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

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: MHJ5531/MPJ5231 Nature of Science**
Academic Year	: 2019/20
Date	:27th September 2020
Time	: 13:30- 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 **Seven (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 hand writing.
7. Do not use Red colour pen.

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

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

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

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

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

(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)

(2). (i). State the Relativistic Velocity Transformation (Addition) Formula (all three components along x, y and z axes).

(ii). An astronaut is in a spaceship which is travelling with velocity 0.8c relative to an observer on the earth. He fires a proton in the direction of motion at a velocity of 0.3c relative to the spaceship. Find the velocity of the proton, relative to the observer on earth. (c is the velocity of light).

(iii). 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?

(03). Read the following passage and the relevant sessions in the course materials of MHJ5531 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 wary of 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?

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

(vi). Explain briefly the method of Induction advocated by Francis Bacon.

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

(4). 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 overbooks 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?

(ii). How does Popper defend the continuity of the growth of science?
(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.

(iv). Explain briefly the concept 'Verisimilitude' introduced by Karl Popper to explain the progress (growth) of science.

(5). (i). Explain briefly the concept 'Paradigm' introduced by Thomas Kuhn.
Give two examples for Paradigms.

(ii). Briefly explain the following relationships based on Thomas Kuhn's views regarding the process of science
(a). Normal Science, Paradigm and Scientific Community
(b). Revolutions in Science, Paradigms, Anomalies and Scientific Community

(iii). Explain briefly the drawbacks of Thomas Kuhn's philosophy of science according to the critique of modern science namely Vandana Shiva.

(6). 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 and the relevant sessions of the Course Material MHJ5531.

(07). 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 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. In classical mechanics, 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.

(8). 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 became 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 the mechanistic science according to the above passage.

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

(iv). Based on the relevant session of the Course Material MHJ5531, state the Ontological and Epistemological assumptions of Reductionism which is extensively used in Western Science.