SEMESTER 2

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Physics**					
Course Name	**Modern Physics**					
Type of Course	**DSC A**					
Course Code	**MG2DSCPHY100**					
Course Level	**100**					
Course Summary	This course is an overview of the developments in Physics in the 20th century. The discussion of Einstein's theory of Relativity, Quantum theory of light, the Dual nature of matter, Light matter interaction will help the student to develop a broad knowledge in Modern physics.					
Semester	2	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1	0	75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To acquire in depth knowledge on the Special theory of relativity and its applications	U, A	1, 2
2	To illustrate the dual nature of matter and radiation and importance of De-Broglie hypothesis in the development of quantum mechanics	U, A	1, 2
3	To explain the different atomic models and the atomic structure	U	1, 2
4	To appreciate the effects of the structure of matter.	U, Ap	1, 2
5	To understand the basic concepts leading to quantum physics.	U	1, 2

6	To gain hands on expertise in experiments related to modern physics	S, A, An	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Theory of Relativity**		**10**	
	1.1	Frames of Reference, Postulates of Special Relativity	1	1
	1.2	Length Contraction, Time Dilation and Twin Paradox	3	1
	1.3	Doppler Effect and the Expanding Universe	3	1
	1.4	Mass Energy Relation, General Theory of Relativity.	3	1
2	**2.1 Particle properties of waves**		**8**	
	2.1.1	Electromagnetic waves, Blackbody Radiation, Planck's quantum theory of radiation	**3**	2
	2.1.2	Photoelectric effect, Quantum Theory of Light	**2**	2
	2.1.3	X-rays, Compton Effect, Pair Production	**3**	2
	2.2 Wave Properties of Particles		**7**	
	2.2.1	De Broglie's Waves, Wave function, Describing a wave using general wave formula.	**3**	2
	2.2.2	Davisson–Germer experiment	**2**	2
	2.2.3	Heisenberg Uncertainty Principle: mathematical form.	**2**	2
3	**3.1 Atomic Structure and Applications of Quantum Mechanics**		**10**	
	3.1.1	Bohr atom model, Electron Orbits, Atomic Spectra, Orbital Radii in Bohr Atom, Vector Atom Model	**3**	3

	3.1.2	Energy Level and Spectra of Atoms, Origin of line spectra, Hydrogen spectrum.	**2**	3
	3.1.3	LASER: basic properties, stimulated absorption, spontaneous and stimulated emissions, population inversion, Practical Lasers. Band Theory of Solids, Superconductivity.	**5**	4
	3.2 Introduction to Quantum Mechanics		**10**	
	3.2.1	Wave functions and wave equation.	**2**	5
	3.2.2	Schrodinger Equation – Time dependent form	**1**	5
	3.2.3	Expectation values and Operators	**2**	5
	3.2.4	Schrodinger equation - Steady state form	**1**	5
	3.2.5	Particle in a box, Nanostructures	**4**	5
4	**Practical**		**30**	**6**
	1	Refractive index of water using laser (by forming circular ring).		
	2	Plotting of waveforms using GeoGebra (Sine wave, Cosine Wave etc) and understanding of phase relationships.		
	3	Determine the angle of the given prism using a spectrometer.		
	4	Measure the thickness of a thin wire using a travelling microscope.		
	5	Solar cell- understanding of power generation- measure the output current and voltage for a fixed load for two different intensities and plot the V-I graph		
	6	Study the climate parameters (temperature, pressure, humidity) at a location from satellite data (MOSDAC) and graphically represent the same over a period of time.		
	7	Verification of Stefan's law using low power (DC) incandescent lamp.		
	8	Determination of least count of a ruler using laser – Reflection grating.		
	9	Plot the black body spectrum using a Python program for different temperatures.		

	10	Plot superposition of two sine waves of different frequencies using Python.		
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstrations, Presentations, Discussions
Assessment Types	**MODE OF ASSESSMENT** **A.Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** **Formative assessment** ● Quiz ● Assignment ● Seminar **Summative assessment** ● Written test **Practical:15 marks** ● Lab involvement ● Viva
	B. End Semester Examination **Theory: 50 marks** ● Short answer type questions: Answer any 7 questions out of 10(7*2=14) ● Short essay-type questions: Answer any 4 questions out of 6(4*6=24) ● Essay type questions: Answer any 1 question out of 2(1*12=12) **Practical: 35 marks** ● Lab Exam:30 marks ● Record: 5 marks

Textbook

1. Beiser, Arthur, Mahajan. Shobhit, Choudhury, S. Rai. Concepts of modern physics. McGraw Hill Education, 2017 7th Edition

References

1. Tipler, Paul A., and Llewellyn, Ralph A., Modern Physics, W. H. Freeman and Company, 2008. https://web.pdx.edu/~pmoeck/books/Tipler_Llewellyn.pdf
2. Young, Hugh D., Roger A. Freedman, and Ragbir Bhathal. University physics: Australian edition. Pearson Higher Education AU, 2010.Krane,
3. Kenneth S. Modern physics. John Wiley & Sons, 2019.
4. Shankar R. Fundamentals of Physics II – Electromagnetism, Optics, and Quantum Mechanics: The Open Yale Courses Series) Yale University Press 2019.

Mahatma Gandhi University

Kottayam

Programme	**BSc (Hons) Physics**					
Course Name	**Observational Astronomy**					
Type of Course	**MDC**					
Course Code	**MG2MDCPHY100**					
Course Level	**100**					
Course Summary	The course is structured to spark curiosity among the students and encourage them to explore and appreciate the vastness of the universe using diverse tools of astronomy. The course immerses students in the vast realm of astronomy, imparting a deep understanding of astronomical scales, positional concepts, and the evolution of stars. It further equips learners with the skills to identify celestial objects, constellations, and galaxies, as well as handling tools for observational astronomy.					
Semester	2	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2	0	1	0	60
Pre-requisite, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To comprehend astronomical scales and basic concepts of positional astronomy	U	1
2	To gain knowledge on different telescopes used in the visible part of the spectrum and other electromagnetic bands.	U	1, 2
3	To analyse the different stages in the evolution of star	U, An	1, 2

4	To identify the different galaxies, constellations and the salient features	U	1, 2
5	To categorise the diverse objects in the Solar system	U	1
6	To gain expertise in handling different tools for observational astronomy	U, A, An	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**1.1 Observational Astronomy**		**8**	
	1.1.1	Introduction to astronomy, Astronomical distances- Astronomical unit, Light year- Scale of the universe	3	1
	1.1.2	Introduction to constellation - Orion (Equitorial), Ursa Major (North circumpolar), Crux (South circumpolar)	5	1, 4
	1.2 Tools for Observational Astronomy		**7**	
	1.2.1	Electromagnetic spectrum, Types of telescopes- optical Telescopes-Reflective telescopes, Refractive telescopes - Hubble Space Telescope, James Webb Space Telescopes. Radio telescopes- GMRT.	7	2
2	**2.1 Stars and galaxies**		8	
	2.1.1	Stars-Classification of stars based on temperature.	2	3
	2.1.2	Stellar Masses (Chandrasekhar limit) - Birth of stars, Nebula, Protostar, Main sequence star, Red giant, Death Stages- White Dwarf, SuperNova- Neutron star- Black hole.	4	3
	2.1.3	Galaxy-Classification of Galaxies- Milky Way.	2	4
	2.2 Exploring Solar System		**7**	

	2.2.1	Objects in Solar Systems- Sun, Planets, Asteroids, Comets, Meteors. Exoplanets	4	5
	2.2.2	Eclipses- Solar Eclipses, Lunar Eclipses, Lunar Phases	3	5
3	**Practical**		**30**	6
	1	Familiarization of telescopes and focusing the objects using a telescope		
	2	Illustration of visible spectrum using prism and telescope.		
	3	Virtual observatory exploration		
	4	Making models of astronomical phenomena and objects		
	5	Identifying and documenting planets/stars		
	6	Find the Orion Constellation. Name three stars in the belt and prepare a report of these stars as pointer stars		
	7	Mapping and categorization of constellations		
	8	Observe and sketch the map of constellations observable in any one night		
	9	Moon Phase calendar- Have students create a personalized moon phase calendar for a month. They can sketch the moon's appearance each night and note the date, enhancing their observational skills.		
	10	Starry Night Picnic- Organize a casual evening picnic where students can gaze at the night sky, and identify constellations using a stargazing app.		
	11	Learn to use Astronomy software - Any two activities of identification		

	12	Astrophotography-Night Sky Photography		
	13	Telescope making workshop		
	14	Observatory visit		
	15	Observe and Identify Sunspots		
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Demonstration, Field Trip, Observation, Group discussion.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:15 marks** **Formative assessment** • Assignment • Seminar • Tutorial work **Summative assessment** • MCQ exams **Practical:15 marks** • Lab involvement • Viva
	B. Semester End Examination **Theory: 35 marks** • MCQ exams **Practical: 35 marks**

	• Lab Exam: 30 marks • Record: 5 marks

Textbooks

1. Moché, Dinah L. Astronomy. A self-teaching guide. Seventh Edition, John Wiley and Sons 1993.
2. Basu, Biman Joy of star watching by, National Book Trust, India 2017.

References

1. Morrison, Ian Introduction to Astronomy and Cosmology , John Wiley & Sons Inc; 1st edition 2008.
2. Moore, Patrick An amateur astronomer 12th edition, Springer 2006.
3. Astronomy, Openstax, Rice University (Free Astronomy book) 2nd Edition 2022