Syllabus of

International Olympiad on Astronomy and Astrophysics (IOAA)

General Notes

1. Extensive contents in basic astronomical concepts are required in theoretical and practical problems.
2. Basic concepts in physics and mathematics at high school level are required in solving the problems. Standard solutions should not involve calculus.
3. Astronomical software packages may be used in practical and observational problems. The contestants will be informed the list of software packages to be used at least 3 months in advance.
4. Contents not included in the Syllabus may be used in questions but sufficient information must be given in the questions so that contestants without previous knowledge of these topics would not be at a disadvantage.
5. Sophisticated practical equipments may be used in the questions but sufficient information must be provided.

A. Theoretical Part

The following theoretical contents are proposed for the contestants.

1. Basic Astrophysics

Contents	Remarks
Celestial Mechanics	Kepler's Laws, Newton's Laws of Gravitation
Electromagnetic Theory & Quantum Physics	Electromagnetic spectrum, Radiation Laws, Blackbody radiation, Doppler effect
Thermodynamics	Thermodynamic equilibrium, Ideal gas, Energy transfer
Spectroscopy and Atomic Physics	Absorption, Emission, Scattering, Spectra of Celestial objects, Line formations
Nuclear Physics	Basic concepts

2. Coordinates and Times

Contents	Remarks

Celestial Sphere	Spherical trigonometry, Celestial coordinates, Equinox and Solstice, Circumpolar stars, Constellations and Zodiac
Concept of Time	Solar time, Sidereal time, Julian date, Heliocentric Julian date, Time zone, Universal Time, Local Mean Time

3. Solar System

Contents	**Remarks**
The Sun	Solar structure, Solar surface activities, Solar rotation, Solar radiation and Solar constant, Solar neutrinos, Sun-Earth relations, Role of magnetic fields, Solar wind
The Solar System	Earth-Moon System, Formation of the Solar System, Structure and components of the Solar System, Structure and orbits of the Solar System objects, Sidereal and Synodic periods
Phenomena	Tides, Seasons, Eclipses, Aurorae, Meteor Showers

4. Stars

Contents	**Remarks**
Stellar Properties	Distance determination, Radiation, Luminosity and magnitude, Color indices and temperature, Determination of radii and masses, Stellar motion, Stellar variabilities
Stellar Interior and Atmospheres	Stellar nucleosynthesis, Energy transportation, stellar atmospheres and spectra
Stellar Evolution	Stellar formation, Hertzsprung-Russell diagram, Pre-Main Sequence, Main Sequence, Post-Main Sequence stars, End states of stars

5. Stellar Systems

Contents	Remarks
Binary Star Systems	Classification, Mass determination in binary star systems, Light and radial velocity curves of eclipsing binary systems, Doppler shifts in binary systems
Star Clusters	Classification and Structure
Milky Way Galaxy	Structure and composition, Rotation, Interstellar medium
Normal and Active Galaxies	Classification, Distance determination
Accretion Processes	Basic concepts

6. Cosmology

Contents	Remarks
Elementary Cosmology	Cluster of galaxies, Dark matter, Gravitational lenses, Hubble's Law, Big Bang, Cosmic Microwave Background Radiation

7. Instrumentation and Space Technologies

Contents	Remarks
Multi-wavelength Astronomy	Observations in radio, microwave, infrared, visible, ultraviolet, X-ray, and gamma-ray wavelength bands, Earth's atmospheric effects
Instrumentation and Space Technologies	Ground- and space-based telescopes and detectors (e.g. charge-coupled devices, photometers, spectrographs), Magnification, resolving and light-gathering powers of telescopes

B. Practical Part

This part consists of 2 sections: observations and data analysis sections. The theoretical part of the Syllabus provides the basis for all problems in the practical part.

The observations section focuses on contestant's experience in

1. naked-eye observations,
2. usage of sky maps and catalogues,
3. usage of basic astronomical instruments–telescopes and various detectors for observations but enough instructions must be provided to the contestants.

Observational objects may be from real sources in the sky or imitated sources in the laboratory. Computer simulations may be used in the problems but sufficient instructions must be provided to the contestants.

The data analysis section focuses on the calculation and analysis of the astronomical data provided in the problems. Additional requirements are as follows:

1. Proper identification of error sources, calculation of errors, and estimation of their influence on the final results.
2. Proper use of graph papers with different scales, i.e., polar and logarithmic papers.
3. Basic statistical analysis of the observational data.