# Written Examination Special Relativity MFN 1313

## Academic Year 2014–2015: 15 September 2015, 2-4 PM

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**Please read the following INSTRUCTIONS**

**A. Answer at most TWO questions. You may answer in english or in italian. A pass is obtained for one complete answer.**

**B. You may not use notes or textbooks, but the course notes are available for consultation at the front desk.**

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**1.** Argue that the set of all Lorentz boosts is a group (the direction of the $x$ and $x'$ remaining the same). What are the physical meanings of the identity and the inverse of an element in this group? Is this group abelian? Given a pair of consecutive transformations corresponding to velocities $v_1$ and $v_2$, what is the velocity corresponding to the composition of the two transformations? Justify all answers.

**2.** In an inertial frame $S$ two photons of frequencies $\nu_1$ and $\nu_2$ travel in the positive and negative $x$ directions respectively.

a) Find the velocity of the CM (centre of mass) frame relative to $S$.

b) Calculate the photon frequencies in the CM frame

**3.** Consider a process with a number of initial and a number (maybe different) of final particles. Show that if total energy is conserved for all observers, then so is total three–momentum, and vice–versa.