Syllabus subtopic: Science and Technology- developments and their applications and effects in everyday life, Achievements of Indians in science & technology, indigenization of technology and developing new technology.

Prelims and mains focus: About neutrinos, the Neutrino project, and its significance

News: The Centre has reiterated that the Indian Neutrino Observatory (INO) will be established in Theni in south Tamil Nadu though there has been opposition to the project by locals.

About the project:

The India-based Neutrino Observatory (INO) Project is a multi-institutional effort aimed at building a world-class underground laboratory with a rock cover of approx. 1200 m for non-accelerator based high energy and nuclear physics research in India. The initial goal of INO is to study neutrinos.

It is a mega-science project jointly funded by the Department of Atomic Energy (DAE) and the Department of Science and Technology (DST).

The project includes:

- Construction of an underground laboratory and associated surface facilities at Pottipuram in Bodi West hills of Theni District of Tamil Nadu.
- Construction of an Iron Calorimeter (ICAL) detector for studying neutrinos.
- Setting up of National Centre for High Energy Physics at Madurai, for the operation and maintenance of the underground laboratory, human resource development and detector R&D along with its applications.

About Neutrinos

- Neutrinos, first proposed by Swiss scientist Wolfgang Pauli in 1930, are the second most widely occurring particle in the universe, only second to photons, the particle which makes up light. In fact, neutrinos are so abundant among us that every second, there are more than 100 trillion of them passing right through each of us — we never even notice them.
- Neutrinos occur in three different types, or flavours. These are separated in terms of different masses. From experiments so far, we know that neutrinos have a tiny mass, but the ordering of the neutrino mass states is not known and is one of the key questions that remain unanswered till today. This is a major challenge INO will set to resolve, thus completing our picture of the neutrino.

Significance

Neutrinos hold the key to several important and fundamental questions on the origin of the Universe and the energy production in stars. Another important possible application of
neutrinos is in the area of neutrino tomograph of the earth, that is detailed investigation of the structure of the Earth from core onwards. This is possible with neutrinos since they are the only particles which can probe the deep interiors of the Earth.

Why underground laboratory?

Neutrinos are notoriously difficult to detect in a laboratory because of their extremely weak interaction with matter.

- The background from cosmic rays (which interact much more readily than neutrinos) and natural radioactivity will make it almost impossible to detect them on the surface of the Earth. This is the reason most neutrino observatories are located deep inside the Earth’s surface.
- The overburden provided by the Earth matter is transparent to neutrinos whereas most background from cosmic rays is substantially reduced depending on the depth at which the detector is located.