



**Karmaveer Bhaurao Patil University,
Satara**

**Syllabus for
B. Sc. II Astrophysics
Under**

Faculty of Science and Technology
(As per NEP 2020)

**With effect from Academic Year
2025-2026**

Syllabus for Bachelor of Science (B.Sc.) Part – II Astrophysics

PREAMBLE:

The B.Sc. Astrophysics course will be introduced in the academic year 2025-2026. This syllabus is framed to focus on the fundamental aspects of materials science which every materials scientist is supposed to be familiar with. The course discusses the fundamental properties of materials, classification of materials. It has been designed to meet the specific needs of B.Sc. Materials Science students in accordance with the NEP 2020 guidelines. The curriculum has been developed to reflect the expanding scope of materials science. The focus is on equipping students with up-to-date knowledge while maintaining a strong foundation in materials science. The course also includes new practical exercises, providing students with hands-on experience with the latest techniques currently in use. Additionally, the course is intended to inspire students to pursue higher studies in materials science, become entrepreneurs, and seek employment in materials-based industries.

1. TITLE: **Astrophysics**
2. YEAR OF IMPLEMENTATION: **2025-2026**
3. DURATION: **01 year**
4. PATTERN: **Semester examination**
5. MEDIUM OF INSTRUCTION: **English**
6. STRUCTURE OF COURSE:
7. COURSE TITLE:

As per NEP-2020 (2.0)

Level	Sem	Subject				OE	VSC/SEC	AEC/VEC/IKS/	Total
		DSC		DSE*					
		T	P	T	P				
5.0	III	Major V (2)	Major P III (2)	Minor V (2)	Minor P III (2)	OE III (2)	VSC I (2) (Major Specific) SEC I (2) (P)	AEC I (2) (English) IKS II (2) (Major Specific)	22
		Major VI (2)		Minor VI (2)					
5.0	IV	Major VII (2)	Major P IV (2)	Minor VII (2)	Minor P IV (2)	OE IV (2)	VSC II (2) (Major Specific) SEC II (2) (P)	AEC II (2) (English) VEC II (2) (Environmental Studies)	22
		Major VIII (2)		Minor VIII (2)					

B.Sc. – II Minor

Semester –III

Course Title	Theory			Practical		
	Course Code	Lectures Per week	Credits	Course Code	Lectures per week	Credits
Numerical Methods for Astronomy	BAPT 234	2	2	BAPP 236	4	2
Fundaments of Astrophysics-II	BAPT 235	2	2			

B.Sc. – II Minor

Semester –IV

Course Title	Theory			Practical		
	Course Code	Lectures Per week	Credits	Course Code	Lectures Per week	Credits
Galaxies, Planets and Cosmology	BAPT 244	2	2	BAPP 246	4	2
Hydrodynamics and Cosmic Electrodynamics	BAPT 245	2	2			



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Board of Studies in Science and Technology

Programme: B.Sc. II

Semester - III

Type : Minor V

Marks: 50

Credits : 2

From: A. Y. 2025-26

Name of the Course: BAPT 234 Numerical Methods for Astronomy

Course Objectives: student should be able to....

- 1) understand fundamentals of numerical methods.
- 2) develop problem solving skill.
- 3) connect numerical methods to scientific application.
- 4) bridge theory and applications.

Course Outcomes: After completion of syllabus, student will be able to...

- 1) apply numerical methods
- 2) perform numerical differentiation
- 3) solve numerical integration
- 4) evaluate errors.

Module	Title and Contents	Hrs
Module -1:	Numerical Solutions to Algebraic and Transcendental Equations 1.1 Introduction, 1.2 Solutions of algebraic and transcendental equations in astronomical calculations 1.3 Bi-section method, 1.4 Method of false-position 1.3 Newton-Raphson method 1.4 Useful deductions from the Newton-Raphson formula 1.5 Problems related to astronomical computations	7
Module -2:	Numerical Differentiation 2.1 Introduction, 2.2 Derivatives using Newton's forward difference formula, Newton's backward difference formula 2.3 Central difference formula, 2.4 Stirling's interpolation formula 2.5 Applications in analyzing planetary motion, orbital dynamics, 2.6 Problems related to astronomical computations.	8
Module -3:	Numerical Integration 3.1 Introduction 3.2 General quadrature formula and error analysis 3.3 Trapezoidal rule 3.4 Simpson's 1/3 rule and Simpson's 3/8 rule 3.5 Applications in estimating total energy output of stars over time and integrating light curves of variable stars	8
Module -4:	Numerical Solutions of Differential Equations 4.1 Introduction 4.2 Solution of first and second-order ordinary differential equations 4.3 Picard's method 4.4 Taylor series method 4.5 Euler's method	7

	4.6 Modified Euler's method 4.7 Runge-Kutta methods 4.8 Applications in orbital mechanics, stellar evolution	
Reference Books:- 1) Chapra, Steven C., and Raymond P. Canale. <i>Numerical Methods for Engineers</i>. 7th ed. McGraw Hill Education India Private Limited, 2016. 2) Gerald, C. F., and P. O. Whitely. <i>Applied Numerical Analysis</i>. 7th ed. Pearson Education India, 2007. 3) Jain, M. K., S. R. K. Iyengar, and R. K. Jain. <i>Numerical Methods for Scientific and Engineering Computation</i>. 6th ed. New Age Pvt. Pub., 2012. 4) Boyd, Stephen, and Lieven Vandenbergh. <i>Introduction to Applied Linear Algebra: Vectors, Matrices, and Least Squares</i>. 1st ed. Cambridge University Press, 2018.		
Evaluation Pattern: 40:60		
Total Marks: 50		
Internal Examination: 20 Marks CCE- I: 10 Marks CCE- II: 10 Marks CCE- III: 10 Marks (Best of two CCE)		End Semester Examination: Total- 50 Marks Question -1 – Attempt any five (5 X 2 M =10 M) Question -2 – Solve any two (2 X 10 M =20 M) Question -3 – Solve any four (4 X 5 M =20 M) (50 marks are converted to 30 marks)



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Programme: B.Sc. II

Semester - III

Type : Minor VI

Marks: 50

Credits : 2

From: A. Y. 2025-26

Name of the Course: BAPT 235 Fundaments of Astrophysics-II

Course Objectives: student should be able to....

- 1) study electromagnetic radiation from stars, atomic spectra and classification of stars.
- 2) understand various tools of astronomer.
- 3) learn Hertzsprung - Russel diagram for population of stars and nuclear energy source of stars.
- 4) differentiate stellar evolution of small and massive star, pulsars, neutron star and black holes.

Course Outcomes: After completion of syllabus, student will be able to...

- 1) explain electromagnetic radiation and electromagnetic radiation from heated object.
- 2) understand optical telescopes (Galilean, Newtonian, Cassegrainian and Hubble space telescope).
- 3) differentiate death of small stars and massive stars, pulsars (neutron stars) and black holes.
- 4) analyze HR diagram (population of stars, main sequence, dwarfs and giants).

Module	Title and Contents	Hrs
Module -1:	Electromagnetic Radiation and Message of the star light 1.1 Electromagnetic radiation 1.2 Electromagnetic radiation from heated object 1.3 Doppler effect 1.4 Hydrogen spectrum 1.5 Emission spectra 1.6 Absorption spectra 1.7 Stellar spectra 1.8 Classification of star.	7
Module -2:	Tools of the Astronomer 2.1 Optical telescope (Galilean, Newtonian, Cassegrain and Hubble space telescope) 2.2 Magnifying power of telescope 2.3 Resolving power of telescope 2.4 Spectroscope (Prism and grating) 2.5 Radio telescope 2.6 X - ray Astronomy 2.7 IR Astronomy, JWST	8
Module -3:	Stellar Evolution 3.1 Protostar 3.2 birth, maturity, Aging of stars (main sequence) 3.3 Death of small stars 3.4 Death of massive stars (supernova explosion) 3.5 Pulsars and neutron stars 3.6 Black hole	8
Module -4:	The Hertzsprung-Russell diagram and Nuclear Energy source 4.1 The colour of glowing object (stars) 4.2 Brightness (luminosity) of stars	7

	4.3 HR diagram (population of stars, main sequence, dwarfs and giants) 4.4 Nuclear reactions 4.5 Nuclear reactions in star	
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Reference Books:-

- 1) Karttunen, H., P. Kröger, H. Oja, M. Poutanen, and K. J. Donner. Fundamental Astronomy. 5th ed. Springer, August 9, 2007.
- 2) Jay, M. Astronomy: From the Earth to the Universe. 4th revised ed. Pasachoff Books/Cole Thomson Course. W.B. Saunders Co. Ltd., 1992.
- 3) Arny, Thomas T. Exploration: An Introduction to Astronomy. 3rd ed. Mosley-Year Book Inc., 1994.
- 4) Jay, M. Astronomy: From the Earth to the Universe. 4th revised ed. Pasachoff Books/Cole Thomson Course. W.B. Saunders Co. Ltd., 1992.
- 5) Jastrow, R., and M. H. Thomson. Astronomy: Fundamentals and Frontiers. 4th revised ed. John Wiley and Sons Publications, 1984.

Evaluation Pattern: 40:60

Total Marks: 50

Internal Examination: 20 Marks CCE- I: 10 Marks CCE- II: 10 Marks CCE- III: 10 Marks (Best of two CCE)	End Semester Examination: Total- 50 Marks Question -1 – Attempt any five (5 X 2 M =10 M) Question -2 – Solve any two (2 X 10 M =20 M) Question -3 – Solve any four (4 X 5 M =20 M) (50 marks are converted to 30 marks)
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Board of Studies in Science and Technology

Programme: B.Sc. II

Semester - III

Type : Minor P III

Marks: 50

Credits : 2

From: A. Y. 2025-26

**Name of the Course: BAPT 236 Experimental Techniques in Astronomy
Lab III**

Course Objectives: student should be able to....

- 1) learn the numerical calculations.
- 2) understand the parallax.
- 3) study magnifying and resolving powers of telescopes.
- 4) define the drawing of constellation maps.

Course Outcomes: After completion of syllabus, student will be able to...

- 1) solve the numerical problems in astronomy and astrophysics.
- 2) understand 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.

Module	Title and Contents	Hrs
	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. Analyze the light curves of variable stars to determine their key properties, such as period, amplitude, and nature of variability. 8. Spherical Aberration of lens (Caustic Curve). 9. Handling FITS data file for astronomy using python. 10. Resolving power of telescope. 11. Magnifying power of telescope. 12. Constellation Map drawings- a) Orion b) Ursa Major (Big Dipper) 13. Constellation Map drawings c) Auriga d) Taurus. 14. Sun spot activity analysis. 15. To calculate the great circle distance between two geographic points using the Haversine formula	60

Reference Books:-

- 1) Worsnop, B. L., and H. T. Flint. *Advanced Practical Physics for Students*. 9th rev. ed. London, 1969.
- 2) Singh, Harnam, and Dr. P. S. Hemne. *B. Sc. Practical Physics*. Delhi: S. Chand Publishing, 2014.

- 3) Arora, C. L. *Practical Physics*. New Delhi: S. Chand and Company Limited, 2010.
- 4) Singh, Dr. S. P. *Advanced Practical Physics Vol. I*. Meerut: Pragati Prakashan, 2012.
- 5) Singh, Dr. S. P. *Advanced Practical Physics Vol. II*. Meerut: Pragati Prakashan, 2012.

Evaluation Pattern: 40:60

Total Marks: 50

Internal Examination: 20

End Semester Examination: 30



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Programme: B.Sc. II

Semester - IV

Type : Minor VII

Marks: 50

Credits : 2

From: A. Y. 2025-26

Name of the Course: BAPT 244 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) define planet, The Earth, Venus, mercury and Earth's natural satellite- the Moon.
- 4) understand structure of universe, different theories of cosmos.

Course Outcomes: After completion of syllabus, student will be able to...

- 1) explain galaxy the Milky Way galaxy, intergalactic medium, properties of solar system and the condensation theory.
- 2) understand plate tectonics, continental drift, the two super continents- Laurasia and Gondwana land, the terrestrial planets, the red planet- Mars.
- 3) differentiate the structure and evolution of cosmos.
- 4) analyze the open and closed universe.

Module	Title and Contents	Hrs
Module -1:	Galaxies 1.1 Types of galaxies, Dwarf galaxies, Colliding galaxies, Galactic 1.2 cannibalization (CD galaxies) 1.2 Anomalously luminous galaxies 1.3 The massive galactic halo 1.4 The evolution of galaxies 1.5 Cluster of galaxies 1.6 The intergalactic medium 1.7 Super clusters and voids 1.8 Radio galaxies, 1.9 Quasars-Discovery	7
Module -2:	The Milky Way Galaxy and Solar System 2.1 Properties of Milky way galaxy 2.2 The spiral structure of the galaxy 2.3 The interstellar medium 2.4 Clusters of stars, Globular clusters 2.5 Stellar population 2.6 General properties of Solar system – Origin of planets (condensation theory), Origin of earthlike planets 2.7 Composition of planets	8
Module -3:	Planet Formation 3.1 The Earth – early history 3.2 Radioactive heating of the earth 3.3 Differentiation of earth's interior 3.4 The floating crust 3.5 Plate tectonics- the zone of weakness 3.6 A map of earth's plates 3.7 Evidence for continental drift, Terrestrial planets	8

Module -4:	Cosmology 4.1 The expanding Universe 4.2 The Hubble law 4.3 The Big-bang cosmology 4.4 The age of the Universe 4.5 Evidence for the Big-bang 4.6 The steady state cosmology 4.7 The oscillating Universe 4.8 Open and closed Universes	7
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Reference Books:-

- 1) Arny, Thomas T. *Exploration: An Introduction to Astronomy*. 3rd ed. Mosley-Year Book Inc., 1994.
- 2) S, Frank H. *The Physics of Astrophysics, Volume II: Gas Dynamics*. University Science Books, 1992.
- 3) Davis, K. *Ionospheric Radio Propagation*. Institution of Engineering and Technology, 1990.
- 4) Jastrow, R., and M. H. Thomson. *Astronomy: Fundamentals and Frontiers*. 4th revised ed. John Wiley and Sons Publications, 1984.
- 5) Odishaw, H. *Sun, Upper Atmosphere and Space*. 1st ed. The MIT Press, 1964.

Evaluation Pattern: 40:60

Total Marks: 50

Internal Examination: 20 Marks

CCE- I: 10 Marks
CCE- II: 10 Marks
CCE- III: 10 Marks
(Best of two CCE)

End Semester Examination: Total- 50 Marks

Question -1 – Attempt any five (5 X 2 M =10 M)
Question -2 – Solve any two (2 X 10 M =20 M)
Question -3 – Solve any four (4 X 5 M =20 M)
(50 marks are converted to 30 marks)



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Programme: B.Sc. II

Semester - IV

Type : Minor VIII

Marks: 50

Credits : 2

From: A. Y. 2025-26

Name of the Course: BAPT 245 Hydrodynamics and Cosmic Electrodynamics

Course Objectives: student should be able to....

- 1) state properties of electromagnetic radiation
- 2) discuss optical properties of lenses and mirrors.
- 3) distinguish types of scattering and its effects.
- 4) understand various Maxwell's four equations

Course Outcomes: After completion of syllabus, student will be able to...

- 1) explain the types of fluid and terms related to the fluid.
- 2) understand Stoke's law, Bernoulli equation and Euler's equation of motion.
- 3) analyze electrodynamics potentials, EM wave equations, Poisson's and Laplace's equations.
- 4) differentiate the photosphere, the flare and the post flare periods.

Module	Title and Contents	Hrs
Module -1:	Fluid Statics 1.1 Definition of fluid 1.2 Fluids and their properties 1.3 Types of fluid 1.4 mass density, specific weight, specific gravity 1.5 viscosity, viscosity laws 1.6 Surface tension 1.7 Capillarity 1.8 Pascal's law, Applications of Pascal's law 1.9 Condition of Equilibrium of floating and submerged bodies	7
Module -2:	Fluid Dynamics 2.1 Streamline 2.2 Flow line 2.3 Types of flow: Streamline and Turbulent flow 2.4 Critical velocity and Reynold's number 2.5 Continuity equation 2.6 Stoke's law, Terminal velocity 2.7 Bernoulli equation, Applications of Bernoulli equation - Euler's equation of motion, The Navier-Stoke's equation	8
Module -3:	Electrodynamics 3.1 Scalar electric potential 3.2 Magnetic vector potential 3.3 Poisson's and Laplace's equations 3.4 Maxwell's equations in vacuum 3.5 Maxwell's equations in medium 3.6 Electromagnetic waves in vacuum and wave equation	8
Module -4:	The Sun and Solar Activity 4.1 Structure of sun 4.2 photosphere	7

	4.3 chromosphere 4.4 solar corona 4.5 sunspot, structure of sunspot, 11-year solar cycle of sunspot 4.6 solar magnetic field.	
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Reference Books:-

- 1) Rutherford, D. E. *Fluid Dynamics*. Edinburgh: Oliver and Boyd Publications. (1959)
- 2) Griffiths, David J. *Introduction to Electrodynamics*. 4th ed. New Delhi: PHI Learning Pvt. Ltd. (2018)
- 3) Piddington, J. H. *Cosmic Electrodynamics*. 99th ed. New York: Wiley. (1969)
- 4) Basu, Baidhnath. *An Introduction to Astrophysics*. New Delhi: PHI Learning Pvt. Ltd. (2014)
- 5) Harwit, Martin. *Astrophysical Concepts*. 4th ed. New York, NY: Springer. (2010)

Evaluation Pattern: 40:60

Total Marks: 50

Internal Examination: 20 Marks

CCE- I: 10 Marks
CCE- II: 10 Marks
CCE- III: 10 Marks
(Best of two CCE)

End Semester Examination: Total- 50 Marks

Question -1 – Attempt any five (5 X 2 M =10 M)
Question -2 – Solve any two (2 X 10 M =20 M)
Question -3 – Solve any four (4 X 5 M =20 M)
(50 marks are converted to 30 marks)



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Programme: B.Sc. II

Semester - IV

Type : Minor P IV

Marks: 50

Credits : 2

From: A. Y. 2025-26

**Name of the Course: BAPT 246 Experimental Techniques in Astronomy
Lab IV**

Course Objectives: student should be able to....

- 1) develop skills in taking readings/observations obtained from these instruments.
- 2) learn how to analyze and interpret experimental data, including error analysis, graphical representation
- 3) perform calculations to obtain the experimental results.
- 4) test whether the experimental results hold good with theoretical results

Course Outcomes: After completion of syllabus, student will be able to...

- 1) demonstrate basic experimental skills by setting up laboratory equipment/ experiment set up safely and efficiently, instruments calibration, carry out experimental procedure, data collection, analysis and report it in a written sheet manner.
- 2) develop skills in taking precise and accurate measurement to minimize errors.
- 3) demonstrate problem solving skills by encountering and resolving technical challenges that may arise during experiments.
- 4) analyzing experimental observations/readings using numerical calculations, graphical representation to interpret and draw conclusion.

Module	Title and Contents	Hrs
	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. Determining the Sun's surface temperature 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. Plot and analyze galaxy spectra. 11. I-V characteristics of solar cell. 12. Verification of inverse square law of intensity. 13. Moffat 2D plotting and analysis. 14. One dimensional astrophysics data plotting and correlation analysis. 15. Phase shift measurement of RC network using CRO.	60

Reference Books:-

- 1) Gupta, S. L., and V. Kumar. *Practical Physics*. 29th ed. Meerut: Pragati Prakashan. (2017).
- 2) Chattopadhyay, D., and P. C. Rakshit. *An Advanced Course in Practical Physics*. 8th ed. Calcutta: New Central Book. (2013).
- 3) White, Marsh W., and Kenneth V. Manning. *Experimental College Physics: A Laboratory Manual*. 3rd ed. New York: McGraw-Hill Publication. (1954).
- 4) Prakash, and Ramakrishna. *A Textbook of Practical Physics*. 11th ed. Kitab Mahal. (2011).
- 5) Singh, H. Harnam, and P. S. Hemne. *B.Sc. Practical Physics*. 17th ed. New Delhi: S. Chand & Co. Ltd. (2011).

Evaluation Pattern: 40:60**Total Marks: 50****Internal Continuous Evaluation: 20****Internal Continuous Evaluation: 30**