Physics Course: Special Theory of Relativity

For B. Sc. (Hon.) Part-I

Paper - I

Dr. Sudhaker Upadhyay

Assistant professor

Department of Physics

K.L.S. College, Nawada

Email: sudhakeruadhyay@gmail.com

I.   TUTORIAL

1. The mean lifetime of stationary muons is measured to be 2.2 μs. The mean lifetime of high-speed muons in a burst of cosmic rays observed from Earth is measured to be 16 μs. What is the speed parameter β of these cosmic-ray muons relative to Earth?

2. A spaceship of rest length 130 m races past a timing station at a speed of $0.74c$. (a) What is the length of the spaceship as measured by the timing station? (b) What time interval will the station clock record between the passage of the front and back ends of the ship?

3. Observer S reports that an event occurred on the x axis of his reference frame at $x = 3 \times 10^8$ m at time $t = 2.5$ s. Observer S' and her frame are moving in the positive direction of the x axis at a speed of $0.4c$. Further, $x = x' = 0$ at $t = t' = 0$. What are the (a) spatial and (b) temporal coordinate of the event according to S?

4. A particle moves along the x' axis of frame S' with velocity $0.4c$. Frame moves with velocity $0.60c$ with respect to frame S. What is the velocity of the particle with respect to frame S?

5. A spaceship, moving away from Earth at a speed of $0.9c$, reports back by transmitting at a frequency (measured in the spaceship frame) of 100 MHz. To what frequency must Earth receivers be tuned to receive the report?

6. How much work must be done to increase the speed of an electron from rest to (a) $0.5c$, (b) $0.99c$, and (c) $0.999c$?

7. What must be the momentum of a particle with mass m so that the total energy of the particle is 3 times its rest energy?