



THE OPEN UNIVERSITY OF SRI LANKA  
 BACHELOR OF TECHNOLOGY – LEVEL 05  
 FINAL EXAMINATION – 2012/2013  
 MPJ5231 – NATURE OF SCIENCE  
 FOUR HOURS (ESSAY TYPE PAPER)  
 OPEN BOOK EXAMINATION (OBE)

Date: 24<sup>th</sup> August 2013

Time: 0930 hr. – 1330 hr.

The questions are grouped in the following manner.

Section A: 1-2

Section B: 3-7

Section C: 8-10

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.

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

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

Find the velocity of the frame S’ relative to 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  $S \rightarrow S'$ ,

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

Where  $U_x$  and  $U_x'$  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). Hypothesisism 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 justify induction on the grounds of circularity in argument.  
 (iv). Explain briefly how Hume's critique of the principle of induction shook the very foundations of science.  
 (v). What was Hume's response to the problem of induction?
- (5). Read the following passage and the Summary & Additional Notes for Unit 1 (MPJ5231), and answer the following questions.  
 It is freely admitted that new theories are conceived of in a variety of ways and often by a number of routes. They may occur to the scientist in a flash of inspiration, as in the mythical story of Newton's discovery or construction of the law of gravitation being triggered by his seeing an apple fall from a tree. Alternatively, a new discovery might occur as a result of an accident, as Roentgen was led to the discovery of X-ray by the constant blackening of photographic plates stored in the vicinity of his discharge tube. Or again, a new discovery might be arrived at after a long series of observations and calculations, as exemplified by Kepler's discoveries of his laws of planetary motion. Kekule's discovery of the molecular structure of the Benzene molecule is attributed to Kekule's dream of seeing six snakes joining to form a circular loop. Theories may be, and usually are, conceived of prior to the making of those observations necessary to test them. Constructions or discoveries of theories are highly creative acts which require genius and they defy logical analysis.
- (i). Give brief descriptions of the four ways of conceiving new theories (with relevant examples) in the passage given above .  
 (ii). Compare and contrast the views of the Logical Positivists and of the given passage regarding the conceiving of theories in science.  
 (iii). Explain briefly the views of Logical Positivists regarding (a) observations  
 (b). methodology of science.
- (6). (i). Based on Karl Popper's views, briefly explain the following relationships  
 (a). Falsification and Demarcation of science from non-science  
 (b). Falsification and Ad-hoc modification to theories  
 (c). Verisimilitude and Progress of science.  
 (ii). Describe briefly the major drawback of Karl Popper's method of falsification.
- (7). Based on the views of Thomas Kuhn, explain the following in brief.
- (i). The relationship between Paradigm and Normal science  
 (ii). The role played by the scientific community in bringing forth a Revolution in science.  
 (iii). The relationship between Paradigms and the uniqueness of science among other knowledge systems.

## SECTION C

- (8). Read the passage given below and the Session 14 of Unit 2 (page 101) "Reductionism and limits to science" in your course material of Nature of Science (MPJ5231), and answer the following questions.

According to Vandana Shiva, a physicist by training, a philosopher of science and a leading environmentalist, the nexus (bond) between modern science and violence is obvious from the fact that 80% of all scientific research is devoted to war industry and is frankly aimed at large-scale violence. She argues that modern science is violent even in peaceful domains such as health care and agriculture, where the professed objective of scientific research is not violence but human welfare. Her argument is based on the premise that modern science is basically reductionist. Reductionist science is also at the root of the growing ecological crisis.

Violence is inflicted on the subject socially through the sharp division between the expert and the non-expert. But even the expert is not spared. Fragmentation of knowledge converts the expert into a non-knower in fields of knowledge other than his/her specialization. In order to prove itself superior to alternative modes of knowledge and be the only legitimate mode of knowing, reductionist science resorts to suppression and falsification of facts and thus commits violence against science itself. Reductionism provided the assumptions and criteria which guide modern science. Those basic assumptions are:

- (a). a system is reducible to its parts
- (b). all systems are made up of the same basic constituents which are discrete and atomistic
- (c). all systems have the same basic processes which are mechanical.
- (d). sum total of knowledge of all the parts of a system gives knowledge of the whole system
- (e). 'experts' and 'specialists' are the only legitimate knowledge-seekers and knowledge justifiers.

All that can be granted to reductionist science is that it is an approach, a way to looking, a mode of thought.

- (i). How does Vandana Shiva explain the bond between modern science and violence according to the passage given above?
  - (ii). Explain briefly how the reductionist approach of modern science inflict violence against the society (laymen and experts) and against science itself, according to the above passage.
  - (iii). Explain briefly the major drawbacks of the two assumptions of Reductionism, namely (d) & (e) of the passage given above.
- (9). An important component of Feyerabend's analysis of science is his view on incommensurability, which has something in common with Kuhn's view. Feyerabend's conception of incommensurability stems from theory-dependence of observation. The meanings and interpretations of concepts and the observation statements that employ them will depend on the theoretical context in which they occur. In some cases the fundamental principles of two rival theories may be so radically different that it is not possible even to formulate the basic concepts of one theory in terms of the other with the consequence that the two rivals do not share any observation statements. In such cases it is not possible to logically deduce some of the consequences of one theory from the tenets of its rival for the purpose of comparison. The two theories will be incommensurable. One of Feyerabend's examples of incommensurability is the relationship between classical mechanics and relativity theory.

According to the former, physical objects have shape, mass and volume. Those properties exist in physical objects and can be changed as a result of physical interference. In relativity theory, properties such as shape, mass and volume no longer exist, but become relations between objects and a reference frame and can be changed, without any physical interaction, by changing from one reference frame to another. Consequently, any observation statement referring to physical objects within classical mechanics will have a different meaning to a similar looking observation statement in relativity theory. The two theories are incommensurable and cannot be compared by comparing their logical consequences. Some other pairs of incommensurable theories mentioned by Feyerabend are Classical Mechanics / Quantum Mechanics and Newtonian Mechanics/Impetus theory.

**Read the passage given above and answer the following questions**

- (i). What lies at the root of Feyerabend's conception of incommensurability?
  - (ii). According to the passage given above, explain briefly how Feyerabend describes the incommensurability of two rival theories.
  - (iii). Compare and contrast the interpretations of the properties of physical objects namely shape, mass and volume within the two incommensurable theories classical mechanics and relativity theory.
- (10). Another important aspect of Feyerabend's view of science concerns the relationship between science and other systems of knowledge. Feyerabend complains, with justification, that defenders of science typically judge it to be superior to other systems of knowledge without adequately investigating those other systems. Feyerabend is not prepared to accept the necessary superiority of science over other systems of knowledge. Further, in the light of his incommensurability thesis, he rejects the ideas that there ever can be a decisive argument in favour of science over other systems of knowledge incommensurable with it. If science is to be compared with other systems of knowledge, then it will be necessary to investigate the nature, aims and methods of science and those other systems of knowledge. This will be done by the study of historical records, textbooks, original papers, records of meetings and private conversations, letters and the like. It cannot even be assumed, without further investigation, that a system of knowledge under investigation must conform to the rules of logic as they are usually understood by contemporary philosophers and rationalists. Failure to conform to the demands of classical logic may well be, but is not necessarily, a fault. An example offered by Feyerabend concerns modern quantum mechanics. To consider the question whether the modes of reasoning involved in some version of quantum theory violate the dictates of classical logic or not, it is necessary to investigate quantum mechanics and the way in which it functions. Such an investigation may reveal a new kind of logic operating which can be shown to have certain advantages, in the context of quantum mechanics, over more traditional logic.

**Read the passage given above and answer the following questions**

- (i). What is the major objection of Feyerabend to the widely accepted view that modern science is superior to other knowledge systems?
- (ii). According to the passage given above, how should an investigation regarding a particular knowledge systems be done?
- (iii). What are the views of Feyerabend regarding classical logic and the logic involved in quantum mechanics?

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