

Special and General Theory of Relativity PHY 407

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Course Objectives : The course is designed to cover Special Theory of Relativity at an advanced level utilizing techniques of Lorentz covariant four dimensional tensor analysis for the first half. The second half of the course provides an introduction to the General Theory of Relativity employing generally covariant tensor analysis in a component formulation leading upto the Einstein equations and the Schwarzschild solution.

Pre-requisites : There are no pre requisites but a first course in Special Theory of Relativity at the level of PHY 226B or equivalent will be helpful. Course is for 3rd year BS/B.Tech and MS/MSc students. Second year BS/B.Tech students are strongly advised not to register as the course will be above their level.

Evaluation: Online exams and quizzes. Modalities will be communicated by email.

- **2 Quiz: 20 + 20**
- **Mid Sem: 60**
- **End Sem: 100**
- **Total : 200**

Texts and References:

- Classical Mechanics by Goldstein (Chapter on Special Relativity)
- Classical Theory of Fields by Landau and Lifshitz
- Gravitation and Cosmology by Steven Weinberg
- Lecture Notes by Mathias Blau (available on the web)
- Lecture Notes by Sean Carroll or the book Space-time and Geometry

Consultation or Discussion: Discussion hour as per timetable (exact hour may be revised after course commences as per convenience). For emergency only, use mobile number provided in the contact section of my website.

Tips: Regular access of online course materials (including problem solving sessions) released one week in advance for every week and attendance of one hour live discussion session as per the time table (may be subject to change once the course commences). This is essential to remain up to date with course required to negotiate quizzes. Note that the course has no tutorials but problems will be solved during the lectures and problem sheets in PDF format are planned to be provided by email.

Fail Grade: Lack of effective study of online materials, problem solving and utilization of discussion hours along with lack of attention towards understanding of concepts may lead to a fail grade.

Online Lectures will be released one week in advance on appropriate platform via PDF screen share and embedded audio. This will be informed over the course email. PDF of lectures will also be shared.

DOAA Instructions: The copyright of all the course materials are owned by the authors of the books used for preparation of the lectures. This lecture material was distributed only to the students attending the course PHY407 of IIT Kanpur, and should not be distributed in print or through electronic media without the consent of the instructor. Students can make their own copies of the course materials for their use.

Lecture Plan : 40 Lectures

- Week 1. Inertial Frames. Galilean Principle of Relativity. Special Relativity and Lorentz transformations. Applications. (3)
- Week 2,3,4: General Tensor Analysis and Four dimensional formulation (9)
- Week 5 : Relativistic Mechanics. Four velocity and four momentum. Conservation Laws and energy momentum. (3)
- Week 6,7: Relativistic Collisions. (6)
- Week 8. Equivalence principle and General Covariance (3)
- Week 9,10,11: Covariant derivatives, Connections and Curvature (9)
- Week 12, 13: Einstein field equation and Schwarzschild solution (6 + 1)