Karmaveer Bhaurao Patil University, Satara

Syllabus for

B. Sc. I Astrophysics

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2024-2025

Preamble:

This syllabus is framed to give sound knowledge with understanding of Physics to undergraduate students at first year of three years of B.Sc. degree course.

Students will learn Physics as a separate subject from B.Sc. I. The aim of the syllabus is to make the study of physics interesting, encouraging and popular to the students for higher studies including research.

The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universitiesand the needs of industries and research.

The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields.

The units of the syllabus are well defined, taking into consideration the level and capacity of students.

General Objectives of the Program:

1. To nurture academicians with focus and commitment to their subject.
2. To shape good and informed citizens from the students entering into the program.
3. To create a skilled work force to match the requirements of the society.
4. To impart knowledge of science is the basic objective of education.
5. To develop scientific attitude is the major objective to make the students open minded, critical, curious.
6. To develop skill in practical work, experiments and laboratory materials and equipments along with the collection and interpretation of scientific data to contribute the science.

Program Outcomes:

1. The student will graduate with proficiency in the subject.
2. The student will be eligible to continue higher studies in his subject.
3. The student will be eligible to pursue higher studies abroad.
4. The student will be eligible to appear for the examinations for jobs in government organizations.
5. The student will be eligible to appear for jobs with minimum eligibility as science graduate.
6. The student will be eligible to appear for industrial jobs with minimum eligibility as physics graduate.

Program Specific Objectives:

1. The students are expected to understand the fundamentals, principles, concepts and recent developments in the physics.
2. The practical course is framed in relevance with the theory courses to improve the understanding of the various concepts in physics.
3. It is expected to inspire and boost interest of the students in physics.
4. To develop the power of appreciations, the achievements in science and role in nature and society.

5. To enhance student sense of enthusiasm for science and to involve the intellectually stimulating experience of course in a supportive environment.

Program Specific Outcomes:

1. Understand the basics of physics.
2. Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
3. Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.
4. Identify their area of interest in academic, research and development.
5. Perform job in various fields' like science, engineering, education, banking, business and public service, etc. or be an entrepreneur with precision, analytical mind, innovative thinking, clarity of thought , expression, and systematic approach.

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.-I Semester-I

Sr.No.	Course Title	Theory			Practical		
		Course Code	Lectures per week	Credit	Course Code	Lectures per week	Credit
1	Fundamentals of Astronomy	BAPT 111	5	2	Practical Course –I (BAPP 113)	4	2
2	The Earth and Positional Astronomy	BAPT 112		2			

B.Sc.-I Semester-II

Sr.No.	Course Title	Theory			Practical		
		Course Code	Lectures per week	Credit	Course Code	Lectures per week	Credit
1	Introduction to Space Science	BAPT 121	5	2	Practical Course –II (BAPT 123)	4	2
2	Basic Physics for Astronomy	BAPT 122		2			

7. Titles of Courses of B.Sc.Course:

B.Sc.-I (Semester-I)

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

Course – I: BAPT 111 :Fundamentals of Astronomy

Course – II: BAPT 112 :The Earth and Positional Astronomy

Practical: 60 lectures: 60 hours (Total)

Practical: BAPT 113: Experimental Techniques in Astronomy Lab I

B.Sc.-I (Semester-II)

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

Course–III: BAPT 121: Introduction to Space Science

Course–IV: BAPT 122: Basic Physics for Astronomy

Practical: 60 lectures: 60 hours (Total)

Practical: BAPT 123: Experimental Techniques in Astronomy Lab II

B.Sc. I Semester-I
Course-I: BAPT 111: Fundamentals of Astronomy (Credits: 02)

Course Objectives: Students should be able to:

1. understand history of astronomy.
2. learn astronomical theories and paradigm shifts.
3. describe stellar distance and stellar distance measurement methods.
4. know luminosity, stellar temperature and stellar radii.

Credits (Total Credits 2)	Semester I BAPT 111: Fundamentals of Astronomy	No. of hours per unit/credit
Unit I	**History of Astronomy-I**	**07**
	The ancient study of astronomy, connections between seven days of week and astronomical objects, Geocentric and heliocentric universe, Ptolemy's astronomical work, Copernican heliocentrism, Tycho Brahe's contribution to astronomy.	
Unit II	**History of Astronomy-II**	**08**
	Confirmation of Copernican theory by Galileo, Galileo's discovery with telescope, Galileo and the church's opposition, Kepler's contribution, Kepler's three laws of planetary motion, The law of gravity by Isaac Newton. Newton's reasoning on motion of the moon.	
Unit III	**The Stellar Distances**	**08**
	Measurement of terrestrial distances, distance of moon, distance of planets, Astronomical unit aberration of star light, Definition of parallax and Geocentric parallax, Trigonometric parallax of stars, light years and parsec.	
Unit IV	**Basic Astronomical Parameters**	**07**
	Astronomical scales (Distance, Mass and Time), Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus, Measurement of Astronomical Quantities (Distances, Stellar Radii, Masses of Stars from binary orbits, Stellar Temperature, Color index of stars).	

Course Outcomes: After completion of the course, Student will be able to:

1. discuss history of astronomy.
2. analyze astronomical theories and paradigm shifts.
3. examine stellar distance and stellar distance measurement methods.
4. define basic astronomical parameters.

Reference Book:

1. Bradley W. Carroll,Dale A.O, *An Introduction to Modern Astrophysics* , (Cambridge University Press, 2017)
2. Dan .M., *Astrophysics in a Nutshell* , (Princeton University Press, 2016)
3. Jeffrey O. B., Megan O. D., Nicholas .S., and Mark .V., *The Cosmic Perspective* ,(Pearson, 2016)
4. Andrew .L. , *An Introduction to Modern Cosmology* , (Wiley, 2015)
5. Baidhnath Basu, An Introduction to Astrophysics, (New Delhi, PHI Course Pvt. Ltd. 2nd edition, 2014)
6. Thomas T. Arny, Exploration – An Introduction to Astronomy, (Mosley-Year Book Inc, 3rd edition 1994).
7. Jay M, Astronomy – From the Earth to the Universe (Pasachoff Books /Cole Thomson Course. W B Saunders Co Ltd; 4 th revised edition 1992)
8. Frank H. S, The Physics of Astrophysics, Volume II: Gas Dynamics, (University Science Books, 1992)
9. Frank H. S, The Physics of Astrophysics, Volume I: Gas Dynamics, (University Science Books, 1991)
10. R. Jastrow, M. H. Thomson, Astronomy Fundamentals and Frontiers, (John Wiley and Sons Publications, 4th revised edition 1984).

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B.Sc. I Semester-I

Course- II: BAPT 112: The Earth and Positional Astronomy (Credits:2)

Course Objectives: Students should be able to:

1. learn the motion of Earth in space.
2. understand different types of eclipses.
3. know different coordinate systems.
4. study celestial coordinates.

Credits (Total Credits 2)	Semester I BAPT 112: The Earth and Positional Astronomy	No. of hours per unit/credit
Unit I	**The Earth in Space**	**07**
	Motions of the Earth, rotation of Earth, proof of the Earth's motion, The moon and the Earth, The phases of the moon, moon rise and moonset.	
Unit II	**Eclipse**	**07**
	Solar eclipse, total eclipse, the annual eclipse, the partial eclipse, lunar eclipse, the eclipse seasons, the lunar tide, the solar tide, the effect of tides on the rotation of the Earth.	

Unit III	**Introduction to Coordinate Systems**	**08**
	Cartesian coordinate system, Non-Cartesian coordinate systems: plane polar coordinates, spherical and cylindrical polar coordinates; position vector, unit vector, areal and volume element.	
Unit IV	**Basic concepts of positional astronomy**	**08**
	Spherical Trigonometry, the Earth, the celestial sphere, latitude and longitude, the positions of stars, horizontal system, the equatorial system, the elliptical system, the galactic coordinates, perturbation of coordinates, positional astronomy.	

Course Outcomes: After completion of the course, student will be able to….

1. interpret the effects of rotation of Earth.
2. classify different types of eclipses.
3. describe different coordinate systems.
4. implement celestial coordinates for position of star.

Reference Books:

1. Andrew .L. , *An Introduction to Modern Cosmology* , (Wiley, 2015)
2. Baidhnath .B., *An Introduction to Astrophysics*, (New Delhi, PHI Course Pvt. Ltd. 2nd edition, 2014.)
3. Karttunen.H., Kröger.P., Oja.H., Poutanen.M., DonnerK.J., *Fundamental Astronomy* (Springer; 5th edition, 9 August 2007)
4. Thomas T. A., Exploration – An Introduction to Astronomy, (Mosley-Year Book Inc, 3rd edition 1994).
5. Jay M, Astronomy – From the Earth to the Universe (Pasachoff Books /Cole Thomson Course. W B Saunders Co Ltd; 4 th revised edition 1992)
6. Thomas T. Arny, Exploration – An Introduction to Astronomy, (Mosley-Year Book Inc, 3rd edition 1994).
7. Jay M, Astronomy – From the Earth to the Universe (Pasachoff Books /Cole Thomson Course. W B Saunders Co Ltd; 4 th revised edition 1992)
8. Frank H. S, The Physics of Astrophysics, Volume II: Gas Dynamics, (University Science Books, 1992)
9. Frank H. S, The Physics of Astrophysics, Volume I: Gas Dynamics, (University Science Books, 1991)
10. R. Jastrow, M. H. Thomson, Astronomy Fundamentals and Frontiers, (John Wiley and Sons Publications, 4th revised edition 1984).

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B.Sc. I Semester-I

Practical Course I: BPAP 116: Experimental Techniques in Astronomyy Lab I (Credits:2)

Course Objectives: Students should be able to:

1. develop fundamental experimental skills to perform an experiment.
2. learn the experimental setup and procedure to perform given experiment.
3. develop skills in taking readings/observations obtained from these instruments.
4. learn how to analyze and interpret experimental data, including error analysis, graphical representation.

Experiments:

Sr. No.	Titles of Experiment
1.	To determine intensity distribution curve of ordinary electric bulb using photo cell.
2.	To determine focal length of a convex lens by plane mirror method.
3.	To determine the refractive index of a glass slab using a travelling microscope.
4.	To determine percentage error and relative error.
5	Determining light intensity with a Lummer Brodhum photometer.
6.	To measure light pollution at different places.
7.	To analyze the motion of a projectile and determine its range and maximum height using cartesian coordinates.
8.	Spectral analysis of light sources (mercury source, sodium source, hydrogen source, helium source)
9.	To determine particle size of lycopodium powder.
10.	Exploring Lunar Phases: Observing and Analyzing Moon Phases
11.	To observe and analyze the PLEIADS star cluster, noting its characteristics and identify individual stars within the cluster using software.
12.	To observe planet Venus, noting its characteristics and phases.
13.	To familiarize with Stellarium software.
14.	To understand variation in temperature at deferent altitude with given data.
15.	To calculate and design optimal paths for spacecraft to efficiently navigate and reach their intended destinations

Course Outcomes: After completion of the course, students 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. display practical skills in measuring focal length using experimental setups.
4. exhibit practical skills in comparing intensities of different bulbs using L.B. photometer.

Reference Books:

1. Gupta S.L. and V. Kumar., Practical physics.(Meerut: Pragati Prakashan,29thEdition.2017).
2. Chattopadhyay D. and P.C.Rakshit, An advanced course in practical physics (Calcutta: New Central Book,8th Edition,2013)
3. I.Prakash and Ramakrishna, A Textbook of Practical Physics,(Kitab Mahal,11th Edition ,2011)
4. Singh H. Harnam and Hemne P. S., B.Sc. Practical Physics, (New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011)
5. White, Marsh W. and Kenneth V. Manning, Experimental college physics; a laboratory manual, (New York: McGraw-Hill Publication,3rd Edition, 1954)
6. Worsnop B.L. and H.T. Flint., Advanced practical physics for students, (London: Methuen & Co., Ltd, 9th Edition, 1951).

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B.Sc. I Semester II
Course-III BAPT 121: Introduction to Space Science (Credits: 2)

Course Objectives: Students should be able to:

1. explain Kepler's Laws and solar system.
2. recognize Earth's Atmosphere.
3. understand tools for space science.
4. distinguish fundamental particles and fundamental forces.

Credits (Total Credits 2)	Semester II BAPT 121: Introduction to Space Science	No. of hours per unit/credit
Unit I	**Introduction to Planetary and Interplanetary Space**	**09**
	Solar System, Kepler's Laws, Earth-Moon System, solar and lunar types, exploration of solar system by telescopes, Rockets andSatellites.	
Unit II	**Earth's Atmosphere**	**07**
	Structure of Earth's Atmosphere- Lower, Middle and Upper Troposphere (0-10 km), Stratosphere (10-50km), Ionosphere (50-1000 km), Protonosphere (10,000 to 60,000 km towards sun), Interplanetary space (beyond 60,000 km towards the sun), Earth as a magnetic comet.	
	Tools for Space Science	**07**

Unit III	Observational and experimental tools for astronomy and spaceScience: In-situ measurements of chemical, physical and dynamical parameters using kites, balloons, aeroplanes, rockets and satellite payloads.	
Unit IV	**Fundamental Particles and basic forces**	**08**
	Protons, Electrons, Neutrons, Neutrinos, Mesons, leptons, hadrons. The concept of basic forces viz., strong, weak, electromagnetic and gravitational forces	

Course Outcomes: After completion of the course, **Student will be able to:**

1. describe Kepler's Laws and solar system.
2. classify Earth's Atmosphere.
3. understand tools for space science.
4. remember fundamental particles and fundamental forces.
5. distinguish fundamental particles into mesons, leptons and hadrons.

Reference Books:

1. Jay M, Astronomy – From the Earth to the Universe (Pasachoff Books /Cole Thomson Course. W B Saunders Co Ltd; 4 th revised edition 1992)
2. Thomas T. Arny, Exploration – An Introduction to Astronomy, (Mosley-Year Book Inc, 3rd edition 1994).
3. Frank H. S, The Physics of Astrophysics, Volume II: Gas Dynamics, (University Science Books, 1992)
4. Frank H. S, The Physics of Astrophysics, Volume I: Gas Dynamics, (University Science Books, 1991)
5. Davis.K., *Ionospheric Radio Propagation* (Institution of Engineering and Technology, 1990).
6. R. Jastrow, M. H. Thomson, Astronomy Fundamentals and Frontiers, (John Wiley and Sons Publications, 4th revised edition 1984).
7. Odishaw.H., Sun, Upper Atmosphere and Space, (The MIT Press, 1st Edition, 1964)
8. Ratcliffe.J.F., Physics of Upper Atmosphere, (Academic Press Inc., 3rd Edition, 1960)
9. Mitra.S.K., The Upper Atmosphere, (Asiatic Society, 2st Edition 1952)

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B.Sc. I Semester II

Course –IV: BAPT 122: Basic Physics for Astronomy (Credits: 2)

Learning Objectives: Students 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. explain different nuclear reactions.

Credits (Total Credits 2)	Semester II BAPT 122 : Basic Physics for Astronomy	No. of hours per unit/credit
Unit I	**Electromagnetic radiation**	**07**
	The nature of light: light as an electric vibration, properties of electromagnetic wave, electromagnetic spectra, the electromagnetic radiation from a heated object, blackbody radiation Doppler shift blue shift read shift.	
Unit II	**Optics**	**08**
	Reflection of light, spherical mirrors, mirror formula, refraction of light, refraction at spherical surfaces, lenses, thin lens formula, lensmaker's formula, magnification, power of a lens, combination of thin lenses in contact.	
Unit III	**Scattering of light**	**07**
	Brief discussion on scattering of light, Tyndall effect, types of scattering: elastic scattering: blue colour of sky and reddish apprearance of the sun at sunrise and sunset.	
Unit IV	**Nuclear reaction in stars**	**08**
	Types of nuclear reactions, nuclear fission reaction, controlled chain reaction, nuclear reactor, nuclear fusion reaction, energy released in fusion reaction, nuclear reactions in star.	

Course Outcomes: After completion of the course, Student will be able to:

1. **e**nlist properties of electromagnetic radiation
2. compare optical properties of lenses and mirrors.
3. interpret different types of properties of light.
4. explain differentiate types of scattering and its effects.
5. classify different nuclear reactions.
6. enlist different types nuclear reactions in the star.

Reference Books:

1. Ajoy Ghatak, *Optics* (McGraw Hill; Seventh edition, 2020)
2. Dikshitulu K. Kalluri, *Principles of Electromagnetic Waves and Materials* (CRC Press; 2nd edition, 2019)
3. Francis A. Jenkins and Harvey E. White, Fundamentals of Optics (McGraw Hill Education; 4th edition,2017)
4. Thomas T. Arny, Exploration – An Introduction to Astronomy, (Mosley-Year Book Inc, 3rd edition 1994).
5. Frank H. S, The Physics of Astrophysics, Volume II: Gas Dynamics, (University Science

Books, 1992)
6. B. B. Laud, *Electromagnetics,* (New Delhi: New age international (P) Ltd.,2nd Edition, 1987).
7. David Griffiths, *Introduction to elementary particles,* (John Wiley & Sons, Inc., 2nd Edition, 1987)
8. Max Born and Emil Wolf, Principles of Optics: Electromagnetic Theory of Propagation, Interference, and Diffraction of Light (Pergamon; 6th edition, 1980)
9. Mitra.S.K., The Upper Atmosphere, (Asiatic Society, 2st Edition 1952)

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B.Sc. I Semester II

Practical Course-II: BAPP 123: Experimental Techniques in Astronomyy Lab II (Credits: 2)

Course Objectives: Students should be able to:

1. develop fundamental experimental skills to perform an experiment.
2. learn the experimental setup and procedure to perform given experiment.
3. develop skills in taking readings/observations obtained from these instruments.
4. learn how to analyze and interpret experimental data, including error analysis, graphical representation
5. perform calculations to obtain the experimental results.
6. test whether the experimental results hold good with theoretical results.
7. acquire knowledge and practice safe laboratory procedures, including proper handling of equipment, electrical, and potential hazards.

Experiments:

Sr. No.	Titles of Experiment
1.	To determine the approximate size of the Sun using their angular diameter and known distance.
2.	To determine the approximate sizes of the Moon using their angular diameter and known distance.
3.	To determine size of the Sun and Moon using the eclipse Method.
4.	To explore and understand the relationship between the distance from a light source and the observed brightness.
5	A simple night sky observation activity and identify key celestial objects visible to the naked eye.
6.	To simulate the use of a telescope and explore different astronomical objects.
7.	To observe and create a constellation map by identifying and drawing Orion constellation visible in the night sky.
8.	To use specific constellations to locate and determine the direction of the North Pole.
9.	To simulate and visualize the energy levels in the Bohr model of atomic physics using a software-based simulation tool.
10.	To observe and create a constellation map by identifying and drawing Taurus constellation visible in the night sky.
11.	Study of Michelson Morley interferometer.
12.	To analyze and interpret exoplanet transit data to detect and characterize exoplanets.
13.	To familiarize with Cassegrain telescope and make observation of moon
14.	To familiarize with Galilean telescope and make observation of moon.

15.	To use astrophysical techniques to collect data and gain insights into Earth's atmosphere.

Course Outcomes: After completion of the course, 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.
5. discuss and correlate their physics theory concepts and theoretical values with practical and experimental values.
6. exhibit collaborative skills in working as part of a group to perform experiment.
7. exhibit strong awareness of laboratory safety practices (proper handling of equipment, following dos and don'ts laboratory protocols)

Reference Books:

1. Worsnop B.L. and H.T. Flint., *Advanced practical physics for students*, (London: Methuen & Co., Ltd, 9th Edition, 1951).
2. Gupta S.L. and V. Kumar., *Practical physics.*(Meerut: Pragati Prakashan,29thEdition.2017).
3. Chattopadhyay D. and P.C.Rakshit, *An advanced course in practical physics* (Calcutta: New Central Book,8th Edition,2013).
4. White, Marsh W. and Kenneth V. Manning, *Experimental college physics; a laboratory manual*, (New York: McGraw-Hill Publication,3rd Edition, 1954).
5. Prakash and Ramakrishna, *A Textbook of Practical Physics*, (Kitab Mahal,11th Edition ,2011).
6. Singh H. Harnam and Hemne P. S., B.Sc. Practical Physics, (New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011)

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