SYLLABUS

UNDER
SKILL DEVELOPMENT CENTRE

CERTIFICATE COURSE

IN

OBSERVATIONAL ASTRONOMY

DURATION- 6 MONTHS

Effective from the Academic Session 2025

SIDHO-KANHO-BIRSHA UNIVERSITY

Curriculum

OBSERVATIONAL ASTRONOMY

Paper Code	TOPIC	CREDIT	INSTRUCTORs
SCOAST 101	Fundamental Physics	3	CB/SML
SCOAST 102	Basic Astronomy	3	SP/SKM
SCOAST 103	Observational Techniques	3	RKD/TB
SCOAST 104	Instruments and Basic Data Analysis	3+2	SM/SKM
SCOASP 105	Practical + Excursion	4+2	SKM/CB /RKD/TB/SM
	Total credit 20, Total Marks 250		

SYLLABUS

SCOAST 101: Fundamental Physics CREDIT: **3**

Mechanics:
Mechanics of a particle and system of particles: Generalized coordinates. Forces in classical mechanics. Inertial reference frame. Newton laws of motion, Newton's first law of motion example in daily life, Application of first law of motion. Collisions: Elastic and In elastic. 4 **L**

Motion Under Central Forces: Central force, Central orbit. Characteristics of motion under central force. General equation to any central orbit. Arial velocity, Energy in a central force field. Effective potential energy and stability of orbit. Conservation of energy in central motion: Equation of orbit from energy conservation. The two body problem; Motion under inverse square law of force. Properties of ellipse. Kepler's laws of planetary motion. Law of gravitation from Kepler's laws. Celestial dynamics. Kepler's intellectual legacy. Derivation of Kepler's laws. General remarks on Kepler's law. Artificial satellite; Geo-stationary satellite, Eccentricity of orbit of a satellite. Escape velocity. 4 **L**

Gravitation and Gravity: Gravitation. Newton's Law of Gravitation. Gravity in our universe. The Universal law of gravitation; Strength of Gravity, Newton's 2^{nd} theorem; Centrifugal force, Centripetal force; Circular and Escape velocity; Barycenter, center of mass, center of gravity, Barycenter in solar system. Earth-like planets in other solar systems. Gravitational Field, Gravitational potential, Gravitational potential due to a point mass. **6 L**

Basic Quantum Mechanics: Schrodinger equation and its interpretation; Probability, Normalization; Momentum; The Uncertainty Principle; Blackbody radiation: Stefan-Boltzmann law, Rayleigh and the Ultraviolet Catastrophe, Planck and the quantum mechanical behavior of light, Bosons and Fermions **6 L**

Basic Spectroscopy: Fundamentals of Spectroscopy. Basic elements of spectroscopy. Recapitulation and role of quantum mechanics. Different types of spectroscopy. Molecular spectroscopy. Atomic spectroscopy; Atomic emission spectroscopy, Atomic absorption spectroscopy, Atomic fluorescence spectroscopy. Advantages of spectroscopy. Spectrum of hydrogen atom. 10 **L**

Interaction of electromagnetic waves with matter:
Introduction. Radiation. Types of radiation. General characteristics of EMR. Dual nature of EMR. Non-ionizing vs Ionizing radiation. Nature of matter. Binding energy. Interaction of radiation with matter. Photon-beam interactions. Absorption, Scattering, Photo absorption, Photoelectric effect, Compton effect, Pair production. Rayleigh Scattering. Raman scattering. **7 L**

SCOAST 102: History of Astronomy CREDIT: **3**

Unit 1: Early Astronomy and Ancient Cultures (10L)

Introduction to Astronomy as a Historical Science: Rise of astronomy, What is astronomy? application of astronomical phenomena to calendars, time-keeping, navigation aid, How do we study its history?
Prehistoric Astronomy: Megaliths, Stonehenge, archaeoastronomy, sky myths
Astronomy in Mesopotamia: Ziggurats, omens, lunar calendars, planetary records
Egyptian Astronomy: Calendars, Sirius, pyramids aligned with stars
Indian Astronomy (Vedic to Siddhantic): historical development of astronomy in India, Aryabhata, Brahmagupta, Surya Siddhanta
Chinese and Mesoamerican Astronomy: Oracle bones, eclipse records, Mayan calendar

Unit 2: Greek and Hellenistic Astronomy (7L)

Natural Philosophy and the Cosmos: Thales, Anaximander, Pythagoras
The Geocentric Universe: Plato and Aristotle: Celestial spheres, perfection of the heavens
Hipparchus and the Star Catalog: Precession of the equinoxes
Claudius Ptolemy and the Almagest: Epicycles, deferents, geocentric perfection
Critiques and Alternatives: Islamic critiques, early heliocentric hints

Unit 3: Islamic and Medieval Astronomy (8L)

Astronomy in the Islamic Golden Age: Baghdad's observatories, astrolabes, translations
Al-Tusi, Ibn al-Shatir, and Non-Ptolemaic Models: Innovations leading toward heliocentrism
Astronomy in Medieval Europe: Monastic learning, universities, calendar reform
The Transmission of astronomical Knowledge: from Middle East Asia to Europe

Unit 4: The Copernican Revolution (6L)

Nicolaus Copernicus and the Heliocentric Model: "On the Revolutions of the Celestial Spheres"
Tycho Brahe and Precise Observation: Tychonic system, observatories
Johannes Kepler and Laws of Planetary Motion: Ellipses, harmonies of the spheres
Galileo Galilei and the Telescope: Moons of Jupiter, sunspots, phases of Venus
The Church and Science: Galileo's trial and the conflict narrative

Unit 5: Newtonian and Enlightenment Astronomy (6L)

Isaac Newton and Universal Gravitation: *Principia*, laws of motion
Astronomy in the 18th Century: Halley, cataloguing stars, mapping the sky
Astronomy and Navigation: Longitude problem, John Harrison's clock
Philosophical Shifts: From divine cosmos to mechanistic universe

Unit 6: Modern Astronomy and Cosmology (8L)

19th Century Breakthroughs: Spectroscopy, evolution of our concepts of astronomical objects and classification systems and their effects, astrophysics begins,
The Expanding Universe: Hubble, redshift, nebulae debates
Relativity and Space-Time: Einstein, gravity as curvature

Big Bang and Modern Cosmology: CMB, nucleosynthesis
Exploration and the Telescope Age: Hubble Space Telescope, exoplanets, JWST
Reflections and the Future of Astronomy: The role of AI, SETI, and the long view of cosmic history

SCOAST 103: Observational Techniques CREDIT: **3**

Spherical trigonometry: Concept of spherical trigonometry; great circle and small circle; terrestrial latitude and longitude; spherical triangle; derivation and application of the sine formula. **10 L**

Celestial Coordinates: Celestial sphere: concept of celestial sphere, concept of earth-centric system; why and how to define a coordinate system; different types of coordinate systems; Horizontal coordinate system: definition of horizon and variation with terrestrial coordinates; Equatorial coordinate system: definition, concept of equinox and solstice; Concept of solar motion and construction of the ecliptic coordinate system; the galactic coordinate system; conversion between different coordinate systems, concept of circumpolar stars, proper motion and parallax of stars; tutorial with different astronomical problems **25 L**

Astronmical Time: Astronomical time systems; Sidereal and Solar time; Definition and concept of Mean Sun; Concept of hour angle; Derivation of rising and setting time of stars; concept of meridian and local sidereal time, concept of time zone; tutorial with different astronomical problems. **10 L**

SCOAST104 : Instruments and Basic data Analysis CREDIT: **3**

Electromagnetic waves and propagation:
Wave Equation. Electromagnetic waves. Properties of electromagnetic waves. Propagation of electromagnetic waves. Modes of propagation of electromagnetic waves (Ground waves, Sky waves and Space waves). Direction of propagation of electromagnetic waves. Transverse nature of light waves. Plane polarized light Circular polarization **8L**

Electromagnetic spectrum: Blackbody radiation – Planck law, Wien's law and Rayleigh Jean's approximation; Electromagnetic waves in the electromagnetic spectrum. Properties and applications of Gamma ray, X-rays, UV rays, Visible light, IR rays, Microwaves and Radio waves. Significance of the Electromagnetic Spectrum. The colours of stars. Ultraviolet astronomy. Aurora. Electromagnetic spectrum and Astronomical observations; Multiwavelength observations of Milky ways and overview of Interstellar medium (ISM) **8L**

Magnitude system – Apparent, Absolute, and bolometric magntitudes **4L**

Quantification of Radiations: Stellar luminosity, effective temperature and other fundamental parameters; and stellar radiation; Spectral type of stars **3L**

Astronomical instruments – Telescopes and it's capability; Brief history of telescope development – Galileo to Large telescopes; Optical configuration of different-type telescopes (Newtonian; Cassegrain; Dobsonian Telescope) and related parameters; Brief of different telescope mounts; Detection limits, Magnification; Light gathering power
Indian Telescopes : Ground and Space-based facilities; Major International optical/Infrared telescope facilities **10L**

Detectors: Introduction; Detector types; The eye; semiconductors; Detector parameters; Optical and Infrared detection (PMT, Photographic, CCD, Near-IR arrays and CMOS); Ultraviolet detection; X-ray detector; Gamma ray Detector; Neutron detector; Astronomical filters; Understanding of Signal-to-Noise Ration; Schematic of spectrograph **12L**