University of Science and Technology of Hanoi
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COURSE SYLLABUS

Subject: Introduction to Relativity **Academic field: Space and Application**

Lecturer: Tran Minh Hieu

Phone: 0983847769 **E-mail: tranminhhieu00@yahoo.com**

Academic year: 2013-2014

COURSE DESCRIPTION

Credit points	3 ECTS	
Level	Undergraduate	
Teaching time Location	University of Science and Technology of Hanoi	
Time Commitment	Lecture	28 hrs
	Exercises	8 hrs
	Total	36 hrs
Prerequisites	Advanced Mathematics: Linear Algebra, Multi-variables Analysis, Partial Differential Equations. General Physics	
Recommended background knowledge	Tensor Calculus	
Subject description:	This course introduces the basic ideas of Special Relativity: equivalence principal, Lorentz transformation, energy-mass relation. Relativistic effects and Applications of Special Relativity will also be given.	
Objectives & Out-come	*(Knowledge &/ Skills gained via the course)* Theory of Special Relativity, Application to electrodynamics	
Assessment/ Evaluation	Attendance/Attitude	%
	Exercise(s)	%
	Mid-term test	40 %
	Final exam	60 %
Prescribed Textbook(s)	[1] Resnick, Robert. *Introduction to Special Relativity*. New York, NY: Wiley, 1968. ISBN: 9780471717256. [2] French, Anthony Philip. *Special Relativity*. New York, NY: Norton, 1968. ISBN: 9780393097931.	

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COURSE CONTENTS & SCHEDULE

Class	Contents	Hours			Ref./Resources	Assignment(s)
		Lect.	Exr.	Prc.		
1	**Course Overview** • Related Subjects; Brief History of Physics	1			[1], [2], [5]	
2	**Symmetry and Invariance** • Background and History • Galilean Transformation, Inertial Reference Frames • Classical Wave Equations; Transformation to Other Frames • Michelson-Morley Experiment; ether; Postulates of Special Relativity • Minkowski Diagrams, World Lines	3	1		[1], [2], [5]	
3	**Relativistic Kinematics** • Derivation of Lorentz-Einstein Transformations • Matrix Representation of Lorentz transformation • Introduction of Four-Vectors • Simultaneity • Time Dilation and Length Contraction • Spacetime Intervals • First Discussion of Accelerated Clocks • Addition of Velocities	3	1		[1], [2], [5]	
4	**Relativistic Kinematics (cont.)** • Angle Transformation for Trajectories • Doppler Effect o Classical Doppler Effect for Sound o Relativistic Doppler Effect • Astrophysical Examples • Stellar Aberration • Doppler Effect and Angle Transformation via Transformation of Phase of Plane Waves • Fully Calibrated Minkowski Diagrams o Pole-Vaulter Problem o Twin Paradox	3	1		[1], [2], [5]	

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5	**Variational Calculus** • Short Discourse on the Calculus of Variations o Extremization of Path Integrals ▪ The Euler-Lagrange Equations and Constants of the Motion o Extremal Aging for Inertially Moving Clocks o Optional Problems in the Use of the Calculus of Variations as Applied to Lagragian Mechanics and Other Problems in the Extremization of Path Integrals • Relativistic Lagrangian for point-like particle	3			[1], [3]	
6	**Relativistic Dynamics** • Relativistic Momentum Inferred with Inelastic Collisions • Relativistic Relations between Force and Acceleration • Relativistic Version of Work-Energy Theorem o Kinetic Energy, Rest Energy, Equivalence of Mass-Energy o $E^2 - p^2$ Invariant • Nuclear Binding Energies	3	1		[1], [2], [5]	
7	**Relativistic Dynamics (cont.)** • Relativistic Motion in a B Field, Lorentz Force • Further Gedanken Experiments Relating to Mass-Energy Equivalence, Relativistic Momentum • Transformation of momentum, energy, mass, and force	3	1		[1], [2], [5]	
8	**Relativistic Dynamics (cont.)** • Formal Transformation of E and P as a Four-Vector o Revisit the Relativistic Doppler Effect • Relativistic Invariant $E^2 - p^2$ for a Collection of Particles • Quantum Nature of Light	3	1		[1], [2], [5]	
9	**Relativity and Electromagnetism** • Coulomb's Law • Transformation of Coulomb's Law • Force on a Moving Test Charge o Magnetic Field and Relativity o Derivation of Lorentz Force	3	1		[1], [2], [5]	

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	• The interdependence of E and B					
10	**Relativity and Electromagnetism (cont.)** • General Transformation Laws for E and B • Magnetic Force due to Current-Bearing Wire • Force between Current-Bearing Wires • Invariance of Maxwell's equations • Possible limitations of special relativity	3	1		[1], [2], [5]	

Notes:

- Abbreviation: Lect. (lecture), Exr. (Exercise), Prc. (Practise).
- Exercises may include assignment, reports, student's presentation, homework, class exercises ...for each class sessions
- Practicals mostly refer to Lab- work or outside practice such as field trip.

Reference Literature:

[1]. Resnick, Robert. *Introduction to Special Relativity.* New York, NY: Wiley, 1968. ISBN: 9780471717256.
[2]. French, Anthony Philip. *Special Relativity.* New York, NY: Norton, 1968. ISBN: 9780393097931.
[3]. Landau, Lifshitz, *Course of Theoretical Physics*, Vol.1 – Mechanics
[4]. Landau, Lifshitz, *Course of Theoretical Physics*, Vol.2 – The classical theory of fields
[5]. W. Rindler, *Introduction to special relativity*, Clarendon Press – Oxford, 1982