THE OPEN UNIVERSITY OF SRI LANKA

BACHELOR OF TECHNOLOGY – LEVEL 05

FINAL EXAMINATION – 2015/2016

MPJ5231 – NATURE OF SCIENCE

OPEN BOOK EXAMINATION (OBT)

DURATION – FOUR (04) HOURS.

Date : 16th December 2016 **Time: 9.30 – 13.30 hrs.**

Answer any six (06) questions.

SECTION A

01. (i) State the Galilean Transformation equations.

(ii) What was the problem with Maxwell's laws of electromagnetism with regards to Galilean Transformation?

(iii) What did Lorentz notice with Maxwell's laws of electromagnetism and the new transformation he introduced, namely Lorentz Transformation?

(iv) What did Einstein postulate regarding the laws of physics?

(v) What was the bold decision that Einstein took with regards to Maxwell's laws of electromagnetism and Newton's laws of mechanics?

(vi) The two inertial frames of reference S and S' are such that S'moves with uniform velocity V along the x-axis relative to frame S. the space-time coordinates of the two events as measured by frame S are

$x_1 = 6 \times 10^4 m,\ y_1 = z_1 = 0,\quad t_1 = 1 \times 10^{-4} S$

$x_2 = 12 \times 10^4\, m,\ y_2 = z_2 = 0,\quad t_2 = 2 \times 10^{-4} S$

What must be the velocity of S', with respect to S, if an observer in S' measures the two events occur simultaneously?

02. (i) State the Relativistic Velocity addition formula (all three components along x, y and z axes)

(ii) F_1, F_2 and F_3 are three inertial frames. The mapping $F_1 \rightarrow F_2$ and $F_2 \rightarrow F_3$ are special Lorentz Transformations in x and y directions respectively such that the velocities for F_2 relative to F_1 and F_3 relative to F_2 are (v, 0,0) and $(0, v', 0)$ respectively.

Show that the velocity of F_3 relative to F_1 is $\left[v, v'\sqrt{1-\frac{v^2}{c^2}}, 0\right]$

(iii) Twin brothers T_1, T_2 are each 20 years old on earth (E), when T_2 sets off on a journey to a distant star S. T_2 moves with an uniform speed V for most of the journey and returns to earth E, by the same route with the uniform speed V. When T_2 arrives on earth, T_1 is 61 years old and T_2 is 29 years old.

a) Find V/c and the distance to the star from earth in light years.

b) How long will T_2 live after the death of his twin brother T_1 assuming that the span of life is 70 years.

SECTION B

03) Read the following passage and answer the questions given below.

Francis Bacon (1581-1626) is best known as the originator of the 'Scientific method' of discovery, or a 'new machine for the mind 'as Bacon himself prefers to call it. The method is such that it leaves no scope for the freedom of a person 's mind; it leads the mind along the correct path, 'not leaving it to itself, but directing it perpetually from the very first, and attaining our end as it were by mechanical aid'. Bacon is quite aware that the human understanding, left to itself, does not act as a mechanical engine. Man sees the world in his own image. And this image derives its features, from the nature of the mind in general, from the idiosyncrasies (peculiar characteristics or habits) of the individual, from the individual's interaction with others, and from the philosophical dogmas current at the time. Bacon realized that those aspects of the human condition which intervene between the world and man's understanding of it are important constraints on human knowledge.

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 that 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 writing, 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) According to the passage given above, why did Bacon preferred to call his 'Scientific method' a new machine for the mind?

(ii) What aspects of the human condition act as the important constraints in the process of gaining (acquiring) human knowledge according to the above passage?

(iii) According to the relevant session in your course material for (MPJ5231(Unit 1) on Francis Bacon's method of science, explain briefly the analogy given by Bacon to identify his method by comparing the methods of the craftsmen and the scholars of his era.

(iv) Explain briefly the method of induction introduced by Francis Bacon.

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

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

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

(ii) Explain briefly why Hume rejected the "argument of uniformity in nature" put forward by the inductivists to justify induction against Hume's critique.

(iii) Explain briefly the link between induction and cause-effect reduction (causality) by considering the procedure adopted by medical scientists in determining the cause of a particular fever (eg: malaria)

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

05) (i) Compare and contrast the views of Logical Positivists and Karl Popper regarding the following

(a) Observations (b) Theories of Science (c) Method of science

(ii) Why did Karl Popper reject ad-hoc modification to theories?

(iii) How does Karl Popper demarcate science from non science?

(06) (i) Explain briefly how Kuhn utilized his concept 'Paradigm' to explain the following

(a) Normal Science (b) Scientific Revolutions

(c) Incommensurability of Paradigms (d) Uniqueness of science

(ii) Compare the views of Karl Popper and Thomas Kuhn regarding the 'Progress of science'.(Hint: Use the concepts 'verisimilitude' and 'paradigm')

(07) Thomas Kuhn claims that western science is the uniquely valid knowledge system available to humanity, simply because no other culture has ever possessed any science. However, Kuhn does not happen to be an authority on non-western cultures and their sciences (eg. Chinese science and technology) Feyerabend complains, with justifications 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 idea that there ever can be a decisive argument in favour of science over other systems of knowledge incommensurable with it. If western science is to be compared with other systems of knowledge, then it will be necessary to investigate the nature, aims and methods of science of those other systems of knowledge. This will be done by the study of historical records, text books, original papers, records of meetings and private conversations, letters and the like.

Compare and contrast the views of Kuhn and Feyeraband regarding the uniqueness of western science among other knowledge systems according to the above passage.

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 given 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 the knowledge of all the parts of a system gives the 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 inflicts 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.

09. 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 observations. 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.

(ii) Compare and contrast interpretations of the properties of physical objects namely shape, mass and volume within the two incommensurable theories classical mechanics and relativity theory.

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