Teach Yourself
Special Relativity

A set of 8 self-learning lectures by

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Goal: To enable students to learn this beautiful subject with zero or minimal assistance.

Assumed background: Pre-college algebra and trigonometry

Languages: Urdu and English

Duration: About 50 minutes each

Number of lectures: 16 (8 Urdu, 8 English)

Availability of lectures: All lectures are available for free download from the website of the Eqbal Ahmad Centre for Public Education http://eacpe.org/special-relativity/.

Suggested method of teaching: The lectures are too long and contain too much material to be absorbed in one sitting. The teacher should break at an appropriate point after roughly 8-10 minutes to engage students in a discussion. The lectures should be used in conjunction with any book of your choice that contains special relativity. Problems should be assigned after every lecture from that book.

Recommended Textbook: Feel free to choose your favorite one.

COURSE CONTENTS

Lecture 1: **Space and Time** 1. Relative motion 2. Space-time 3. Frames of reference 4. Galilean transformations 5. The search for ether	Lecture 2: **Einstein's Postulates** 1. Einstein's two postulates 2. Time dilation – first look 3. Length contraction – first look 4. Lorentz transformation – derivation 5. Time dilation and length contraction
Lecture 3: **Simultaneity and Causality** 1. Synchronizing clocks 2. Why simultaneity is relative 3. Revisit length contraction and time dilation 4. The invariant interval 5. Causality	Lecture 4: **Adding Velocities** 1. How we usually add velocities 2. Relativistic addition of velocities 3. The usual Doppler shift 4. Relativistic Doppler shift 5. Problems
Lecture 5: **Scalars, Vectors, and Tensors** 1. 4-Dimensional notation 2. Minkowski space 3. Einstein summation convention 4. The general Lorentz transformation 5. Scalars, Vectors, and Tensors	Lecture 6: **Momentum and Energy** 1. Proper time 2. Relativistic velocity 3. Relativistic momentum 4. Relativistic energy 5. Exercise
Lecture 7: **Applications of Relativity** 1. Rest energy and kinetic energy 2. Energy released in fission 3. Units of energy in nuclear physics 4. The energy and momentum of photons 5. Application	Lecture 8: **Relativity and Electromagnetism** 1. What are electric and magnetic fields? 2. Charges in motion. Currents. 3. Electric current as a 4-vector. 4. Electric and magnetic fields of a long wire. 5. Transforming electric and magnetic fields.