Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara
(Autonomous)

(Lead College of Karmaveer Bhaurao Patil University, Satara)

Syllabus for B.Sc. II

Astrophysics Minor

As per NEP 2020

w. e. f. 2024-25

1. Title: Astrophysics

2. Year of Implementation: The syllabus will be implemented from June, 2024.

3. Duration: The course shall be a full time.

4. Pattern: Semester examination.

5. Medium of Instruction: English

6. Structure of Course:

B.Sc. II Semester III

Sr. No.	Course Title	Theory			Practical		
		Course Code	Total Lectures	Credit	Course Code	Total Lectures	Credit
1	**Galaxies, Planets and Cosmology**	**BAPT 235**	30	2	Practical Course – III (BAPP 236)	60	2

B.Sc. II Semester IV

Sr. No.	Course Title	Theory			Practical		
		Course Code	Total Lectures	Credit	Course Code	Total Lectures	Credit
1	**Fundamentals of Astrophysics**	**BAPT 245**	30	2	Practical Course – IV (BAPP 246)	60	2

B: B.Sc. P: Physics T: Theory, P: Practical

7. Titles of Courses of B.Sc.II

B.Sc. II (Semester III)

Theory: 30 lectures, 30 hours (for each Course)

Course – V: BAPT 235: Galaxies, Planets and Cosmology

Practical: 60 lectures: 60 hours (Total)

Practical Course III: BAPP236: NUMERICAL CALCULATIONS, PARALLAX, PHOTOMETRY and SOUND

B.Sc. II (Semester IV)

Theory: 30 lectures, 30 hours (for each Course)

Course – VI : BAPT 245: Fundamentals of Astrophysics

Practical: 60 lectures: 60 hours (Total)

Practical Course II: BAPP 246: SPECTROSCOPY and ELECTRONICS

Astrophysics Minor

B.Sc. II

Semester – III

Course – V: BAPT 235 Galaxies, Planets And Cosmology

Course Objectives: Student should be able to:

1. learn galaxies, types of galaxies, evolution of galaxies, their halos, radio galaxies and quasars
2. study our own galaxy the Milky way, stellar population and solar system (condensation theory)
3. Explain planet. the Earth, Venus, mercury and Earth's natural satellite- the Moon.
4. Differentiate structure of universe, different theories of the cosmos.

Credits (Total Credits 2)	**SEMESTER-III BAPT 235 Galaxies, Planets And Cosmology**	**No. of hours per unit/credits**
UNIT - I	**Galaxies**	**(7)**
	• Galaxy, Types of galaxies: Dwarf galaxies, Colliding galaxies, Galactic cannibalization (CD galaxies), Anomalously luminous galaxies • The massive galactic halo, Cluster of galaxies • The intergalactic medium • Super clusters and voids. • Characteristics of Radio Galaxies • Twin Lobed Shape of radio galaxies • Discovery of Quasars.	
UNIT - II	**The Milky Way Galaxy and Solar System**	**(8)**
	• Structure and components of the Milky Way • Overview of spiral arms, Composition and phases of the interstellar medium • Overview of the solar system • Comparative planetary studies • Condensation theory and planet formation • Models of planetary formation • Habitable zones and exoplanet.	

UNIT - III	**Planets**	**(7)**
	• The Earth: Formation of Earth • Radioactive heating of the Earth • Differentiation of Earth's interior • Plate tectonics: Theory of Plate Tectonics, the zones of weakness • Mapping Earth's tectonic plates • Terrestrial planets: Mercury, Venus, Mar,. • The Moon: Interior structure of the Moon, Theories of Moon formation, Lunar exploration and missions.	
UNIT - IV	**Cosmology**	**(8)**
	• Introduction to cosmology, Historical perspectives on cosmology • The expanding universe • The Big-Bang cosmology, Evidence for the Big-Bang • The Hubble law • Methods for estimating the age of the universe • The steady state cosmology, The oscillating universe • Open and closed universes.	

Course Outcomes: Students will be able to:

1. Explain different properties of planets.
2. Explain the Milky Way galaxy, intergalactic medium, properties of the solar system and condensation theory.
3. Differentiate different cosmological theories.
4. Analyze expansion of the universe.

References:

1. Baidhnath Basu, 2014, *An Introduction to Astrophysics,* 2nd edition PHI Course Pvt. Ltd. New Delhi.
2. Theo Koupelis Jones and Barttlett Course, 2010, *In Quest of the Universe,* 6th edition, LLC Publications.
3. Thomas T. Arny, 1994, *Exploration – An Introduction to Astronomy,* 3rd edition, Mosley-Year Book Inc.

4. Jay M., 1992, *Astronomy – From the Earth to the Universe*, 4th revised edition, Pasachoff Books /Cole Thomson Course. W B Saunders Co Ltd.

5. R. Jastrow, M. H. Thomson, 1984, *Astronomy Fundamentals and Frontiers*, 4th revised edition, New York: John Wiley and Sons Publications.

BAPP 236: NUMERICAL CALCULATIONS, PARALLAX, PHOTOMETRY and SOUND

Course Objectives: Student should be able to:

1. Learn the optical leveling of spectrometer and Schuster's method.
2. Explain the spectrums of different sources.
3. Study the thickness of Fabry-Perot etalon and wavelength of LASER source.
4. Evaluate the Earth's magnetic field.
5. Verify the inverse square law.
6. Derive the Planck's constant using LED.

Credits (Total Credit 02)	**SEMESTER-III BAPP 236 NUMERICAL CALCULATIONS, PARALLAX, PHOTOMETRY and SOUND**	**No. of hours per unit/credits** (60)
	1. Numerical integration. 2. Numerical differentiation. 3. Numerical Interpolation. 4. Solution of ordinary differential equations. 5. To use the idea of parallax to determine large distances. 6. Measurement of terrestrial distance using Sextant. 7. Spectrometer Simulation 8. Spherical Aberration (Caustic Curve). 9. Michelson Interferometer. 10. Resolving power of telescope. 11. Magnifying power of telescope. 12. Distance modulus explorer simulation 13. Explore the lifecycle of stars by observing different types of stars and their characteristics in Stellarium. 14. Parallax calculator 15. Use Stellarium to observe and track the positions of planets in the night sky over time.	**03 Hrs / Practical**

	16. Constellation Map drawings- a) **Cassiopeia** b) **Leo** 17. Constellation Map drawings a) **Cygnus** b) **Taurus**. 18. Latitude and altitude measurement using stellarium. 19. Verify Snell's law using simulation. 20. H-R diagram using simulation	

Course outcomes: After completion, Students will be able to:

1. Adjust the spectrometer for parallel light.
2. Study the H and H lines of the hydrogen spectrum.
3. Determine the thickness of F. P. etalon and wavelength of He-Ne LASER source.
4. Measure horizontal and vertical components of Earth's magnetic field.
5. Determine the Planck's constant using LED.

References:

1. B. Sc. Practical Physics, Harnam Singh and Dr. P. S. Hemne S. Chand (Publishing Delhi) 2014.
2. Advanced Practical Physics Vol. – I, Dr. S. P. Singh Pragati Prakashan, Meerat, 2012.
3. Advanced Practical Physics Vol. – II, Dr. S. P. Singh Pragati Prakashan, Meerat, 2012 Advanced
4. Practical Physics, C. L. Arora S. Chand Publishing New Delhi 2009.
5. practical Physics for Students, B. L. Worsnop and H. T. Flint, Asia Pub. House, 1971.

SEMESTER- IV

Course – VI: BAPT 245: Fundamentals of Astrophysics

Course Objectives: Students should be able to:

1. Learn electromagnetic radiation from stars, atomic spectra and classification of stars.
2. Study various tools of astronomer.
3. Explain Hertzsprung - Russel diagram for population of stars and nuclear energy source of stars.
4. Evaluate stellar evolution of small and massive stars

Credits (Total Credits 2)	**SEMESTER-IV BAPT 245: Fundamentals of Astrophysics**	**No. of hours per unit/credits**
UNIT - I	**Electromagnetic Radiation and Message of the Star Light**	**(7)**
	• Electromagnetic radiation, Properties of electromagnetic radiation, Electromagnetic spectrum, • Electromagnetic radiation from heated object • Black body radiation • Atomic spectra of hydrogen atom, • Solar spectrum • Classification of stars.	
UNIT - II	**Tools for Astronomy**	**(8)**
	• Optical telescope, Construction and working of Galilean, Newtonian, Cassegrain telescope • Hubble space telescope • Magnifying power of telescope • Resolving power of telescope, Radio telescope, • X - ray Astronomy, UV Astronomy, IR Astronomy, Spectroscope (Prism and grating).	
UNIT - III	**The Hertzsprung-Russell Diagram and Nuclear Energy Source**	**(7)**
	• The colour of glowing object (stars) • Brightness (luminosity) of stars • HR diagram (population of stars, main sequence, dwarfs and giants) • Nuclear energy sources: Nuclear fusion, Nuclear fission, Nuclear reaction in stars.	

UNIT - IV	**Stellar Evolution**	**(8)**
	• Protostars, Birth of Stars, Maturity and Characteristics, Death of Small Stars, Death of Massive Stars • Supernova Explosions • Pulsars and Neutron Stars • Black Holes, Structure of black hole.	

Course Outcomes: Students will be able to:

1. Explain properties of electromagnetic radiation.
2. Understand different optical telescopes.
3. Differentiate phases of star.
4. Analyze stellar evolution.

References:

1. Baidhnath Basu, 2014, *An Introduction to Astrophysics,* 2nd edition PHI Course Pvt. Ltd. New Delhi.
2. Theo Koupelis Jones and Barttlett Course, 2010, *In Quest of the Universe,* 6th edition, LLC Publications.
3. Michael Zeilik and Stephen A. Gregary, 1997, *Introductory Astronomy and Astrophysics*, 4th edition, Saunders College Publishing.
4. Jay M., 1992, *Astronomy – From the Earth to the Universe,* 4th revised edition, Pasachoff Books /Cole Thomson Course. W B Saunders Co Ltd.
5. K. D. Abhyankar, 1992, *Astrophysics – Stars and Galaxies,* 1st edition, Tata McGraw Hill Publishing Company.
6. R. Jastrow, M. H. Thomson, 1984, *Astronomy Fundamentals and Frontiers*, 4th revised edition, New York: John Wiley and Sons Publications.

Practical Paper : BAPP 246: SPECTROSCOPY AND ELECTRONICS

Course Objectives: Students should be able to:

1. Learn the numerical calculations.
2. Explain the parallax.
3. Study magnifying and resolving powers of telescopes.
4. Learn drawing of constellation maps.

Credits (Total Credit 02)	**SEMESTER-IV** **BPP 246** **SPECTROSCOPY and ELECTRONICS**	**Total No. of hours per unit/credits** (60)
	1. Calibration of Spectrometer. 2. Measurement and identification of spectral lines. 3. Study of Balmer lines. 4. Band absorption spectrum of liquid (KMnO4 solution). 5. Study of line absorption spectrum and measurement of temperature of sodium flame. 6. Study of the solar spectrum. 7. Measurement of thickness of F. P. Etalon. 8. Measurement of wavelength of given LASER source using diffraction grating. 9. Measurement of Earth's magnetic field using Earth inductor. 10. HR diagram explorer (Simulation) 11. Flux simulator 12. Study of Lissajeous figures using CRO. 13. Determination of Planck's constant using LED. 14. Sun spot activity analysis. 15. Velocity of sound using CRO and Microphone. 16. Exploring Angular Separation and Time Difference 17. Calculating Distances to Key Geographic Points 18. Exploring Angular Separation and Local Meridian 19. Study of sun spot and sunspot cycles 20. Verify Kepler's laws of planetary motions using simulation	**03 Hrs / Practical**

Course Outcomes: Students will be able to:

1. Solve the numerical problems in astronomy and astrophysics.
2. Gain the skill of parallax zeroing techniques.
3. Determine the magnifying and resolving powers of refracting telescopes.
4. Study the drawing of constellation maps of Orion, Big dipper, Auriga and Taurus.

References:

1. Harnam Singh and Dr. P. S. Hemne S. Chand Publishing Delhi 2014. Advanced Practical Physics Vol. – I, Dr. S. P. Singh Pragati Prakashan, Meerat, 2012.
2. Advanced Practical Physics Vol. – II, Dr. S. P. Singh Pragati Prakashan, Meerat, 2012.
3. Practical Physics, C. L. Arora S. Chand Publishing New Delhi 2009. B. Sc. Practical Physics,
4. Advanced practical Physics for Students, B. L. Worsnop and H. T. Flint, Littlehampton Book Services Ltd, 9 th revised edition, 1951.