THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY – LEVEL 05
FINAL EXAMINATION – 2014/2015
MPJ5231 – NATURE OF SCIENCE
FOUR HOURS (ESSAY TYPE PAPER)
OPEN BOOK EXAMINATION (OBE)

Date: 15th September 2015 **Time: 0930 hr. – 1330 hr.**

Answer any six (6) questions only

SECTION A

(1). (i). What was the role played by the concept 'ether' with regards to James Clerk Maxwell's theory of electromagnetism?
(ii). What was the purpose of the Michaelson-Morley (M-M) experiment?
(iii). Express the hypothesis that was proposed to explain the null result of M-M experiment.
(iv). What was Einstein's response to 'ether' hypothesis?
(v). What happens to Maxwell's laws of electromagnetism when Lorentz transformation is applied to them?
(vi). What was the modification that Einstein suggested to Newton's second law of motion?
(vii). The space and time coordinates of two events as measured in the reference frame S are as follows.

Event A: $x_1 = x_0,\ y_1 = 0,\ z_1 = 0,\ t_1 = \frac{x_0}{c}$

Event B: $x_2 = 3x_0,\ y_2 = 0,\ z_2 = 0,\ t_2 = \frac{x_0}{3c}$

Find the velocity of the frame S' relative to the frame S in which the above events A and B occur simultaneously.

(2). (i). Using the velocity transformation formula in the x - direction for frames S → S',

Prove that $\left(1-\frac{U_x^2}{c^2}\right)^{1/2} = \frac{\left(1-\frac{U_x'^2}{c^2}\right)^{1/2}\left(1-\frac{V^2}{c^2}\right)^{1/2}}{\left[1+\frac{U_x'V}{c^2}\right]}$

Where U_x U_x' and are velocities of a particle in the x-direction relative to frames S and S' respectively, V is the velocity of frame S' with respect to frame S, and c is the velocity of light.

(ii). According to the Special Theory of Relativity (STR) the inertial mass m of an electron moving with speed v is given by $m = m_0 \left[1 - \frac{v^2}{c^2}\right]^{-1/2}$ where m_0 is the rest mass of the electron and c is the speed of light.

(a). Use this equation to explain what happens to the mass m, if the electron is accelerated to speeds very close to that of light.

(b). How does the theory (STR) forbid electrons from traveling at speeds greater than c?

SECTION B

(3). Read the following passage and the Summary & Additional Notes for Unit 1 (MPJ5231) and answer the following questions.

Francis Bacon (1581-1626) is best known as the originator of the 'scientific method'. Bacon's reputation as the prophet of the new culture of the west has persisted even to the present era. One salient feature of Bacon's approach in gaining knowledge is that he declares freedom of knowledge from all the constraints of the prevalent ideas of good and evil. Having done that, he subjects it to a new overriding constraint; it should generate power. Power and utility are in fact the key concepts of Bacon's thought. Bacon asserted the knowledge in the pursuit of power ought to be organized by the King. All his books were addressed to the King. According to Bacon, knowledge is power over nature for the benefit of mankind. In his writings, nature appears almost as an enemy, to be dissected and tortured to make it yield its secrets. Bacon's 'nature' includes man, when he talks of knowledge as power over nature, power over man and other nations is also implied.

(i). Explain briefly the approach of Bacon towards nature in extracting the secrets of nature, according to the passage given above

(ii). Explain briefly Bacon's method of science.

(iii). According to the passage given above, give a brief description of Bacon's views on the relation between knowledge and power.

(iv). Briefly explain the following relationships

(a). Inductivism and Empiricism

(b). Hypothesism and Rationalism

(4). (i). What was the critique of David Hume regarding the principle of induction?

(ii). What was the argument put forward by inductivists to justify induction against Hume's critique?

(iii). Explain why Hume rejected the above mentioned argument to defense of induction.

(iv). Explain briefly how Hume's critique of the principle of induction shook the very foundations of science. (Hint: the link between induction and cause – effect relation)

(v). What was Hume's response to the problem of induction?

(5). (i). The argument on verification in science used by Logical Positivists goes as follows

$H \rightarrow P$	:	H implies P
P	:	P is true
$\therefore H$	:	Therefore H is true

Explain why the above argument is logically invalid.
How did Karl Popper overcome the difficulties inherent in the above argument?

(ii). Compare and contrast the views of Logical Positivists and Karl Popper regarding
(a). Observations (b). Theories is Science

(6). (a). For Karl Popper, revolutions are frequent in science, but for Thomas Kuhn, revolutions are rare occurrences in science.
Explain the above statement clearly, bringing out the views of Popper and Kuhn with regards to revolutions in science.

(b). Compare the views of Popper and Kuhn regarding the progress of science.

(7). Explain briefly the following relations
(i) . Falsification and demarcation criteria for science according to Popper
(ii). Auxiliary hypotheses and the main drawback of the method of falsification
(iii). Paradigms and Incommensurability according to Thomas Kuhn
(iv). "Anything goes' with regards to methodology of science according to Paul Feyerabend, citing Galileo's defense of Copernicus as example.

SECTION C

(8). Read the following passage and answer the given questions.

Many people who have not studied science are baffled by scientists' insistence that animal and plants are machines, and that humans are robots too, controlled by computer-like brains with genetically programmed software. It seems more natural to assume that we are living organisms, and so are animals and plants. Organisms are self-organizing; they form and maintain themselves, and have their own ends or goals. Machines, by contrast, are designed by an external mind; their parts are put together by external machine makers and they have no purposes or ends of their own.

The starting point for modern science was the rejection of the older, organic view of the universe. The machine metaphor become central to scientific thinking, with very far reaching consequences. In one way it was immensely liberating. New ways of thinking became possible that encouraged the invention of machines and the evolution of technology.

Before the seventeenth century, almost everyone took for granted that the universe was like an organism, and so was the earth.
Seventeenth century science created a vision of the universe as a machine intelligently designed and started off by God. Everything was governed by eternal mathematical laws, which were ideas in the mind of God. This mechanistic philosophy was revolutionary precisely because it rejected the animistic view of nature taken for granted in Medieval Europe.

Mechanistic science rejected these animistic doctrines and expelled all souls from nature. The material world became literally inanimate, a soulless machine. Matter was purposeless and unconscious; the planets and stars were dead. In the entire physical universe, the only non-mechanical entities were human minds, which were immaterial, and part of a spiritual realm that included angles and God. No one could explain how minds related to the machinery of human bodies, but Rene Descartes speculated that they interacted in the pineal gland, the small pine-cone-shaped organ nestled between the right and left hemispheres near the centre of the brain.

(i). Compare and contrast the world views (views regarding animals, plants and universe) before and after the birth of western science in the 17th century in Europe.

(ii). Briefly explain the salient features of mechanistic science according to the above paragraph.

(iii). How did Rene Descartes explain the interaction between mind and body.

(9). The following passage is taken from an article by Vandana Shiva, a physicist by training, a philosopher of science and a leading environmentalist.

Thomas Kuhn, Paul Feyerabend, Michael Polanyi and others have convincingly argued that modern science does not proceed according to a well-defined and stable scientific method. All that can be granted to reductionist science is that it is an approach, a way of looking, a mode of thought. Considering its predatory treatment of nature, attested to by the ecological crisis, it is indeed a very unreliable way.
Controlled experiment in the laboratory is a central element of the methodology of reductionist science. The object of study is arbitrarily isolated from its natural surroundings, from its relationship with other objects and observer(s). The context (the value framework) so provided determines what properties are perceived in nature, and leads to a particular set of beliefs about nature.
There is threefold exclusion in this methodology: (i). ontological, in that other properties are not taken note of; (ii). epistemological, in that other ways of perceiving and knowing are not recognized; and (iii). sociological, in that the non-expert is deprived of the right both of access to knowledge and of judging the claims of knowledge.

Science claims that since scientific truths are verifiable, they are justified beliefs and therefore universal, regardless of the social context. The verificationist model of science was forcefully

presented by positivism. It claimed that verification was direct observation of the 'facts' of nature, free from the proclivities of the observer. This was, however, challenged by post-positivist philosophers. Kuhn, for example, showed that facts and data in science are determined by the theoretical commitment of scientists. In other words, scientific facts are determined by the social world of scientists, not by the natural world.

While the Kuhnian model challenged the neutrality of scientific facts, it failed to provide an adequate epistemological framework for handling the violence of reductionist science. By insisting that 'nature fits into the realistic boxes of paradigms', Kuhn rendered his model of science materially and politically vacuous. Moreover, he failed to take into account the value system of the larger society that determines the choice of scientific research. Value-determination in the Kuhnian model is done by scientific paradigms, not by social, political, economic interests. By restricting itself to the social world of scientists, the Kuhnian model is unable to deal with the more significant value-determination of scientific facts by the demands made on the science system by economic interests. Moreover, by restricting himself to the material world of the lab, Kuhan was unable to deal with those ecological situations in which reductionist claims are falsified by nature, as symbolized by ecological crises.

(i). Explain briefly the methodology and the salient factures of a controlled experiment according to the above passage.

(ii). What are the main drawbacks of the controlled experiment according to the above passage.

(iii). Compare and contrast the views of Verificationists (Positivists) and Thomas Kuhn regarding 'facts and data' in science, according to the above passage.

(iv). Explain briefly the drawbacks and limitations of Kuhnian model by Vandana Shiva, according to the above passage.

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