

DISCIPLINE SPECIFIC ELECTIVE COURSE – PHYSICS DSE 14c: PHYSICS OF EARTH

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Physics of Earth PHYSICS DSE – 14c	4	3	1	0	Class XII Pass with Science	NIL

LEARNING OBJECTIVES

This course familiarizes the students with the origin of earth in the solar system and various processes occurring in atmosphere, oceans and earth's internal structure.

LEARNING OUTCOMES

At the end of this course student will be able to,

- Have an overview of structure of the earth as well as various dynamical processes occurring on it.
- Develop an understanding of evolution of the earth.
- Apply physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure.
- Understand the origin of magnetic field, geodynamics of earthquakes and the description of seismic sources; a simple but fundamental theory of thermal convection; the distinctive rheological behaviour of the upper mantle and its top.
- Explore various roles played by water cycle, carbon cycle, nitrogen cycles in maintaining steady state of earth leading to better understanding of the contemporary dilemmas (climate change, bio diversity loss, population growth, etc.) disturbing the Earth
- Develop the problem solving skills by adding numerical and simulations to clarify the fundamental concepts.

SYLLABUS OF DSE – 14c

THEORY COMPONENT

Unit – I

(10 Hours)

The Earth and the Universe:

- General characteristics and origin of the Universe. The Big Bang Theory. Estimation of age of the Universe and Hubble constant. Formation of Galaxies. Types of galaxies, Milky Way galaxy, Nebular hypothesis, Solar system, The Terrestrial and Jovian planets (Sizes, Acceleration due to gravity, Obliquity, Flatness, Eccentricity, Density, Temperature, Pressure, Atmosphere, Moons, Exceptions in trends). Titius-Bode law. Asteroid belt. Asteroids: origin types and examples, Meteorites.
- Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. Earth's orbit and spin, the Moon's orbit and spin.
- Energy and particle fluxes incident on the Earth.

Unit – II

(8 Hours)

Structure of Earth:

- a) Internal structure of Earth: Core, mantle, magnetic field. Origin of the Magnetic field. Convection in Earth's core and production of its magnetic field. Dynamo Theory, calculation of magnetic fields, Causes of variation of Magnetic Field and Palaeomagnetism.
- b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. Ocean circulations. Oceanic current system and effect of Coriolis forces.
- c) The Cryosphere: Polar caps and ice sheets. Mountain glaciers, permafrost.

Unit – III

(8 Hours)

Dynamical Processes:

- a) The Solid Earth: Concept of plate tectonics; types of plate movements, hotspots; sea-floor spreading and continental drift.
- b) Earthquake and earthquake belts. Types and properties of Seismic waves, Richter scale, geophones.
- c) Volcanoes: types, products and distribution.
- d) Concepts of eustasy, air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.

Unit – IV

(10 Hours)

The Atmosphere

- a) The Atmosphere: Features of different layers, variation of temperature with altitude; Dry, moist and environmental lapse rate, variation of density and pressure with altitude, Types of clouds and formation.
- b) The Atmosphere: Atmospheric circulation. Causes of Atmospheric circulation, Formation of three cells, Easterlies and Westerlies, and ICTZ, Weather and climatic changes. Earth's heat budget. Cyclones and anti-cyclones, tropical storms, hurricanes and tornadoes.
- c) Climate: Earth's temperature and greenhouse effect. Paleoclimate and recent climate changes. The Indian monsoon system.

Unit – V

(9 Hours)

Disturbing the Earth – Contemporary dilemmas

- a) Hydrosphere: Fresh water depletion.
- b) Geosphere: Chemical effluents, nuclear waste.
- c) Biosphere: Biodiversity loss. Deforestation. Water cycle, Carbon cycle. The role of cycles in maintaining a steady state.
- d) Air Pollution: Types of air pollutants, Effects on atmosphere and living organisms. Ozone Hole.

References:

Essential Readings:

- 1) Planetary Surface Processes, H. J. Melosh, 2011, Cambridge University Press.
- 2) Holme's Principles of Physical Geology, 1992, Chapman & Hall.
- 3) Planet Earth, Cosmology, Geology and the Evolution of Life and Environment, C. Emiliani, 1992, Cambridge University Press.
- 4) Physics of the Earth, F. D. Stacey, P. M. Davis, 2008, Cambridge University Press.
- 5) Environmental Physics: Sustainable Energy and Climate Change, E. Boecker and R.V. Grondelle, 3rd edition, 2011, Wiley, UK
- 6) Atmospheric Remote Sensing (Principles and Applications, Editors – S. Tiwari and A. K.

Singh, Chapter-1 (Composition and thermal structure of the Earth's atmosphere, by S. K. Dhaka and V. Kumar), 1st edition, Elsevier

Additional Readings:

- 1) The Blue Planet: An Introduction to Earth System Science, B. J. Skinner, S. C. Portere, 1994, John Wiley & Sons.
- 2) Consider a Spherical Cow: A course in environmental problem solving, J. Harte, University Science Books.
- 3) Fundamentals of Geophysics, W. Lowrie, 1997, Cambridge University Press.
- 4) The Solid Earth: An Introduction to Global Geophysics, C. M. R. Fowler, 1990, Cambridge University Press.
- 5) Climate Change: A Very Short Introduction, M. Maslin, 3rd edition, 2014, Oxford University Press.
- 6) The Atmosphere: A Very Short Introduction, P. I. Palmer, 2017, Oxford University Press.
- 7) IGNOU Study material: PHE 15 Astronomy and Astrophysics Block