



Birla Institute of Technology & Science, Pilani

Hyderabad Campus

1st SEMESTER 2023-24 Course Handout Part II

Date: 11.8.2023

Course No. : PHY F317
Course Title : INTRODUCTION TO RADIO ASTRONOMY
Instructor in Charge : Sarmistha Banik

Objectives & Scope of the Course:

The course aims to give Physics/non-Physics major students an elementary introduction and overview of Radio Astronomy. This is for students who were always curious about the sky out there but never had a chance to know it deeper. And of course, for students who want to pursue their career in Astronomy. We give a general overview of Astronomy and introduce the students to some of the recent and upcoming radio telescope facilities of India and abroad.

Text Book: Essential Radio Astronomy, Condon and Ransom. Princeton University Press, [2016] [Also available online
<https://www.cv.nrao.edu/~sransom/web/xxx.html>]

Reference Book: David J. Griffiths, Introduction to Electrodynamics

Detailed Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
1-2	Introduction	Why observe at radio wavelengths? Observations at different EM spectra	Class notes
3 to 4	Review of Electromagnetic theory	Maxwell's equations and basics of electric and magnetic fields, Basic Electromagnetic Theory and radiation of electromagnetic waves, E & B Field Measurable quantities and Polarization.	RB:Griffiths
5 to 17	Radio Astronomy Fundamentals	Discoveries in Radio Astronomy, Brightness, Flux density and sky brightness, Basics of Radiative Transfer- Absorption, Emission, Emission & Absorption in the Atmosphere, Polarization, Stokes parameters, Black Body Radiation- The Rayleigh-Jeans Law, Planck radiation law, Cosmic Microwave Background Radiation, Nyquist Theorem and Noise Temperature.	TB Chapters 1 & 2, class notes
18 to 22	Pulsar timing array	Pulsar Properties & Discovery, Neutron Star Masses and Densities, Magnetic Fields, Magnetic Dipole Radiation Spin-Down Luminosity, Minimum Magnetic Field Strength, Characteristic Age, Braking Index, The Lives of Pulsars, Emission Mechanisms, Pulsars and the Interstellar Medium, Pulsar Observation and Pulsar timing technique	TB Chapter 6, class notes

23-25	Project 1	Radio Data Analysis	The resources will be shared
26-29	Antennas and noise	Antenna power patterns and beams. Effective area and aperture efficiency. Antennas as resistances and Nyquist's Theorem, Antenna temperature, directivity and gain, Reciprocity Theorem.	TB Chapter 3 Class notes
30-32	Interferometers	Coherence, The Two-Element Quasi-Monochromatic Interferometer, Fourier Transform.	TB Chapter 3, class notes
33-37	Free-Free Radiation, Synchrotron Radiation	Emission Mechanisms of Continuous Radiation, Thermal and Nonthermal Emission, Free-Free Radio Emission from H _{II} Regions, Synchrotron Radiation	TB Chapters 4, 5 class notes
38-40	Project 2	Fourier Transform	Python Codes will be shared

5. Evaluation Scheme:

	Evaluation	Duration	Weight age (%)	Date, Time	Nature of Component
1.	Mid-Sem	90 mins.	25.00%	11/10 - 11.30 - 1.00PM	Closed Book
2.	Project 1	1 week	20.00%	September, TBA	Open Book
3.	Project 2	1 week	20.00%	November, TBA	Open Book
4.	Comprehensive Examination	180 mins.	35.00%	12/12 AN	Closed Book

6. Chamber Consultation Hour: TBA

7. Notices: Notices for the course will be displayed on CMS.

8. Make-up Policy: Make up for Mid-Sem and Compre will be given to emergency (hospitalization) case only, if forwarded by chief warden. Make up requests should reach the IC before the examination. No make up can be given for the Projects.

9. Academic honesty and integrity policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-charge
PHY F317**