00171

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mathematics & Philosophy Of Engineering

Study Programme	: Bachelor of Technology Honours in Engineering Bachelor of Industrial Studies Honours
Name of the Examination	: Final Examination
Course Code and Title	**: MHJ5343Nature of Science**
Academic Year	: 2021/2022
Date	:1stof March 2023
Time	: 13:30 hrs. -17:30 hrs.
Duration	**: 4 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight(8)**questions in **Six (6)** pages.
3. Answer any **Six(6)**questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. **This is an Open Book Test(OBT).**
6. Answers should be in clear handwriting.
7. Do not use Redcolour pen.

(01). (i). What is the relation between 'ether' and 'Maxwell's theory of electromagnetism'? (15 marks)

(ii). What was the purpose of the Michaelson-Morley (M-M) experiment? (10 marks)

(iii). State the hypothesis that was proposed to explain the null result of the M-M experiment. (10 marks)

(iv). What was the problem with Maxwell's laws of electromagnetism with regards to Galilean transformation? (15 marks)

(v). What was the solution proposed by Lorentz regarding the problem mentioned above? (10 marks)

(vi). Two events P and Q occur simultaneously in a frame (F) and 300,000 km apart on its x-axis. Find the velocity of the frame (F'), moving parallel to the x-axis of F, in which the event P precedes the event Q by 10 seconds. (Velocity of light (c) = 3×10^5 km/sec) (40 marks)

(02). (i). Using the velocity transformation formula in the x - direction for frames S $\rightarrow$ 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 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. (50 marks)

(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. (25 marks)

(b). How does the theory (STR) forbid electrons from traveling at speeds greater than c? (25 marks)

(03). Read the following passage and the relevant sessions in the course materials of MHJ5343 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, form 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. Bacon was critical on both the Empiricists who refuse to generalize beyond the limited particulars of their observations, and the Sophists who make no or little contact with experiment. The true Baconian method thus achieves a golden mean, avoiding the pitfalls of both the Empiricists and the Sophists.

(i). According to the passage given above, why did Bacon preferred to call his 'Scientific method' a new machine for the mind? (20 marks)

(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? (20 marks)

(iii). Explain briefly the two extremes that Bacon tried to avoid in achieving a golden mean for the Baconian method. (20 marks)

(vi). Briefly explain the method of Induction advocated by Francis Bacon. (20 marks)

(v). Explain briefly the views of Francis Bacon regarding 'knowledge' and 'Power' (20 marks)

(04). (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. (25 marks)

How did Karl Popper overcome the difficulties inherent in the above argument? (25 marks)

(ii). Compare and contrast the views of Logical Positivists and Karl Popper regarding.

(a). Observations (25 marks)

(b). Theories areScience. (25 marks)

(05). Read the following passage with your relevant course materials (Unit 1 and Unit 2) and answer the given questions.

According to the Karl Popper, a theory is rejected as false only if we have an alternative which is better than the one at hand in the sense that it has more test implications, and a greater number of its test implications are already borne out. The growth of science is convergent in the sense that the successful part of the old theory is retained in the successor theory, with the result; the old theory becomes a limiting case of the new one. The growth of science thus shows continuity. In other words, it is the convergence of the old theory into the new that provides continuity in the growth of science. Popper is a realist in the sense, according to him, scientific theories are about an unobservable world. This means that according to him, the world of unobservable, though can never be captured entirely by our theories, is becoming more and more available to us. Popper contends that the greater and greater Verisimilitude (truth-nearness) attained by our theories progressively reduce the gap between the truth and our theory (though that gap can never be completely filled). Therefore, the real world of unobservable will be more and more like what our theories say, though not completely so.

But Popper's position regarding the growth (or progress) of science was heavily criticized by later philosophers of science like Thomas Kuhn and Paul Feyerabend. In this connection Popper sights the example of Newtonian theory (theory of motion) and Einsteinian theory (Special theory of relativity). But Popper overlooks the fact that in the actual history of science, such comparisons are very rare. For example, it is absurd to say that Phlogiston theory of combustion is the limiting case of Oxygen theory or Ptolemaic theory is the limiting case of Copernican theory. Even Popper's idea that our successive theories exhibit increasing degree of Verisimilitude is questionable. By this contention Popper means that the world is more like what our present theory says than what our earlier theory said. If so, following Popper we have to say, that the ultimate constituents of matter are more like fields (as contemporary theories of physics say) than particles (as classical physics said). But this is highly unintelligible. By characterizing the old theory as an approximation to the new one, Popper assumes that when a fundamental theory shift takes place, the meanings of the terms remain invariant. This assumption has been demolished by philosophers like Kuhn and Feyerabend by showing that the terms like 'mass', 'time', 'energy' etc. assuming different meanings in Newtonian and Einsteinian theories. Kuhn and Feyerabend have convincingly argued that a shift from one theory to another is accompanied by a shift in the meaning of the terms (concepts) that are common to both the theories. Thus, Popper's characterization of the growth of science, as continuous collapses.

(i). How does Karl Popper contend that the growth of science shows continuity? (20 marks)

(ii). How does Popper defend the continuity of the growth of science? (20 marks)
(Hint: Give an example from the history of science)

(iii). Considering the Copernican Revolution in science (ie. The shift from Ptolemy's theory to Copernican theory), show that Popper's view of the growth of science as continuous cannot be justified.
(30 marks)

(iv). Briefly explain the concept 'Verisimilitude' introduced by Karl Popper to explain the progress (growth) of science. (30 marks)

(06). (i). How does Thomas Kuhn utilize his concept 'Paradigm' to explain the process of science? (20 marks)

(ii). Briefly explain the role of scientific community during

(a). Normal science (20 marks)

(b). Revolutions of science (20 marks)

(iii). How does Thomas Kuhn explain the following?

(a). Incommensurability of successive paradigms (20 marks)

(b). Uniqueness of science among other knowledge systems. (20 marks)

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

Many people who have not studied science are baffled by scientists' insistence that animals 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. (40 marks)

(ii). Briefly explain the salient features of the mechanistic science according to the above paragraph. (40 marks)

(iii). How did Rene Descartes explain the interaction between mind and body. (20 marks)

(08). 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 (e.g., 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, textbooks, original papers, records of meetings and private conversations, letters, and the like.

Compare and contrast the views of Kuhn and Feyerabend regarding the uniqueness of western science among other knowledge systems according to the above passage and the relevant sessions of the Course Material MHJ5343. (100 marks)