MAHATMA GANDHI UNIVERSITY

Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2025 Admission Onwards

SYLLABUS			
SIGNATURE COURSE			
Name of the College	SNM College, Maliankara P.O		
Faculty/ Discipline	Physics		
Programme	BSc (Hons) Physics		
Course Coordinator	Lakshmi S Bose		
Contributors	Mr. Sunilkumar C P, Dr. Urmila K S, Dr. Vidyarajan N		
Course Name	ASTRONOMY: A FIRST LOOK		
Type of Course	DSE		
Specialization title	Astronomy and Astrophysics		
Course Code	MG3DSEPHYA03		
Course Level	200		
Course Summary	This course introduces the evolution and fundamentals of astronomy. It covers early models of the universe, comparing the geocentric model of Ptolemy with the heliocentric model of Copernicus, followed by Kepler's laws of planetary motion and Newton's law of gravitation. The invention of the telescope by Galileo and the contributions of Indian scientists such as Aryabhatta, Varahamihira, and Brahmagupta are highlighted. The course explains lunar phases, seasons, astronomical distance units, stellar properties, the electromagnetic spectrum, and introduces high-energy astronomy, detector technology, and major space telescopes.		
Semester	3	**Credits**	4
Course Details	**Learning Approach** / **Lecture** / **Practical/Lab-P** / **Total Hours** Credits / 3 / 1 / 75		
Pre-requisites, if any	Nil		

Course Outcomes (CO)

Number of COs		**6**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To explain the historical development of astronomical models and describes the laws of planetary motion and gravitation	K, U	PO1, PO2, PO3, PO9, PO10
2	To understand the role of observational astronomy through the invention of the telescope and contributions of Indian astronomers	K, U	PO1, PO2, PO3, PO9, PO10
3	To describe the physical characteristics of celestial bodies and methods for determining sizes and distances	A, An	PO1, PO2, PO3
4	To apply astronomical distance measurement techniques	A, An, C	PO1, PO2, PO3

Number of COs		6	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	To interpret the electromagnetic spectrum, stellar parameters, high-energy astronomy and telescopes	U, A, S	PO1, PO2, PO3, PO5
6	To introduce basics in astronomical tools, astronomical surveys and software	A, C	PO1, PO2, PO3, PO9, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	-	-	-	-	-	1	3
CO 2	3	3	3	-	-	-	-	-	2	3
CO 3	3	3	1	-	-	-	-	-	-	-
CO 4	3	3	3	-	-	-	-	-	-	-
CO 5	3	3	3	-	1	-	-	-	-	-
CO 6	3	3	3	-	-	-	-	-	2	3

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Introduction to Astronomy			
	1.1	Geocentric Model : Ptolemy, Heliocentric Model : Copernicus	4	["1"]
	1.2	Kepler's Laws of Planetary Motion, Newton's Laws of Gravitation	4	["1"]
	1.3	Telescope: Galileo's contribution	2	["2"]
	1.4	Contributions of Indian Scientists : Aryabhatta, Varahamihira, Brahmagupta	2	["2"]
2	Astronomy from surface of Earth			
	2.1	Moon – Phases of Moon, Distance and Size of Sun and Moon, Size and Shape of Earth, Seasons of Earth	3	["3"]
	2.2	Astronomical units of distance – Lightyear, AU, Parsec, Relation Between Parsec and lightyear, Parallax Method	5	["3", "4"]
	2.3	Electromagnetic spectrum, Luminosity of a star, Radiant flux of a star, Solar constant	6	["3", "4"]
	2.4	Magnitude scale – Absolute magnitude, Relation Between Luminosity and Absolute magnitude	4	["4"]

Module	Units	Course Description	Hrs	CO No.
3	Astronomy from space			
	3.1	Introduction to high energy astronomy - IR astronomy, UV astronomy and Gamma astronomy	5	["5"]
	3.2	Basics of Detector technology, Cherenkov Radiation, X-ray astronomy- Sound rocket flights, Ballons & X-ray telescope	7	["5"]
	3.3	Familiarization of new missions – Chandra Telescope, Astrosat, Hubble space telescope	3	["5"]
4	Practical			
	4.1	1. Familarization of Stellerium and identify five constellations visible in the night sky from your location during the current month (https://stellarium.org/) 2. Compare the brightness (magnitude) of Sirius and Betelgeuse using Stellarium data. Find the brightest star 3. Using Sky-map, Identify Orion on the sky map. Name its three belt stars and mark their position 4. Identify the zodiac constellations visible in the night sky using the sky map 5. Using object information from Sky safari app, find the distance, magnitude, and type of a selected galaxy or nebula (https://starrynighteducation.com/products-astronomy.html) 6. Familiarization of Focal length Calculator and find the focal length and focal ratio of a telescope (https://astronomy.tools/calculators/focal_length_ratio) 7. Calculate the maximum resolving power of a telescope using the Dawes' Limit formula & Rayleigh Limit formula using telescope capability astronomy tool (https://astronomy.tools/calculators/telescope_capabilities) 8. Calculate the resolution in arc seconds per pixel of a CCD with a particular telescope and calculate the pixel size of a CCD (https://astronomy.tools/calculators/ccd) 9. Create a Starchart at your locations and identify various constellations in the night sky 10. Familiarisation of Aperture Photometry Tool (https://aperturephotometry.org/) 11. Familarization of Flexible Image Transport System (FITS) using Fits viewer app (https://heasarc.gsfc.nasa.gov/docs/software/ftools/fv/fv_download.html) 12. Using Fits viewer app, create a catalogue data of celestial objects in the satellite fits image file (https://heasarc.gsfc.nasa.gov/docs/software/ftools/fv//fv.html) 13. Familiarization of UV astronomy by using GALEX satellite, its UV image, Field of View of a particular location in the night sky (https://galex.stsci.edu/GR6/) 14. Familiarization of IR astronomy by using Spitzer satellite, its survey IRIS, IRAS images of a particular location within 5 degrees in the night sky using Skyview Virtual Observatory (https://skyview.gsfc.nasa.gov/current/cgi/titlepage.pl)	30	["6"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lectures, Hands-on training, Presentations, Discussions

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Both **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 25 Marks** Written Test, Assignment, Seminar, Quiz **• Practical – 15 Marks** Lab Involvement, Viva **B. End Semester Evaluation (ESE)** **• Theory – 50 Marks** Assessment Methods – Written Exam Duration of Examination – 1.50 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B Answer Type: ◦ PART - A ◦ Short answer - (10 out of 12) – 10 × 2 = 20 ◦ PART - B ◦ Short Essays/Problems - (6 out of 8) – 6 × 5 = 30 **• Practical – 35 Marks** Assessment Methods – Lab Exam: 30 Marks, Record: 5 Marks Duration of Examination – 2.00 Hrs

References

- Sharma, Mohit Kumar, and Suresh Chandra: Astronomy and Astrophysics. New Delhi: TechSar Pvt. Ltd., 2024
- Jain, Pankaj: Introduction to Astronomy. University Science Press, 2016
- Basu, Bainthanath: An Elementary Treatise on Astronomy. Macmillan, 1923
- Carroll, B. W. & Ostlie, D. A: An introduction to modern astrophysics (2nd ed.) Cambridge University Press, 2017

Suggested Readings

- Abhyankar, K. D. Astrophysics: Stars and galaxies. Tata McGraw-Hil, 1977
- Zeilik, M. & Gregory, S. A: Introductory astronomy and astrophysics (4th ed.). Saunders College Publishing, 1998
- Roy, A. E. & Clarke, D: Astronomy: Principles and practice (4th ed.). CRC Press, 2013
- Ryden, B. & Peterson, B: Foundations of astrophysics. Cambridge University Press, 2021

Affidavit

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Undergraduate Programmes (HONOURS)
2025 Admission Onwards

SYLLABUS			
SIGNATURE COURSE			
Name of the College	SNM College, Maliankara P.O		
Faculty/ Discipline	Physics		
Programme	BSc (Hons) Physics		
Course Coordinator	Lakshmi S Bose		
Contributors	Mr Sunilkumar C P, Dr Urmila K S, Dr Vidyarajan N		
Course Name	OBSERVATIONAL TECHNIQUES IN ASTRONOMY		
Type of Course	DSE		
Specialization title	Astronomy and Astrophysics		
Course Code	MG4DSEPHYA03		
Course Level	200		
Course Summary	This course introduces fundamental, observational and physical concepts in astronomy. It covers astronomical scales and dimensions, the night sky, constellations, retrograde motion of planets, sidereal time, and the use of astronomical catalogs and software. The course explains the principles of telescopes, including refracting and reflecting systems, telescope mounts, resolution limits, and observations at visible frequencies. Radio, space-based telescopes, interferometry, and detector technology such as CCDs are also discussed. It further examines radiation from astronomical sources, including continuous, synchrotron, bremsstrahlung, and line spectra. The Doppler effect, spectral line broadening, molecular bands, and extinction are also discussed.		
Semester	4	**Credits**	4
Course Details	**Learning Approach** / **Lecture** / **Practical/Lab-P** / **Total Hours** Credits / 3 / 1 / 75		
Pre-requisites, if any	Nil		

Course Outcomes (CO)

Number of COs		**6**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To understand and explain astronomical scales, coordinate systems, constellations, retrograde motion of planets, and the concept of sidereal time	K, U, An	PO1, PO2, PO10
2	To use astronomical catalogs and software tools to identify, classify, and analyze celestial objects and observational data	U, C	PO1, PO2, PO3, PO9, PO10
3	To describe the principles, construction, and working of optical telescopes	U, A, An	PO1, PO2
4	To explain advanced observational techniques, interferometry and detector technologies	A, An, C	PO1, PO2, PO3, PO10

Number of COs		6	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	To analyze radiation mechanisms from astronomical sources and interpret different types of spectra	U, A, S	PO1, PO2, PO3
6	To implement computational programming to astronomy based problems	A, C	PO1, PO2, PO9, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	-	-	-	-	-	-	-	1
CO 2	3	3	1	-	-	-	-	-	2	1
CO 3	3	3	-	-	-	-	-	-	-	-
CO 4	3	3	2	-	-	-	-	-	-	1
CO 5	3	3	1	-	-	-	-	-	-	-
CO 6	3	3	-	-	-	-	-	-	2	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Scales in Astronomy			
	1.1	Scales and dimensions	3	["1"]
	1.2	Night sky, Constellations, Stars, Galaxies	4	["1"]
	1.3	Retrograde Motion of Planets, Sidereal time	2	["2"]
2	Telescope, Interferometer & Detectors			
	2.1	Introduction to telescope, Mirror telescopes – Refracting & Reflecting	6	["3"]
	2.2	Observations at visible frequencies, theoretical limit of resolution	2	["3", "4"]
	2.3	Mounting of telescope – Equitorial and Azimuthal mount	4	["3", "4"]
	2.4	Radio telescope and space based telescope	3	["4"]
	2.5	Interferometry, Detectors – Charge coupled devices, Basics of operations	5	["4"]

Module	Units	Course Description	Hrs	CO No.
3	Photometry			
	3.1	Radiation from astronomical sources – Continuous spectra – Synchrotron radiation	3	["5"]
	3.2	Bremsstrahlung radiation and Crompton scattering	2	["5"]
	3.3	Absorption and emission line spectra , Doppler Effect, Radial velocity due to Doppler effect, cause of finite width of spectral lines	6	["5"]
	3.4	Molecular band spectra and Extinction	5	["5"]
4	Practical			
	4.1	1. Write a Python program to convert astronomical distances between kilometers, astronomical units (AU), light-years, and parsecs 2. Write a Python program to calculate the angular size of a celestial object given its physical diameter and distance 3. Develop a python program to convert parallax in milli arcseconds to distance in parsecs 4. Develop a python program to convert temperature from Celsius to Kelvin 5. Write a python program to convert temperature from Fahrenheit to Celsius 6. Create a python program to convert temperature from Fahrenheit to Kelvin 7. Write a python program to calculate the apparent brightness of a star given its luminosity and distance using the inverse-square law 8. Write a python program to compare the brightness of two stars given their apparent magnitudes and identify the brighter star 9. Write a Python program to compute local sidereal time given the observer’s longitude and universal time 10. Write a Python program to compare focal length and magnification of refracting and reflecting telescopes 11. Write a Python program to convert star coordinates for equatorial and azimuthal mounts 12. Calculate radial velocity of a star using observed and rest wavelengths using python 13. Write a Python program to compute distance of a galaxy using Cepheid variable stars (period-luminosity relation) 14. Create a Python program to calculate flux density and intensity given luminosity and distance	30	["6"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lectures, Interactive discussions, Presentations, Discussions

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Both **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 25 Marks** Written test, Assignment, Quiz, Seminar **• Practical – 15 Marks** Lab Involvement, Viva **B. End Semester Evaluation (ESE)** **• Theory – 50 Marks** Assessment Methods – Written Exam Duration of Examination – 1.50 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ∘ PART - A ∘ Short answer - (7 out of 10) – 7 × 2 = 14 ∘ PART - B ∘ Short Essays/Problems - (4 out of 6) – 4 × 6 = 24 ∘ PART - C ∘ Essays - (1 out of 2) – 1 × 12 = 12 **• Practical – 35 Marks** Assessment Methods – Lab Exam: 30, Record: 5 Duration of Examination – 2.00 Hrs

References

- Sharma, Mohit Kumar, and Suresh Chandra: Astronomy and Astrophysics. New Delhi: TechSar Pvt. Ltd., 2024
- Bradt, H. Astronomy methods: A physical approach to astronomical observations. Cambridge University Press, 2004
- A. A. Henden and R. H. Kaitchuck: Astronomical Photometry. Richmond, VA, USA: Willmann-Bell, 1990
- Kitchin, C. R : Astrophysical techniques (7th ed.). CRC Press, 2021
- A. Glindemann: Principles of Stellar Interferometry. Berlin, Germany: Springer, 2011
- Oswalt, T. D., & Bond, H. E. (Eds.). Planets, stars and stellar systems: Vol. 2: Astronomical techniques, software, and data. Springer, 2013

Suggested Readings

- E. Budding and O. Demircan, Introduction to Astronomical Photometry. Cambridge, U.K.: Cambridge University Press, 2007
- Roy, A. E., & Clarke, D : Astronomy: Principles and practice (4th ed.). CRC Press, 2013
- Birney, D. S., Gonzalez, G., & Oesper, D: Observational astronomy. Cambridge University Press, 2006

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Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2025 Admission Onwards

SYLLABUS			
SIGNATURE COURSE			
Name of the College	SNM College, Maliankara P.O		
Faculty/ Discipline	Physics		
Programme	BSc (Hons) Physics		
Course Coordinator	Lakshmi S Bose		
Contributors	Mr. Sunilkumar, Dr. Urmila. K S, Dr. Vidyarajan N		
Course Name	GATEWAY TO STELLAR AND GALACTIC ASTROPHYSICS		
Type of Course	DSE		
Specialization title	Astronomy and Astrophysics		
Course Code	MG5DSEPHYA03		
Course Level	300		
Course Summary	This course introduces fundamental concepts of stellar and galactic astrophysics. It covers astronomical coordinate systems used to locate celestial objects. The stellar magnitude system, stellar temperatures, and spectral classification are discussed, along with the Hertzsprung–Russell diagram. The course examines star formation, stellar evolution from the main sequence to end stages such as white dwarfs, neutron stars, black holes, and supernovae. It also introduces galaxies, their classification, distribution, spectra, luminosity, and methods of determining galactic distances using variable stars and the Hubble constant.		
Semester	5	**Credits**	4

Course Details

Learning Approach	Lecture	Practical/Lab-P	Total Hours
Credits	3	1	75

Pre-requisites, if any	Nil

Course Outcomes (CO)

Number of COs		**6**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To explain astronomical coordinate systems with detailed definitions	K, U, An	PO1, PO2, PO10
2	To apply the stellar magnitude system and temperature concepts to interpret stellar properties	U, A, An	PO1, PO2
3	To describe stellar spectra, spectral classification, Hertzsprung–Russell diagram	U, A, An	PO1, PO2
4	To analyze the processes of star formation and stellar evolution	A, An	PO1, PO2
5	To classify galaxies and explain their distribution and characteristics	U, A, An, S	PO1, PO2, PO10

Number of COs		6	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
6	To develop and implement programs to solve basic astrophysical problems	K, A, An	PO1, PO2, PO9, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	-	-	-	-	-	-	-	1
CO 2	3	3	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	1
CO 6	3	3	-	-	-	-	-	-	1	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Basics of Astrometry			
	1.1	Coordinate systems – Equatorial, Galactic and Ecliptic Co-ordinate system	5	["1"]
	1.2	Stellar Magnitude sequence, Absolute magnitude and Distance Modulus, Bolometric Magnitude, Color Index, Luminosity	6	["2"]
	1.3	Stellar temperature – Ionization, Excitation, Effective temperature, Color temperature	4	["2"]
2	Stars, Stellar Spectra and Classification			
	2.1	Spectral Classification, Blackbody spectrum	2	["3"]
	2.2	Doppler redshift, Relation between B-V magnitude and surface temperature	2	["3", "4"]
	2.3	HR diagram, Early stage of star formation , Fragmentation, Evolution of main sequence, Evolution beyond main sequence	7	["3", "4"]
	2.4	White dwarfs, Pulsar, Neutron star, Black hole, Supernova	4	["4"]
3	Galaxies & Classification			
	3.1	Galaxies – classification- Hubble's Tuning Fork diagram- Elipticals- Normal spirals & barred spirals, lenticular galaxies, irregular galaxies	6	["5"]
	3.2	Distribution of galaxies, Luminosity distribution, Spectra of galaxies	3	["5"]
	3.3	Distance of galaxies, Lyrrae stars, Cephid variables, Hubble constant	6	["5"]

Module	Units	Course Description	Hrs	CO No.
4	Practical (Use : Astropy lib add to python (https://pypi.org/project/astropy/))			
	4.1	1. Write a Python program to convert equatorial coordinates (RA, Dec) to galactic coordinates 2. Write a Python program to convert equatorial coordinates to ecliptic coordinates 3. Write a python program to calculate the distance of a star using parallax, where parallax is given in arcseconds 4. Compute absolute magnitude from apparent magnitude and distance using python 5. Write a Python program to calculate apparent magnitude of a star from its flux 6. Calculate Hubble constant from recession velocity and distance using Python 7. Develop a Python program to compute color index and bolometric magnitude of a star 8. Write a Python program to calculate effective temperature of a star from luminosity and radius 9. Write a Python program to identify stellar end states (white dwarf, neutron star, black hole) based on stellar mass 10. Write a python program to compare the apparent magnitudes of two stars and determine which one appears brighter 11. Develop a python program to compute the distance modulus of a star when its apparent magnitude and absolute magnitude are given 12. Create a python program to classify a star’s spectral type (O, B, A, F, G, K, M) based on its surface temperature 13. Create a python program to calculate the distance of a star using the distance modulus formula 14. Write a python program to convert RA in hours, minutes, seconds to decimal degrees 15. Compute color index (B-V) and identify star’s approximate color using python	30	["6"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Interactive discussions, Presentations, Discussions

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Both **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 25 Marks** Written Test, Assignment, Quizz, Seminar **• Practical – 15 Marks** Lab Involvement, Viva **B. End Semester Evaluation (ESE)** **• Theory – 50 Marks** Assessment Methods – Written Exam Duration of Examination – 1.50 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ Short answer - (7 out of 10) – 7 × 2 = 14 ◦ PART - B ◦ Short Essays/Problems - (4 out of 6) – 4 × 6 = 24 ◦ PART - C ◦ Essays - (1 out of 2) – 1 × 12 = 12 **• Practical – 35 Marks** Assessment Methods – Lab Exam: 30, Record: 5 Duration of Examination – 2.00 Hrs

References

- B. Basu, T. Chattopadhyay, and S. N. Biswas, An Introduction to Astrophysics, 2nd ed. New Delhi, India: PHI Learning Private Limited, 2010
- Sharma, Mohit Kumar, and Suresh Chandra. Astronomy and Astrophysics. New Delhi: TechSar Pvt. Ltd., 2024
- Abhyankar, K. D: Astrophysics: Stars and galaxies. Tata McGraw-Hill, 1977
- Carroll, B. W., & Ostlie, D. A: An introduction to modern astrophysics (2nd ed.). Cambridge University Press, 2017

Suggested Readings

- E. F. Milone and C. Sterken, Eds., Astronomical Photometry: Past, Present, and Future. New York, NY, USA: Springer, 2011
- H. Karttunen, P. Kröger, H. Oja, M. Poutanen, and K. J. Donner, Fundamental Astronomy, 6th ed. Berlin, Germany: Springer, 2017
- E. Böhm-Vitense, Introduction to Stellar Astrophysics, Vol. 1: Basic Stellar Observations and Data. Cambridge, U.K.: Cambridge University Press, 1992
- J. Binney and M. Merrifield, Galactic Astronomy. Princeton, NJ, USA: Princeton University Press, 1998
- M. Zeilik and S. A. Gregory, Introductory Astronomy and Astrophysics, 4th ed. Fort Worth, TX, USA: Saunders College Publishing, 1998

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SYLLABUS			
SIGNATURE COURSE			
Name of the College	SNM College, Maliankara P.O		
Faculty/ Discipline	Physics		
Programme	BSc (Hons) Physics		
Course Coordinator	Lakshmi S Bose		
Contributors	Mr. Sunilkumar C P, Dr. Urmila K S, Dr. Vidyarajan N		
Course Name	ELEMENTARY RESEARCH IN ASTRONOMY AND ASTROPHYSICS		
Type of Course	DSE		
Specialization title	Astronomy and Astrophysics		
Course Code	MG6DSEPHYA03		
Course Level	300		
Course Summary	This course introduces the fundamental ideas of relativity, cosmology, and statistical methods essential for modern astrophysics. It begins with the evolution of relativistic concepts, focusing on spacetime geometry and relativistic quantities such as four-vectors, proper time, and four-momentum. The course then explores basic cosmology, including the expanding universe, redshift, Hubble's law, matter density, cosmological principle, and simple models of the universe such as Einstein's static and steady state universe. The final part emphasizes statistical tools for astronomical data analysis, including descriptive statistics, regression, hypothesis testing, and hands-on exposure to astronomical data sources.		
Semester	6	**Credits**	4
Course Details	**Learning Approach** / **Lecture** / **Total Hours** Credits / 4 / 60		
Pre-requisites, if any	Nil		

Course Outcomes (CO)

Number of COs		**6**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	To explain the basic concepts of relativity, including relativistic space-time, geometry of space-time, and four-dimensional physical quantities	U, An	PO1, PO2
2	To describe fundamental ideas of cosmology and simple cosmological models	U, An, C	PO1, PO2, PO10
3	To apply basic cosmological principles and equations to understand the evolution and structure of the universe	U, A, An	PO1, PO2
4	To use elementary statistical methods, including data presentation, descriptive statistics, Correlation and regression for analyzing scientific data.	U, A, An	PO1, PO2, PO3

Number of COs		6	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
5	To demonstrate basic data analysis skills by applying statistical tools and simple computational methods to real astronomical datasets.	U, A, E, C	PO1, PO2, PO3, PO10
6	To access and interpret astronomical data from standard data sources using basic computational and analytical techniques.	A, An, S	PO1, PO2, PO9, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	1
CO 3	3	3	-	-	-	-	-	-	-	-
CO 4	3	3	2	-	-	-	-	-	-	-
CO 5	3	3	2	-	-	-	-	-	-	2
CO 6	3	3	-	-	-	-	-	-	1	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Overview of Special Theory of Relativity			
	1.1	Past Present and Future in Relativity -Relativistic Space time, Geometry of Space time	6	["1"]
	1.2	Rapidity, Four vectors, Proper time, Four momentum (Basics)	4	["1"]
2	Cosmology			
	2.1	Introduction to cosmology, Red shift and expansion of universe, Hubble's Law	3	["2", "3"]
	2.2	Matter density in the universe and the deceleration parameter- Open, Flat and Closed Universe	5	["2", "3"]
	2.3	Cosmological Principle	2	["2", "3"]
	2.4	Model of the universe –Relativistic model - Static model of Einstein, Friedmann model, The steady - state universe	7	["2", "3"]
3	Introduction to Statistical methods in Astronomy and Astrophysics			
	3.1	Basics to statistics – Classification - geographical, chronological qualitative and quantitative, Frequency distribution, Diagrammatic and Graphical presentation of Data	5	["4"]
	3.2	Measures of central value and measure of variance	5	["4"]
	3.3	Skewness, Moments and Kurtosis (Basic idea)	2	["4"]
	3.4	Correlation analysis – Positive & Negative Correlation, Linear & Non linear correlation Regression analysis –Linear regression	6	["4"]

Module	Units	Course Description	Hrs	CO No.
4	Hands-on session: Sources of Astronomical Data			
	4.1	Introduction –Sloan Digital Sky Survey-access data archive https://skyserver.sdss.org/dr7/en/tools/search/	2	["5", "6"]
	4.2	Vizier Service https://vizier.u-strasbg.fr/viz-bin/VizieR	2	["5", "6"]
	4.3	Data on Eclipsing Binary stars https://exoplanetarchive.ipac.caltech.edu/ Extragalactic Galactic Distance Data Base https://edd.ifa.hawaii.edu/index.html	3	["5", "6"]
	4.4	Data on Pulsars – Australia Telescope National facility http://www.atnf.csiro.au/people/pulsar/psrcat/	2	["5", "6"]
	4.5	Data on Gamma Ray Bursts https://gammaray.nsstc.nasa.gov/batse/	2	["5", "6"]
	4.6	Familiarization of Astronomical and Statistical softwares – Aladin, TOPCAT, Binary Maker 3.0, STATA, S-PLUS, MINITAB, SPSS, R, Virtual Observatory	4	["5", "6"]

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Lectures, Interactive discussions, Presentations, Hands-on training

Assessment Types	
	MODE OF ASSESSMENT Mode of Assessment: Theory
	A. Continuous Comprehensive Assessment (CCA) **• Theory – 30 Marks** Assignments, Seminar, Hands on session
	B. End Semester Evaluation (ESE) **• Theory – 70 Marks** Assessment Methods – Written Exam Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ Short answer - (10 out of 12) – 10 × 2 = 20 ◦ PART - B ◦ Short Essays/Problems - (8 out of 10) – 8 × 5 = 40 ◦ PART - C ◦ Essays - (1 out of 2) – 1 × 10 = 10

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- S. Basu, Cosmology. New Delhi, India: PHI Learning Pvt. Ltd., 2016
- S. P. Gupta, Statistical Methods. New Delhi, India: Sultan Chand & Sons, 2012
- G. J. Babu and E. D. Feigelson, Eds., Astrostatistics. New York, NY, USA: Springer-Verlag, 1996
- A. K. Chattopadhyay and T. Chattopadhyay, Statistical Methods for Astronomical Data Analysis. Hoboken, NJ, USA: Wiley, 2014
- M. Ray and U. N. Singh, Statistical Methods. New Delhi, India: S. Chand & Company Ltd., 2010
- H. Bradt, Astronomy Methods: A Physical Approach to Astronomical Observations. Cambridge, U.K.: Cambridge University

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Suggested Readings

- S. Weinberg, Cosmology. Oxford, U.K.: Oxford University Press, 2008
- J. A. Peacock, Cosmological Physics. Cambridge, U.K.: Cambridge University Press, 1999
- P. J. E. Peebles, Principles of Physical Cosmology. Princeton, NJ, USA: Princeton University Press, 1993
- E. D. Feigelson and G. J. Babu, Modern Statistical Methods for Astronomy With R Applications. Cambridge, U.K.: Cambridge University Press, 2012
- L. M. Sarro, J. A. Caballero, and E. Solano, Eds., Statistical Challenges in Modern Astronomy V. Berlin, Germany: Springer, 2011
- J. B. Hartle, Gravity: An Introduction to Einstein's General Relativity. San Francisco, CA, USA: Pearson, 2003

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