CARBON DIOXIDE (CO_2) LASERS

- The **first CO_2 laser** was developed by Indian-American scientist **C.K.N. Patel**.
- It is a **four-level molecular gas laser** that operates using **vibrational energy states of CO_2 molecules**.
- **Highly efficient**, producing **high-power continuous or pulsed output**.
- **Structure:** A **CO_2 molecule** consists of **one carbon atom** at the center and **two oxygen atoms** on either side. It vibrates in **three independent modes**:
    - **Symmetric Stretching Mode**: Oxygen atoms move **simultaneously** towards or away from the **fixed** carbon atom.
    - **Bending Mode**: Carbon and oxygen atoms vibrate **perpendicular** to the molecular axis.
    - **Asymmetric Stretching Mode**: Oxygen atoms move in **one direction**, while the carbon atom moves in the **opposite direction**.
- **Principle of CO_2 Laser:** The laser transition occurs between **vibrational energy states** of CO_2 molecules. Energy is transferred from **excited nitrogen (N_2) molecules** to CO_2, achieving the **population inversion** necessary for laser action.

Characteristics of CO_2 Laser

- **Type**: Molecular gas, **four-level laser**.
- **Active medium**: Gas mixture of **CO_2, N_2, and He**.
- **Pumping Method**: Electrical discharge.
- **Optical Resonator**: Concave mirrors.
- **Power Output**: Up to 10 kW.
- **Nature of Output**: Continuous wave (CW) or pulsed wave.
- **Wavelength**: 9.6 μm & 10.6 μm (Infrared region).

CARTOSAT-3

- **ISRO's Earth observation satellite, CARTOSAT-3, captured high-resolution images** of the destruction caused by the **7-magnitude earthquake** that struck Myanmar on March 28, 2025.
- The **post-disaster imagery (March 29) was compared with pre-event data (March 18)** to assess the damage in **Mandalay and Sagaing**.

About CARTOSAT-3

- **CARTOSAT-3** is a **third-generation agile advanced Earth observation satellite** developed by **ISRO**.
- It **replaces the IRS (Indian Remote Sensing) series** and has **high-resolution imaging capabilities**.
- Launched aboard the **Polar Satellite Launch Vehicle (PSLV-C47)**.

Applications of CARTOSAT-3

- **National Security & Defense:**
  - **Military applications**: Used for **strategic surveillance, border security, and defense planning**.
  - **Previous use**: **Cartosat-2** aided in **2016 surgical strikes** across the **LoC** and **2015 Myanmar-Manipur operations**.
- **Disaster Management & Urban Planning:**
  - **Assessing natural disasters**: Earthquake, floods, and landslide monitoring.
  - **Urban & Rural Infrastructure Planning**: Road networks, water distribution, and land-use regulation.
  - **Coastal Land Use & Regulation**: Monitoring environmental changes along the coastline.

- **Cartography & Remote Sensing:**
  - High-Resolution Mapping for geospatial applications.
  - Detecting Natural & Man-Made Changes in geographical features.

Cartosat Satellite Series

- **Cartosat-1 to 3:** High-resolution Earth observation, urban and rural planning.
- **RISAT Series:** Radar-based imaging for **cloud-penetrating surveillance**.
- **Oceansat Series:** Monitors **Ocean parameters, weather forecasting, and marine studies**.
- **INSAT & Megha Tropiques:** Atmospheric studies and **climate research**.

ARCTIC COUNCIL

- **The Arctic is governed by the Arctic Council**, an intergovernmental body formed in **1996 through the Ottawa Declaration.**
- **Member States (8):**
  - Canada, Denmark (Greenland), Finland, Iceland, Norway, Russia, Sweden, and the United States.
  - These countries **control land territories** and have **rights over resources** within their **Exclusive Economic Zones (EEZs).**
- **Permanent participants: Six Indigenous groups** representing Arctic inhabitants.
- **Observers (Including India):**
  - **Thirteen countries** (e.g., India, China, Japan, UK, France).
  - **Thirteen intergovernmental organisations.**
  - **Twelve non-governmental organisations.**
- All decisions require the consensus of the eight Arctic States and consultation with permanent participants.

The Northeast Passage

- The **Northeast Passage** (also called the **Northern Sea Route**) runs **along Russia's Arctic coastline**, connecting **Europe and Asia**.
- **Potential Advantages:**
  - **Shortens shipping distances** between **China and Europe** by **up to 8,000 km**.
  - **Reduces dependency** on the **Suez Canal**, which faces security risks.
  - **Economic boost** for Russia, as it controls access to the route.

Why is the Arctic Gaining Strategic Importance?

- **Natural resources:** The Arctic holds **13% of the world's undiscovered oil** and **30% of untapped natural gas.** Rich in **rare earth elements, phosphates, and copper.**
- **New trade routes:** The **Northeast Passage (Russia)** and the **Northwest Passage (Canada)** are emerging as alternatives to the **Suez Canal, reducing travel distances by thousands of kilometers.**
- **Geopolitical interests:** Russia, the US, and China are **increasing military activities** in the region, leading to **rivalry and potential conflicts.**
- **Climate change impact:** Ice melting is **opening previously inaccessible areas for exploration and trade.**
- **Lack of Legal Safeguards:** Unlike Antarctica, which is **protected by international treaties**, the Arctic is primarily governed by **UNCLOS (United Nations Convention on the Law of the Sea).** This allows **territorial claims and military presence.**

ABEL PRIZE 2025

- The Abel Prize recognises pioneering scientific **achievements in mathematics**.
- It is **named after Norwegian mathematician Niels Henrik Abel** (1802-29), who in his short life made pioneering contributions to multiple fields.

- The prize was **established by the Norwegian Parliament in 2002,** on Abel's 200th anniversary.
- The Abel Prize is awarded and **administered by the Norwegian Academy of Science and Letters** on behalf of the Norwegian government.
- The recipients are **chosen by an expert committee appointed** by the Academy **under** the **advice of the International Mathematical Union** (IMU) and the **European Mathematical Society (EMS).**
- **First awarded in 2003**, the Abel Prize is often considered to be an **equivalent of the Nobel Prize,** which does not have a category **for mathematics.** It has been modelled as such.
- The prize includes a monetary award of 7.5 million kroner (roughly USD720,000) and a glass plaque designed by Norwegian artist Henrik Haugan.

Abel Prize 2025:

- It was awarded to **Japanese mathematician Masaki Kashiwara** for his fundamental contributions to **algebraic analysis and representation theory**, in particular the development of the **theory of D-modules** and the **discovery of crystal bases.**
- His work has not only helped solve some hard problems that have been around for a long time but also opened new avenues for research by connecting areas that were not known to be connected before.
- For instance, Kashiwara discovered crystal bases, which allowed mathematicians to replace complex calculations with much simpler graphs of vertices connected by lines.

EXERCISE TIGER TRIUMPH

- It is an **India-U.S. tri-service Humanitarian Assistance and Disaster Relief (HADR) Exercise.**

- The exercise aims to **enhance interoperability for conducting HADR operations** and to **formulate** Standard Operating Procedures **(SOPs) for establishing a Combined Coordination Centre (CCC).**
- The Indian side would be represented by **Indian Naval Ships Jalashwa, Gharial, Mumbai,** and **Shakti,** along with integral helicopters and landing crafts embarked, Long Range Maritime Patrol Aircraft **P8I,** army troops from 91 Infantry Brigade and 12 Mechanical Infantry Battalion, Air Force **C-130 Aircraft,** and **MI-17 Helicopters**, along with the Rapid Action Medical Team (RAMT).
- The US side would be represented by **US navy ships Comstock and Ralph Johnson**, with troops of the US Marine Division embarked.
- Participants from both sides would also engage in training visits, subject matter expert exchanges, sports events, and social interactions.

ALZHEIMER'S

- **Alzheimer's disease is a progressive neurodegenerative disorder** that primarily affects memory, thinking, and reasoning abilities.
- It is **the most common cause of dementia**, accounting for **60-80% of all dementia cases**
- The disease **disrupts communication between brain cells**, leading to a decline in cognitive and functional abilities.

What is Early-Onset Alzheimer's?

- Most cases of Alzheimer's occur in individuals aged 65 or older, but around 5-10% of cases develop before this age—this is called **Early-Onset Alzheimer's Disease (EOAD).**
- Unlike late-onset Alzheimer's, EOAD **progresses more rapidly** and **often affects people in their prime working years**, making it particularly devastating.

- **Genetic factors play a crucial role** in early-onset cases, with mutations in three specific genes—**APP, PSEN1, and PSEN2**—linked to increased risk.
- **The Role of Amyloid Beta and Plaque Formation:** The buildup of amyloid beta proteins in the brain leads to the formation of **amyloid plaques**, a hallmark of Alzheimer's disease.

Gantenerumab

- **Gantenerumab is an experimental drug** that was initially discontinued but has now shown promise in new clinical trials.
- The **latest trial** focused on **patients with genetic mutations** known to cause early-onset Alzheimer's.
- It was a **randomized, placebo-controlled study**, tracking disease progression using **brain imaging and blood biomarkers**.
- **Results showed a significant reduction in amyloid plaque buildup**, suggesting the drug may slow cognitive decline.

How does Gantenerumab Work?

- **It is a monoclonal antibody**, meaning it is **lab-engineered to specifically target amyloid beta proteins.**
- Once attached to amyloid plaques, it **signals the immune system to break them down** and remove them from the brain.
- The drug **activates microglial cells**, which act as the brain's **primary immune defenders**, to clear toxic proteins more efficiently.
- A major challenge in treating neurological diseases is the **blood-brain barrier**, which blocks many drugs from reaching the brain.
- **Gantenerumab can cross this barrier**, making it more effective than some previous Alzheimer's treatments.

JOB CREATION IN INDIA - CHALLENGES AND POLICY IMPERATIVES

- **India's working-age population has increased** significantly since 2017-18 (by about 9 crore), yet **formal sector job creation has not kept pace** (rose by 6 crore), leading to **a deficit of 50 lakh jobs annually**.
- Most new employment has emerged from informal and self-employment sectors, highlighting both **quantitative and qualitative challenges in job opportunities**.

The Rising Capital Intensity of Production:

- **Technological progress and declining labour intensity:**
  - Labour-intensive industries are increasingly adopting capital-intensive production processes.
  - **AI and automation** are accelerating this trend, reducing labour demand across sectors.
- **Why is capital intensity increasing in a labour-abundant economy?** Two key factors contribute to this shift:
  - **Demand-side factors:** Need for **higher productivity and value addition at lower costs.**
  - **Supply-side factors:** Shortage of skilled labour forces employers to opt for automation.
- **Impact on employment and economic sectors:**
  - **Services sector:** Highest value addition, increasing contribution to GDP.
  - **Manufacturing sector:** Stagnant contribution despite industrial policies.
  - **Agriculture sector:** Declining share in GDP, **pushing surplus labour into informal jobs.**

Skills Deficit and the Challenge of Employment Readiness:

- **Less than 10%** of India's workforce has formal technical or vocational training.
- Many educated youths **lack job-ready skills**, widening the skill gap in the labour market.

- The rise of "**skill-biased technological change**" is making certain job roles redundant, reducing labour demand further.
- **Key policy requirement:** Continuous skilling and upskilling **to ensure workforce adaptability to new technologies.**

Government Strategies for Job Creation:

- **PLI scheme:**
  - The production-linked incentive (PLI) scheme aims to **boost high-value production and attract investments.**
  - Over 50% of the PLI budget is allocated to **electronics, IT hardware, and drone manufacturing**.
  - **Employment mismatch:**
    - High job creation in **food processing & pharmaceuticals**, but these sectors receive less financial support.
    - **Labour-intensive industries remain underfunded** despite high employment potential.
- **ELI scheme:**
  - The employment-linked incentive (ELI) scheme **provides government cash transfers via EPFO to encourage private sector hiring.**
  - Supports labour-intensive sectors by reducing initial hiring risks for employers.
  - **Challenges:**
    - **Short subsidy period** (2-3 years), raising concerns about long-term employment sustainability.
    - **Requires tracking of employment outcomes** to assess its effectiveness in skill development.

Conclusion:

- To realize the vision of **Viksit Bharat**, India must adopt **a dynamic and comprehensive employment policy** that simultaneously **expands production capacity and enhances workforce quality.**