IIT-M researchers use artificial materials and ultrasound to detect defects in large structures

Context:

- Researchers in the Indian Institute of Technology Madras and the University of Nairobi have used metamaterials to improve detection of defects in large structures by guided wave ultrasound.
- Engineering structures including buildings, pipelines and rails require periodic testing to prevent catastrophic failures occurring due to corrosion, impact, and strain.
- High-frequency sound waves that travel in the bulk are widely used for non-invasive and non-destructive testing of structural materials.
- Conventional bulk ultrasonic inspection is tedious and time-consuming as it involves point-by-point assessment of structures.

Guided Wave Testing:

- In guided wave testing (GWT), the sound waves are sent along the length of the structure rather than into the structure, allowing the waves to travel longer distances.
- GWT has poorer resolution than conventional ultrasound-based testing due to diffraction limitations.
- The research team used metamaterials to improve the resolution of guided ultrasound waves.

Metamaterial

- A metamaterial is any material engineered to have a property that is not found in naturally occurring materials.
- They are made from assemblies of multiple elements fashioned from composite materials such as metals and plastics.
- The materials are usually arranged in repeating patterns, at scales that are smaller than the wavelengths of the phenomena they influence.
- Metamaterials derive their properties not from the properties of the base materials, but from their newly designed structures. Their precise shape, geometry, size, orientation and arrangement gives them their smart properties capable of manipulating electromagnetic waves: by blocking, absorbing, enhancing, or bending waves, to achieve benefits that go beyond what is possible with conventional materials.
- Appropriately designed metamaterials can affect waves of electromagnetic radiation or sound in a manner not observed in bulk materials.
- Those that exhibit a negative index of refraction for particular wavelengths have been the focus of a large amount of research.
These materials are known as negative-index metamaterials.