

Name of the Course: Physics Major Course 12
MJ - 12: Special Theory of Relativity (2 Credits)

Sr. No.	Heading	Particulars
1	Description the course (Including but Not limited to)	: Introduction, relevance, Usefulness, Application, interest, connection with other courses, demand in the industry, job prospects etc.
2	Vertical	: Major /Minor/Open Electives /Skill Enhancement / Ability Enhancement/Indian Knowledge System
3	Type	: Theory
4	Credits	: 2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	Hours Allotted	: 30 Hours
6	Marks Allotted	: 50 Marks
7	Course Objectives (CO): The students are expected to	
	CO 1.	familiarise with the Michelson-Morely experiment, Lorentz Fitzgerald contraction hypothesis, and ether drag hypotheses.
	CO 2.	understand and apply mathematical formulation of special theory of relativity through Lorentz transformations (space and time, velocity, momentum and energy, electric and magnetic fields), and its consequences (time dilation, length contraction velocity addition)
	CO 3.	introduce and explain the concept of relativistic mass and how it modifies the classical definitions of momentum and force in the context of special relativity.
	CO 4.	learn concept general relativity, equivalence principle, gravitational redshift, blueshift, and pulsars, quasars and blazars.
	CO 5.	apply the concept and solve numerical problems involving length contraction, time dilation, velocity addition, Doppler effect, relativistic mass, energy, momentum, transformations, and astrophysical phenomena.
8	Course Outcomes (OC): After successful completion of the course, the student will be able to	
	OC 1.	explain the significance of Michelson-Morely experiment and limitations of classical mechanics.
	OC 2.	derive and apply Lorentz transformation equations to space, time, velocity, momentum and energy, and electric and magnetic fields
	OC 3.	solve problems based on relativistic consequences such as time dilation, length contraction, Doppler effect, velocity addition, relativistic momentum, and energy
	OC 4.	demonstrate the relationship between mass and energy, analyze relativistic momentum and energy.
	OC 5.	explain the principle of equivalence, general relativity, and phenomena like gravitational redshift.
9	Modules / Units: - There will be One Module / Unit Per Credit	
	Module I / Unit I: Relativistic Kinematics (15 Hours)	
	(Review: Inertial and Non-inertial frames of reference, invariance of physical quantity, Galilean transformation, Newtonian relativity, Conflict of Newtonian mechanics with electromagnetism.) Michelson-Morely experiment (omit derivation part); Lorentz Fitzgerald contraction hypothesis, Ether drag hypothesis (conceptual) ; Postulates of the special theory of relativity, Concept of Simultaneity, Derivation of Lorentz transformation equations, Consequences of the Lorentz transformation equations: Length contraction, Time dilation; The Relativistic	

	addition of velocities and its consequences; Aberration and Doppler effect in relativity; Space–time diagrams, Twin paradox; Application: GPS Technology. Problem based on length contraction, time dilation, velocity addition, Doppler effect RR 1.5-1.7, 1.9, 2.1-2.3, 2.6-2.7, A1, B1, B2 Module II / Unit II: Relativistic Dynamics and Electromagnetism (15 Hours) (Review: Newton’s law of motion and momentum conservation, Energy conservation in classical mechanics, Basic of electric and magnetic fields.) Concept of relativistic mass (omit derivation), Relativistic definition of momentum and force; Relativistic force law and the dynamics of a single particle (Derivation $E=mc^2$, momentum and energy relation, longitudinal and transverse mass) ; The transformation properties of momentum, energy, mass; The transformation equation force (omit derivation); The interdependence of Electric and Magnetic fields, The transformation for E and B; The field of a uniformly moving point charge; The principle of equivalence and brief introduction to general relativity; Gravitational red shift, blue shift, pulsars, quasars ,blazars, Problem based on all above topics. RR 3.2-3.3, 3.5, 3.7, 4.2 -4.4, C2, C3											
10	Reference Books: 1. RR: Introduction to Special Relativity Wiley India Pvt. Ltd. by Robert Resnick (Student Edition) Additional Reference Books: 1. The Special Theory of Relativity PHI PVT Ltd by Srirajan Banarji & Asit Banerjee 2. A Prime of Special Relativity New Age International Publisher by P. L. Sardesai. 3. Special theory of Relativity CRC Press by A. P. French. 4. Concepts of Modern Physics 6th Edition McGraw Hill by Arthur Beiser.											
11	Internal Continuous Assessment: 40% (20 Marks)	External Assessment, (60%) (30 Marks)										
12	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. (at least 3)	Evaluation: through Exam at the End of the Semester / Term.										
13	Format of Question Paper for Semester End Examination Total Marks: 30 Marks Duration: One Hour <table border="1"> <tr> <td rowspan="2">Module I / Unit-I 15 Marks</td><td>Q.1 A) Attempt any Two (Each carry 05 Marks) i) Theory ii) Theory iii) Theory iv) Theory</td><td>10 Marks</td></tr> <tr> <td>Q.1 B) Attempt any One (Each carry 05 Marks) i) Problem /Theory ii) Problem</td><td>05 Marks</td></tr> <tr> <td rowspan="2">Module II / Unit-II 15 Marks</td><td>Q.2 A) Attempt any Two (Each carry 05 Marks) i) Theory ii) Theory iii) Theory iv) Theory</td><td>10 Marks</td></tr> <tr> <td>Q.2 B) Attempt any One (Each carry 05 Marks) i) Problem / Theory ii) Problem</td><td>05 Marks</td></tr> </table>		Module I / Unit-I 15 Marks	Q.1 A) Attempt any Two (Each carry 05 Marks) i) Theory ii) Theory iii) Theory iv) Theory	10 Marks	Q.1 B) Attempt any One (Each carry 05 Marks) i) Problem /Theory ii) Problem	05 Marks	Module II / Unit-II 15 Marks	Q.2 A) Attempt any Two (Each carry 05 Marks) i) Theory ii) Theory iii) Theory iv) Theory	10 Marks	Q.2 B) Attempt any One (Each carry 05 Marks) i) Problem / Theory ii) Problem	05 Marks
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