

International Summer School Manipal University Jaipur [ISSMUJ]-2022

[Hybrid Mode]

Course Overview

Name of Course: Introduction to Astronomical Sciences

Name of instructor: Dr. Laxmi Poonia, Dr. Mohd. Rizwanullah, Dr. Ram Naresh Saraswat

Session: June-July 2022

Language of instruction: English

Number of contact hours: 36

Credit awarded: 03

Objective of Course/Project

After completion of this course:

- To know about Relativity and relation between Space and Time to make students effective citizen.
- Learn to apply the concepts of length contraction and time dilation as well as use Lorentz transformations, that will enhance logical thinking skills.
- Learn to solve tensor equations and employ to use the concepts in the relevant field.
- Employ the concept of Cosmological principals as well as to know use of some important solutions based on these principals.
- To know about basic concepts of Cosmology to make understanding of student towards universe for self-directed lifelong learning.

Syllabus

The special theory of relativity: Michelson and Morley experiment and its results, Inertial frames of reference, Special Galilean Transformations, General Galilean Transformations. **Relation between Space and Time:** Principle of relativity and its postulates, Relative character of space and time, Simultaneity. **Lorentz transformations:** Derivation of special Lorentz transformation equations, Composition of parallel velocities, Time dilation, Lorentz-Fitzgerald contraction formula, Lorentz contraction factor.

Tensors: Introduction, Summation convention, Transformation of coordinates, Tensor of order zero, Kronecker Delta, Contra-variant tensors, Covariant tensors, Tensors of higher order, Symmetric and skew-symmetric tensors, Addition of tensors, Outer product of tensors, Inner product of two tensors, Contraction of tensors.

Cosmology: Introduction to cosmology, Isotropy, Homogeneity, Basic equation of isotropic cosmology, Hubble constant, Weyl postulate, Cosmological principal, Gaussian coordinate system, introduction to FRW metric and Doppler effect or Red shift.

Text books:

1. R. K. Pathria, The Theory of Relativity (2nd edition), Hindustan Publishing Co., Delhi, 1994.
2. J. V. Narlikar, General Relativity & Cosmology (2nd edition), Macmillan Co. of India Limited, 1988.
3. Albert Einstein, Relativity the Special and General theory, General press, Shree Maitrey Printech Pvt.Ltd., Noida.2012.

References:

1. S. K. Srivastava and K. P. Sinha, Aspects of Gravitational Interactions, Nova Science Publishers Inc. Commack, New York, 1998.
2. W. Rindler, Essential Relativity, Springer-Verlag, 1977.
3. R. M. Wald, General Relativity, University of Chicago Press, 1984.
4. S.R Roy and Raj Bali, Theory of Relativity, Jaipur publishing house 1989.

Organization of course

Total contact hrs 36		
1st week:	10 hrs (classes)	2 hrs (self-study/project)
2nd week:	10 hrs (classes)	2 hrs (Mid term exam/assessment/discussion)
3rd week:	10 hrs (classes)	2 hrs (End term exam)

Mode of lectures: Hybrid lecture/Hybrid videos/case study/ discussion/ workshop/ hands-on

Course Plan

S.No.	TOPICS	Session Outcome	Mode of Delivery	Mode of assessing the outcome
1	Introduction and Course Hand-out briefing : Definition of elementary functions.	Understanding the basics of Einstein theory	Hybrid Lecture	MTE-I Assignment & Quiz Test ETE
2-3	The special theory of relativity: Inertial frames of reference	Describe various properties of inertial frames	Hybrid Lecture	MTE-I Assignment & Quiz Test ETE
4	Postulates of the special theory of relativity	Discuss special relativity	Hybrid Lecture	MTE-I Assignment & Quiz Test ETE
5	Relative character of space and time	Relation between space and time	Hybrid Lecture	MTE-I Assignment & Quiz Test ETE
6-7	Derivation of special Lorentz transformation equations	Describe Lorentz equations	Hybrid Lecture	MTE-I Assignment & Quiz Test ETE
8	Composition of parallel velocities	Describe about formula of parallel velocities	Hybrid Lecture	MTE-I Assignment & Quiz Test ETE
9	Lorentz-Fitzgerald contraction formula	Describe about contraction formula	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
10-11	Lorentz contraction factor	Discussing Lorentz contraction factor derivation	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
12	Tensors: Introduction	Describe Basics of tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
13	Summation convention	Describe summation in tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
14	Transformation of coordinates	Discuss about coordinate system in different frames of references	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
15	Tensor of order zero	Explain properties tensors of order zero	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
16	Kronecker Delta	Defining Kronecker delta	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
17	Contra-variant tensors	Describe contra variant tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
18	Covariant tensors	Describe covariant tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test

				ETE
19-20	Tensors of higher order	Describe tensors of higher order	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
21	Symmetric and skew-symmetric tensors	Describe symmetric tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
22	Addition of tensors	Describe Properties of addition and subtraction in tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
23	Outer product of tensors	Describe product of tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
24	Inner product of two tensors	Describe inner product of tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
25	Contraction of tensors	Explain contraction in tensors	Hybrid Lecture	MTE-II Assignment & Quiz Test ETE
26	Introduction to cosmology	Introduce about cosmology	Hybrid Lecture	ETE Assignment & Quiz Test
27	Isotropy	Describing isotropy	Hybrid Lecture	ETE Assignment & Quiz Test
28	Homogeneity	Explaining homogeneity of space	Hybrid Lecture	ETE Assignment & Quiz Test
29	Basic equation of isotropic cosmology	Describe equation of isotropic cosmology	Hybrid Lecture	ETE Assignment & Quiz Test
30-31	Hubble constant	Derive Hubble constant	Hybrid Lecture	ETE Assignment & Quiz Test
32-33	Weyl postulate	Define Weyl postulate	Hybrid Lecture	ETE Assignment & Quiz Test
34	Cosmological principal	Explain cosmological principals	Hybrid Lecture	ETE Assignment & Quiz Test
35	Gaussian coordinate system	Describing Gaussian coordinate system	Hybrid Lecture	ETE Assignment & Quiz Test
36	introduction to FRW metric	Derive FRW metric	Hybrid Lecture	ETE Assignment & Quiz Test
37	Doppler effect or Red shift	Explain Doppler effect	Hybrid Lecture	ETE Assignment & Quiz Test

Brief profile of the instructor

Dr. Laxmi Poonia did her M.Sc., M.Phil. (Mathematics) and Ph.D. in Mathematics (Specialization: Relativity and Cosmology). She is presently working as Assistant Professor(8AGP) in Department of Mathematics and Statistics, Manipal University Jaipur, Rajasthan, India with over 16.9 years of teaching, research, and administrative experience. Dr. Laxmi has published more than 17 research papers in reputed journals, 01 patent and 1 copyright. She has credit of published 2 books on Engineering Mathematics and 01 Ph.D. is submitted under her supervision. Dr. Laxmi is a member of various national and international academic societies.
Mail Id: laxmi.poonia@jaipur.manipal.edu



Dr. Mohd. Rizwanullah did his M.Sc., M.Phil. (Operations Research) and Ph.D. in Mathematics (Specialization: Optimization). He is presently working as Associate Professor in Department of Mathematics and Statistics, Manipal University Jaipur, Rajasthan, India with over 19 years of teaching, research and administrative experience. Dr. Rizwan has published more than 30 research papers in reputed journals, 01 patent and 03 copyright. He has credit of published 3 books on Operations Research and Quantitative Techniques. 02 Ph.D. awarded under his supervision. Dr. Rizwan is a member of various national and international academic committee.
Mail Id: mohd.rizwanullah@jaipur.manipal.edu



Dr. Ram Naresh Saraswat did Ph.D. in Mathematics from MNIT Jaipur. He has 16 years' Teaching and research experience in various institutions. He has supervised 3 PhD thesis and 4 are under working. He was vice president of Rajasthan Ganita Parishad from 2017-2019. He has published 2 patent, two books and about 44 research papers in SCI/Scopus/WoS/refereed Journals. He is member of editorial and reviewer board of various reputed Journals. He is working as an Assistant Professor Department of Mathematics and Statistics Manipal University Jaipur. Mail id: ramnaresh.saraswat@jaipur.manipal.edu

