represents liabilities that can flee the domestic market if global investor sentiment sours.

- **The Myth of Export Competitiveness via Depreciation**

- Mainstream economic theory suggests that a weaker currency automatically boosts exports by making domestic goods cheaper for foreign buyers. However, this text outlines structural realities that break this narrative down:

- **The Price-Taker Trap:** Foreign buyers often demand price cuts in dollar terms when they observe a domestic currency depreciating, stripping away the profit margins Indian exporters hoped to gain.

- **High Input Costs:** Because a massive chunk of India's export manufacturing relies on imported intermediate goods, a weaker rupee inflates input bills, effectively neutralizing the competitive edge in the global market.

- **The Speculative Vicious Cycle:** Rapid, unmediated depreciation breeds anxiety. Importers rush to buy dollars ahead of time to hedge against future drops, while exporters delay bringing their dollar earnings back into the country, expecting a higher rate later. This collective behavior starves the domestic market of dollars, causing the currency to plunge even faster.

- **Historical Evolution of the Issue**

- India's approach to exchange rate management has evolved from rigid, state-controlled frameworks to a pragmatic, market-linked mechanism.

- **Pre-1991 Era (Fixed Exchange Rate Regime):** Post-independence, India followed a fixed exchange rate system where the rupee was pegged to the British Pound and later to a basket of currencies. The valuation was strictly controlled by the government, often leading to overvaluation, chronic shortages of foreign exchange, and a heavily restricted black market for dollars.

- **The 1991 Balance of Payments (BoP) Crisis:** A severe shortage of forex reserves—leaving India with barely two weeks of import cover—forced a historic structural shift. Under IMF conditionalities, India devalued the rupee by nearly **20%** in July 1991 to restore external competitiveness and attract capital.

- **1992: Liberalised Exchange Rate Management System (LERMS):** India introduced a dual exchange rate system where **40%** of foreign exchange earnings had to be surrendered to the RBI at an officially dictated rate, while the remaining **60%** could be converted at market-determined rates. This acted as a transitional stepping stone.

- **1993 Onward: Unified, Market-Determined Exchange Rate (Managed Float):** India moved to a unified exchange rate system. The RBI adopted a "managed float" or "dirty float" policy. Under this framework, the market determines the rupee's value through demand and supply, but the RBI actively steps in to curb extreme volatility and prevent speculative runs, without targeting a specific, rigid number.

- **2013 Taper Tantrum to the Modern Era:** When the US Federal Reserve hinted at winding down its quantitative easing program in 2013, emerging markets experienced massive capital flight. India was labeled part of the "Fragile Five" as the rupee hit historic lows. Learning from this, India aggressively built up its forex reserves, moving from just over \$100 billion in the early 2000s to comfortable structural levels today, providing a much stronger cushion against global monetary shocks.

A DETAILED CIVIL SERVICES PREPARATION GUIDE

UNDERSTANDING EXCHANGE RATES & CORE ISSUE

DEPRECIATION



FOREX RESERVES



IMPORT COVER



CENTRAL BANK INTERVENTION vs. MARKET FORCES

CENTRAL BANK



MARKET FORCES

HISTORICAL EVOLUTION

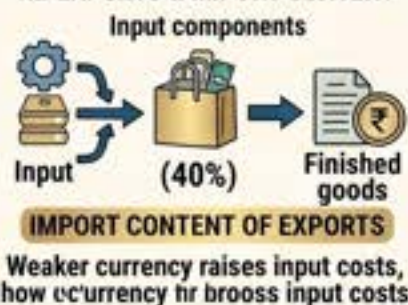


DEBUNKING EXPORT COMPETITIVENESS MYTHS

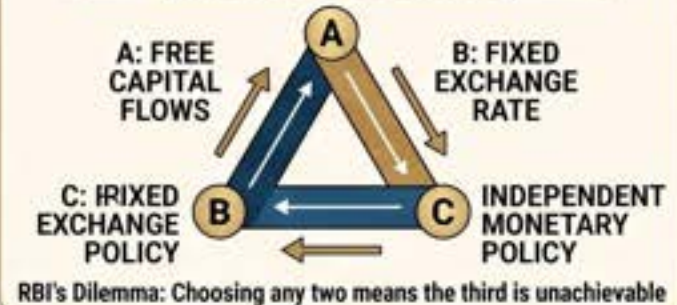
THE PRICE-TAKER EXPORTER EXAMPLE



RE-EXPORTS & IMPORT CONTENT



THE OPEN ECONOMY TRILEMMA (IMPOSSIBLE TRINITY)



MULTIDIMENSIONAL IMPACT ANALYSIS

ECONOMIC

- Imported inflation
- Twin Deficit

SOCIAL

- Regressive tax
- Education cost

POLITICAL

- Public confidence
- Growth focus

LEGAL

- RBI Act mandate
- FEMA

ETHICAL

- Wealth disparity
- Global fairness

INTERNATIONAL

- Geo-economic standing
- Currency wars

PATH TO LONG-TERM SUSTAINABILITY & THE WAY FORWARD

STRUCTURAL EXPORT SHIFT
Higher value-add goods



RUPEE INTERNATIONALIZATION
Local currency trade

SUPPLY CHAIN LOCALIZATION
e.g., PLI scheme focus



UPSC CSE LINKAGES & PREPARATION

GS PAPER II & III

- Indian Economy
- Statutory Bodies

ESSAY THEMES

- Globalization
- Ethics

UPSC PYQS

- 2022 Depreciation and RBI Intervention

MODEL ANSWER



- Model Answer structure for consequences
- Model Answer ensons connrxrosttoration
- Model Answer structure in preparation



• EDUCATION

Why CBSE's digital evaluation method for Class 12 is facing flak

Abhinaya Harigovind
New Delhi, May 25

THE CENTRAL Board of Secondary Education (CBSE) is under fire for its new digital evaluation method, the On-Screen Marking (OSM) system, introduced for Class 12 board examinations this year.

Students who sought access to the scanned copies of their answer books have flagged blurred answer sheets and missing pages. The payment system also collapsed last week, deducting both additional payments and smaller amounts in many cases.

What is the OSM?

Over 98 lakh answer books belonging to over 18 lakh students were evaluated digitally for the first time.

All answer books were marked with a secret code. After they were moved from exam centres to regional offices, the copies were scanned and uploaded to a portal. Evaluators logged in and evaluated copies

under a marking scheme prepared by a pool of CBSE teachers.

The examiner must mark each step and answer, and in case of misses, the marked answer book cannot be submitted, officials said. The system automatically calculates the total marks. Of the 98 lakh answer books, around 13,000 were found illegible and were evaluated manually.

What went wrong?

The results declared on May 13 showed that the pass percentage had dropped from 88.39% last year to 85.29%. The last time a lower pass percentage was recorded was in 2019 (at 83.40%). The number of students scoring over 90% has also dropped.

Parents and students raised concerns, linking the marks to the OSM system.

The board then announced last week that the prices for obtaining a scanned copy of the answer book, verification (checking the totalling of marks or unmarked answers) and re-evaluation (where specific

Demanding answers

- The board has received an unusually high number of requests for answer books.
- Officials told *The Indian Express* on May 23 that 2.94 lakh applications for 8.56 lakh answer books were received.
- This is more than twice the 1.31 lakh applications received last year for 2.82 lakh answer books.

answers are re-checked) fees would be reduced. The fee would be refunded if re-evaluation results in an increase in marks.

However, the portal to apply for copies has also faced glitches, and the initial deadline was extended multiple times till Monday. The board said that the portal faced "unprecedented traffic" and "several attempts of unauthorised interference".

Officials said that students with grievances should wait for the re-evaluation portal to go live and apply through it, but no date has been announced so far.

What has the board said?

CBSE and the Education Ministry have defended OSM, arguing it eliminated totalling errors, and made the marking process standardised, objective, and transparent.


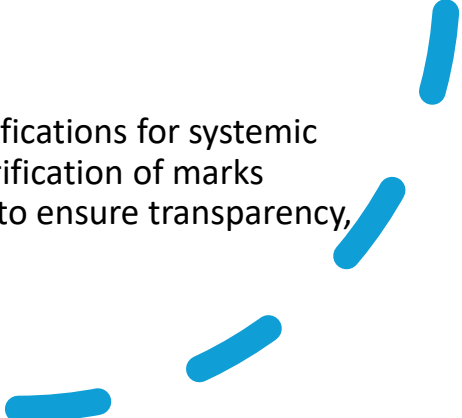
At a press briefing, CBSE Chairman Rahul Singh said that evaluation was earlier carried out in the same regions, but papers could now be sent elsewhere.

CBSE's Governing Body, its highest

decision-making authority, approved OSM last year. Going by the minutes of the meeting, its "members suggested that the on-screen marking may be implemented in all subjects only after completion of pilot projects in some subjects across the various Regional Offices of the Board." The governing body had "noted the suggestion".

However, pilot projects were not conducted across regional offices. A dry run was conducted in five schools, where teachers from Kendriya Vidyalayas, Navodaya Vidyalayas, and state government and private schools were trained in the system. Based on recommendations from the three-day process, the system was updated.

To deal with the technical issues, IIT Kanpur and IIT Madras have now been roped in. Four public sector banks — Bank of India, Bank of Baroda, Canara Bank and Indian Bank — have also been tasked with assisting with the payment gateway. These steps have been taken on Education Minister Dharmendra Pradhan's directions.

- 
- **Key Terms and Explanations**
 - **On-Screen Marking (OSM) System**
 - This refers to a digital evaluation architecture where physical answer scripts are digitized through high-speed scanners, masked with unique encryption or secret codes to maintain candidate anonymity, and uploaded onto a secure cloud network. Evaluators log into a dedicated portal to grade scripts on screen, using digital tools to award marks step-by-step. The system automatically sums up the marks to eliminate manual totaling errors.
 - **Technocratic Governance**
 - An administrative approach where decision-making and public service delivery rely heavily on technical expertise, digital tools, and algorithms. In education, this translates to substituting traditional manual checks with automated workflows, optimizing speed, uniformity, and data processing.
 - **Digital Divide and Glitch Capital**
 - The structural disparity between the intended design of a technological platform and its actual execution capability on the ground. "Glitch capital" refers to the hidden costs—such as mental distress, financial losses due to failed payment gateways, and procedural delays—borne by citizens when public institutions roll out large-scale digital systems without adequate stress-testing.
 - **Grievance Redressal Architecture**
 - The institutional mechanism through which citizens can seek rectifications for systemic errors. In public examinations, this involves a multi-tier structure: verification of marks (checking for omissions), obtaining scanned copies of answer scripts to ensure transparency, and formal re-evaluation by independent subject experts.
- 

- **Main Arguments and Substantive Parts**

- **The Structural Promises of Automated Assessment**

- The core argument for shifting to an electronic evaluation model rests on enhancing institutional efficiency and eliminating human error. Traditional grading systems are plagued by totaling mistakes, skipped pages, and subjectivity tied to localized grading bias. By automating totals and mandating step-by-step grading inputs on screen, the system ensures compliance with marking schemes. This standardizes evaluation across vast geographies, making the process objective, transparent, and secure against physical tampering.

- **The Vulnerabilities of Premature Scaling**

- While the system is conceptually sound, large-scale implementation without extensive, multi-tier pilot testing often exposes deep systemic vulnerabilities. Scaling a digital framework to manage millions of scripts simultaneously demands robust server architecture, flawless payment systems, and high-fidelity scanning. When these foundational elements falter, the system creates fresh vulnerabilities, including:

- Blurry digital reproductions that compromise fair evaluation.
- Intermittent portal crashes.
- Transactional failures that trigger widespread student anxiety.

- **The Correlation Between Automation and Performance Outcomes**

- A major point of contention arises when a sudden drop in macro performance metrics—such as overall pass percentages or high-tier scorers—coincides with the introduction of a digital evaluation platform. While administrators often view these fluctuations as a normalization of grades or the removal of artificial moderation, stakeholders frequently attribute them to systemic flaws, poor image clarity, or rigid interface designs that tire evaluators. This mismatch underscores how critical user-centric design is when deploying technology in public services.



- **Historical Evolution of the Issue**

- **Pre-Independence to Early Post-Independence Foundations**

- The evaluation and examination architecture of India dates back to the colonial era, modeled on the centralized, summative testing frameworks of the University of London via the Wood's Despatch of 1854. Post-independence, the Radhakrishnan Commission (1948-49) and the Mudaliar Commission (1952-53) both criticized the high-stakes, subjective nature of these examinations, warning that they encouraged rote learning and lacked standardized grading.

- **The Kothari Commission and National Policies on Education (1968, 1986)**

- The Kothari Commission (1964-66) recommended a shift toward continuous evaluation and objective marking criteria to minimize examiner subjectivity. This vision was formally adopted in the National Policy on Education (NPE) 1986, which advocated for structural reforms in examinations, including grade moderation, script re-checking mechanisms, and the introduction of transparency measures to protect student rights.

- **The E-Governance Revolution and National e-Governance Plan (NeGP)**

- With the launch of the NeGP in 2006, the Indian administrative apparatus began integrating Information and Communication Technology (ICT) into public service delivery. Educational boards gradually shifted from manual processes to digital systems, starting with online registration and digital admit cards, and eventually moving to CBTs (Computer Based Tests) for competitive entrance examinations.

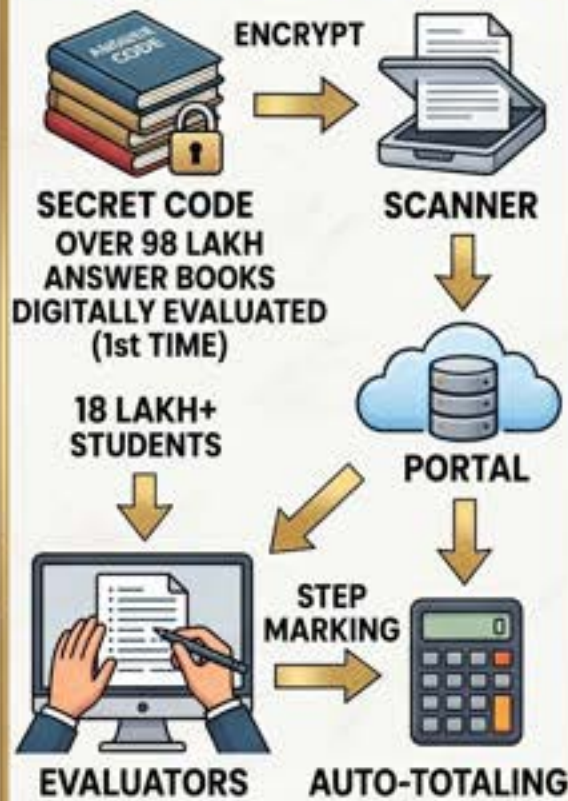
- **The National Education Policy (NEP) 2020 Era**

- NEP 2020 explicitly highlights using technology to achieve transparent, objective, and high-quality formative and summative assessments. This policy push accelerated the transition from manual, paper-based grading to cloud-based On-Screen Marking (OSM) systems, aiming for complete digitization. However, as these platforms scale to handle millions of students across diverse regional offices, they run into systemic hurdles, revealing a gap between policy goals and operational realities.



ANALYSIS: THE CBSE ON-SCREEN MARKING (OSM) SYSTEM - NAVIGATING CHALLENGES & REFORMS

UNDERSTANDING THE OSM PROCESS & SCALE



CORE CHALLENGES & PUBLIC CRITICISM

- ⚠️ **BLURRED ANSWER SHEETS & MISSING PAGES**
- ⚠️ **PAYMENT SYSTEM COLLAPSE**
 **ADDITIONAL AMOUNT DEDUCTIONS**
- ⚠️ **UNPRECEDENTED TRAFFIC & PORTAL GLITCHES**
- ⚠️ **UNUSUALLY HIGH RE-EVALUATION REQUESTS**
 **MORE THAN TWICE LAST YEAR'S APPLICATIONS: 2.94 LAKH for 8.56 LAKH BOOKS**

BOARD'S RATIONALE & MITIGATION EFFORTS

- ✅ **ELIMINATED TOTALING ERRORS**
- ✅ **STANDARDIZED & OBJECTIVE MARKING**
- ✅ **REDUCED REGIONAL BIAS** (Papers marked elsewhere)

RECENT CORRECTIVE STEPS

- 📍 **IITs ROPED IN** (IIT Kanpur, IIT Madras) illustrative
- 📍 **PUBLIC SECTOR BANKS ROPED IN**
 
 
 illustrative

KEY PUBLIC ADMINISTRATION LESSONS FOR IAS ASPIRANTS

TECHNOLOGY ADOPTION & SERVICE DELIVERY

- **IMPORTANCE OF SCALED PILOT TESTING**
note: Dry run not equal to comprehensive pilot
- **DESIGNING ROBUST GRIEVANCE REDRESSAL**
Beyond just a digital portal
- **INTER-INSTITUTIONAL COLLABORATION**
- **TRANSPARENT COMMUNICATION**



As Kerala sets up department for the elderly, a look at India's ageing challenge

Shaju Philip
Thiruvananthapuram, May 25

KERALA IS India's most rapidly ageing state. Last week, its new Congress government announced the formation of a department for the welfare of elderly people — the first such initiative in India. Kerala already has a number of policies to help the elderly, overseen by the Social Welfare department so far. But the setting up of a dedicated department appears to signal a greater focus on dealing with the fallout of a demographic transition — something the rest of the country is also set to experience in the coming decades.

A state turning grey, and fast

According to the India Ageing Report of 2023, around 16.5% of Kerala's population was aged above 60 in 2021, compared with the national average of 10.1%. By 2036, this figure was expected to increase to 22.8% against the all-India projection of 15%.

So what's behind the rapid ageing? First, Kerala's total fertility rate has declined over the years to 1.35 children per

• DUTY OF CARE

• Women's informal unpaid care and domestic work contributes about 15-17% of the GDP.

• Formalising the care economy is crucial to not only care for the elderly but also create jobs.

woman in 2023 according to the state's Vital Statistics data. This is below the national replacement level of 2.1, the rate required for a population to replace itself across generations.

Second, life expectancy has increased owing to better healthcare facilities.

The third factor is migration. Many from Kerala's working age population migrate and often settle abroad, leaving their parents back home. At the same time, large numbers of migrants return from West Asia after retirement.

The challenge ahead — and the opportunity

The growing graph of senior citizens has thrown up challenges for Kerala in the health and service sectors, mainly on shifting its focus to geriatric care. This requires nurturing a care economy in the state.

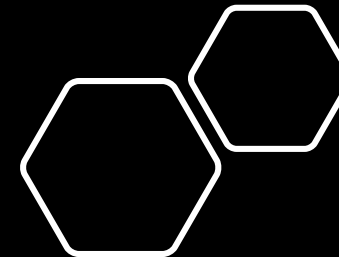
But this challenge is not Kerala's alone.

By 2050, the proportion of elderly persons in the country is expected to increase to 20.8% of the population, that is around 54.7 crore. This would necessitate the need to invest in healthcare, social support and care infrastructure.

India does have laws and policies to support the elderly. These include the Maintenance and Welfare of Parents and Senior Citizens Act of 2007 that mandates children and heirs to provide maintenance, and the National Policy for Senior Citizens, 2011 that aims to provide older people with social security.

Last month, the Telangana Assembly passed a Bill to dock the salary of those deemed to be neglecting their parents. In 2017, Assam passed a similar law that laid out a 10% salary cut for parental neglect by government employees. But coverage gaps remain.

An April 2026 working paper authored by PM-Economic Advisory Council member Shamika Ravi and others flags that the public system of elder care operates with "limited coverage, weak regulatory mechanisms, and financing gaps". The need, say experts, is to look at ageing as not just a welfare issue but a development one.



- **Key Terms and Explanations**

- **Demographic Transition:** This is the historical shift from high birth rates and high infant mortality rates to low birth rates and low death rates as a society modernizes and improves healthcare. India is currently moving through advanced stages of this transition, leading to a rapidly swelling older cohort.

- **Total Fertility Rate (TFR):** The average number of children born to a woman during her childbearing years. The national replacement level—the rate at which a population exactly replaces itself from one generation to the next without migration—is 2.1. Sub-national regions like Kerala have dipped far below this to 1.35, accelerating the graying of the population.

- **Care Economy:** This encompasses all economic activities involving paid or unpaid caregiving services, including eldercare, childcare, and healthcare. It includes the vast, historically invisible sector of unpaid domestic work performed primarily by women, which is estimated to contribute a staggering **15-17%** to the national GDP.

- **Geriatric Care:** A specialized sub-field of medicine and social science focused entirely on the health, preventive care, and unique psychological and physical needs of senior citizens.

- **Demographic Dividend vs. Demographic Tax:** The demographic dividend is the economic growth potential that results from shifts in a population's age structure, specifically when the working-age population (15–64 years) is larger than the non-working-age share. Conversely, a demographic tax occurs when the elderly dependency ratio climbs sharply, straining public finances, healthcare systems, and the active workforce.



- **Main Arguments and Substantive Parts**

- The core thesis surrounding India's contemporary population shift revolves around a crucial realization: population ageing is no longer a distant macroeconomic forecast; it is an immediate structural reality.

- **The Demographic Divergence:** The pacing of this shift is highly unequal across India. Regional bellwethers like Kerala are experiencing an accelerated aging process. In 2021, its senior citizen cohort stood at **16.5%** compared to the national average of **10.1%**. By 2036, this is projected to scale up to **22.8%**, while the national average will chase it at **15%**. By the year 2050, more than one in five Indians (**20.8%**, or approximately **34.7 crore** individuals) will be over the age of 60.

- **The Triple Drivers of Aging:** This rapid graying is propelled by three reinforcing structural factors:

- A sharp drop in TFR far below the replacement threshold.
- Enhanced life expectancy driven by expanded access to modern medical interventions.
- Unique migration dynamics, where working-age youth emigrate for employment—creating "empty nests"—while older retirees return to their home states post-retirement.

- **The Paradigm Shift from Welfare to Development:** There is an urgent need to stop treating eldercare merely as a peripheral charity or social welfare issue. Instead, policy architectures must treat aging as a core developmental challenge that demands dedicated administrative machinery, formal economic integration, and massive public-private investments.

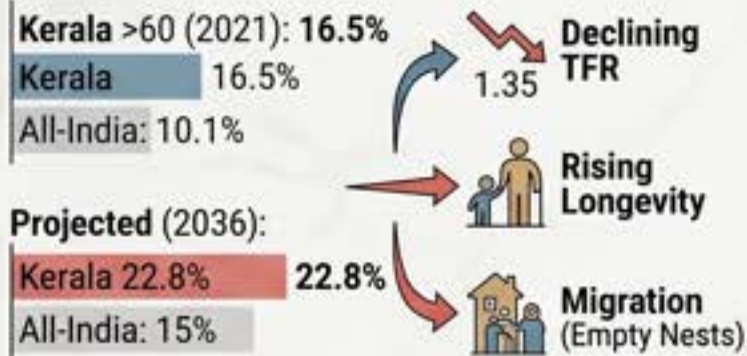
- **Institutional Framework Gaps:** A recent April 2026 working paper from the PM-Economic Advisory Council (PM-EAC) directly identified critical institutional bottlenecks: limited coverage of existing security nets, weak regulatory frameworks for private eldercare facilities, and profound financing deficits that hamper scalable long-term solutions.



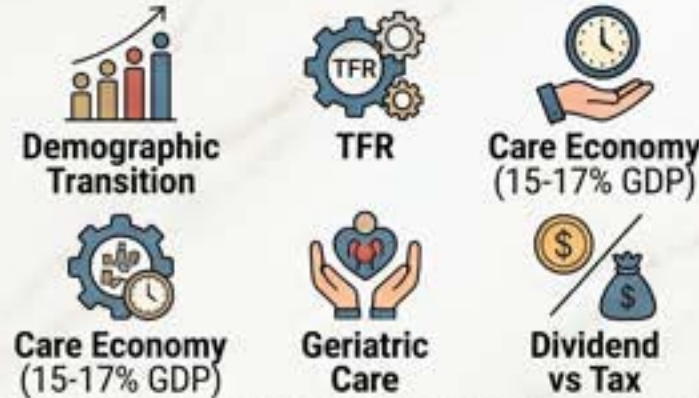
- **Historical Evolution of the Issue**
- The structural approach toward eldercare in India has undergone a profound evolution over the decades:
- **Pre-Independence to Early Independence (Post-1947):** During this phase, eldercare was viewed strictly as a private, familial obligation. The traditional joint family system acted as an unwritten, organic social security net. With national life expectancy hovering around **32 years** at independence, the absolute volume of senior citizens was low, leaving the state to focus primarily on basic survival and famine prevention.
- **The Era of Family Fragmentation (1990s):** The dual forces of economic liberalization and rapid urbanization accelerated the breakdown of the joint family system into nuclear units. Recognizing this emerging crisis, the government formulated the **National Policy on Older Persons (NPOP) in 1999** to officially acknowledge the state's role in ensuring financial security and healthcare for seniors.
- **Statutory and Policy Formalization (2000s–2010s):** Moving from non-binding guidelines to legal mandates, India enacted the landmark **Maintenance and Welfare of Parents and Senior Citizens Act in 2007**. This law turned filial care into a legal obligation, backed by the establishment of maintenance tribunals. This was soon followed by the updated **National Policy for Senior Citizens in 2011**.
- **The Present Era of Executive Focus (2020s–2026):** We are now seeing a transition from reactive legislation to executive institutionalization. State interventions have grown increasingly direct: Assam introduced mechanisms to penalize government employees who neglect parents via salary deductions, Telangana recently passed a similar salary-docking bill, and Kerala has pioneered the creation of a completely independent, dedicated Department for the Welfare of the Elderly.

INDIA'S AGEING CHALLENGE: A COMPREHENSIVE UPSC PERSPECTIVE

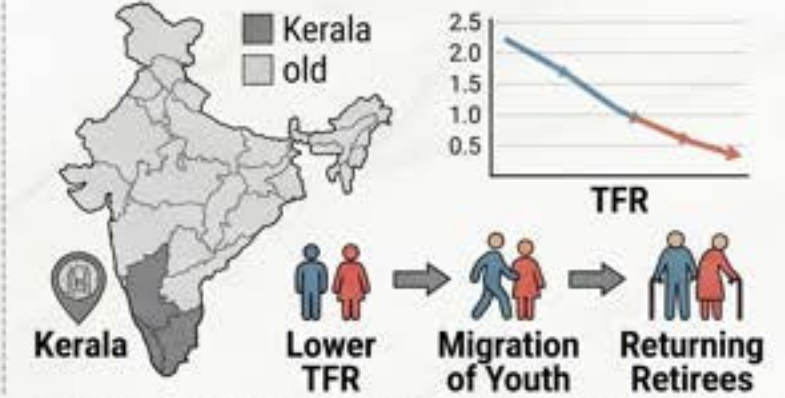
1. CONTEXT & DEMOGRAPHIC TRANSITION



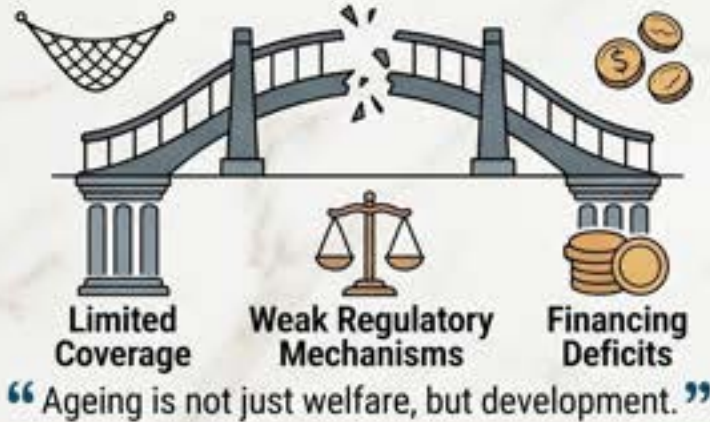
2. KEY CONCEPTS & DEFINITIONS



3. TRIPLE DRIVERS & REGIONAL DIVERGENCE



4. CHALLENGES AHEAD (Institutional Gaps)



5. MULTIDIMENSIONAL ANALYSIS



6. WAY FORWARD & POLICY RECOMMENDATIONS





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