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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	: 2017/18
Date	:15th February 2019
Time	: 09:30- 13:30 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 (7)** 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.

SECTION A

01 (i). State the Galilean Transformation equations.

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

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

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

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

(vi). Why it took such a long time (nearly 200 years) to replace Newtonian Mechanics by Einstein's Relativistic Mechanics?

(vii). 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

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

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

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_2n 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 (i). Explain briefly the method of science advocated by Francis Bacon.

(ii). Explain briefly how the above-mentioned method of Bacon is linked with 'certainty' and 'breadth' in science.

(iii). Explain briefly the method of science advocated by Galileo.

(iv). Explain briefly how the above-mentioned method of Galilea is linked with 'novelty' and 'depth' in science.

(v). Compare and contrast the views of inductivists and Hypothesists regarding "Theoretical Entities (Terms)" in science.

(vi). Give two examples of theoretical entities.

04 (i). Explain briefly the views of 'Positivists' regarding the practice of various knowledge systems especially Social Sciences.

(ii). State two arguments against the view of Logical Positivists namely 'observations are theory independent'.

Give an example to justify your answer.

(iii). Explain briefly the views of Logical Positivists regarding the creation (construction) of theories.

(iv). Compare and contrast the methods of science advocated by Logical Positivists and Karl Popper.

05 (i). Explain briefly how Karl Popper applies his concept 'Verisimilitude' to describe the 'Progress of science'

(ii). Explain briefly the views of Karl Popper regarding 'Ad-hoc modification' of theories.

(iii). How does Popper apply his above-mentioned views regarding the ad-hoc modifications of theories to show that Karl Marx's theory on the evolution of societies is pseudo-science?

(iv). What is the main draw-back of Popper's method of falsification?

06. Briefly explain the following relationships based on Thomas Kuhn's philosophy of science.

(i). Normal Science, Paradigm and Scientific community

(ii). Revolutions in science, Paradigms, Anomalies and Scientific Community

(iii). Uniqueness of science, Paradigms and Schools of science

(iv). Progress of science, Paradigms and Puzzle solving

(vi). Incommensurability and Paradigms.

SECTION C

07. Read the following passages and answer the questions given below

Since Bacon, the goal of science has been knowledge that can be used to dominate and control nature, and today both science and technology are used predominantly for purposes that are profoundly anti-ecological.

The terms in which Bacon advocated his new empirical method of investigation were not only passionate but often outright vicious. Nature, in his view, had to be 'hounded in her wanderings', 'bound into service', and made a 'slave'. She was to be 'put in constraint', and the aim of the scientist was to 'torture nature's secrets from her. Much of this violent imagery seems to have been inspired by the witch trials that were held frequently in Bacon's time. As Attorney General for King James I, Bacon was intimately familiar with such prosecutions, and because nature was commonly seen as a female, it is not surprising that he should carry over the metaphors used in the courtroom into his scientific writings. Indeed, his view of nature as a female whose secrets have to be tortured from her with the help of mechanical devices is strongly suggestive of the widespread torture of women in the witch trials of the early seventeenth century. Bacon's work thus represents an outstanding example of the influence of patriarchal (Male dominant) attitudes on scientific thought.

The ancient concept of the earth as nurturing mother was radically transformed in Bacon's writings, and it disappeared completely as the Scientific Revolution proceeded to replace the organic view of nature with the metaphor of the world as a machine. This shift, which was to become of overwhelming importance for the further development of Western civilization, was initiated and completed by two towering figures of the seventeenth century, Rene Descartes and Isaac Newton.

Contd ...

Descartes' vision had implanted in him the firm belief in the certainty of scientific knowledge, and his vocation in life was to distinguish truth from error in all fields of learning. 'All science is certain, evident knowledge', he wrote. 'We reject all knowledge which is merely probable and judge that only those things should be believed which are perfectly known and about which there can be no doubts.'

The belief in the certainty of scientific knowledge lies at the very basis of Cartesian philosophy and of the world view derived from it, and it was here, at the very outset, that Descartes went wrong. Twentieth-century physics has shown us very forcefully that there is no absolute truth in science, that all our concepts and theories are limited and approximate. The Cartesian belief in scientific truth is still widespread today and is reflected in the scientism that has become typical of our Western culture. Many people in our society, scientists as well as non-scientists, are convinced that the scientific method is the only valid way of understanding the universe. Descartes' method of thought and his view of nature have influenced all branches of modern science and can still be very useful today. But they will be useful only if their limitations are recognized. The acceptance of the Cartesian view as absolute truth and of Descartes' method as the only valid way to knowledge has played an important role in bringing about our current cultural imbalance.

(i). Explain briefly the views and attitudes of Francis Bacon regarding 'Nature' according to the above passage.

(ii). Has it is evident from the above passage that Bacon's work represents the male dominant attitudes in the practice of science?

(iii). What is the hallmark of scientific knowledge according to Rane Descartes?

(iv). Explain briefly how the 20th century physics contradicts (proves wrong) the above-mentioned Descartes' views of scientific knowledge.

(v). What are the main facts that contributed to the current cultural inbalnce accruing to the above passage?

08. Read the following passages and answer the questions given below

Descartes created the conceptual framework for seventeenth-century science, but his view of nature as a perfect machine, governed by exact mathematical laws, had to remain a vision during his lifetime. He could not do more than sketch the outlines of his theory of natural phenomena. The man who realized the Cartesian dream and completed the Scientific Revolution was Isaac Newton, born in England in 1642, the year of Galileo's death. Newton developed a complete mathematical formulation of the mechanistic view of nature, and thus accomplished a grand synthesis of the works of Copernicus, Kepler, Bacon, Galileo, and Descartes.

Contd..

Newtonian physics, the crowning achievement of the seventeenth-century science, provided a consistent mathematical theory of the world that remained the solid foundation of scientific thought well into the twentieth century. Newton's grasp of mathematics was far more powerful then that of his contemporaries. He invented a completely new method, known today as Differential Calculus, to describe the motion of solid bodies; a method that went far beyond the mathematical techniques of Galileo and Descartes. The Newtonian universe was indeed one huge mechanical system, operating according to exact mathematical laws.

Before Newton there had been two opposing trends in seventeenth-century science; the empirical, inductive method represented by Bacon and the rational, deductive method represented by Descartes, Newton, in his Principia, introduced the proper mixture of both methods, emphasizing that neither experiments without systematic interpretation nor deduction from first principles without experimental evidence will lead to a reliable theory. Going beyond Bacon in his systematic experimentation and beyond Descartes in his mathematical analysis, Newton unified the two trends and developed the methodology upon which natural science has been based ever since.

In Newtonian mechanics all physical phenomena are reduced to the motion of material particles, caused by their mutual attraction, that is, by the force of gravity. The effect of this force on a particle or any other material object is described mathematically by Newton's equations of motion, which form the basis of classical mechanics. These were considered fixed laws according to which material objects moved and were thought to account for all changes observed in the physical world. In the Newtonian view, God created in the beginning the material particles, the forces between them, and the fundamental laws of motion. In this way the whole universe was set in motion, and it has continued to run every since, like a machine, governed by immutable laws. The mechanistic view of nature is thus closely related to a rigorous determinism, with the giant cosmic machine completely causal and determinate. All that happened had a definite cause and gave rise to a definite effect, and the future of any part of the system could-in principle – be predicted with absolute certainty if its state at any time was known in all details.

Contd...

At the same time, new discoveries and new ways of thinking made the limitations of the Newtonian model apparent and prepared the way for the scientific revolutions of the twentieth century. One of these nineteenth-century developments was the discovery and investigation of electric and magnetic phenomena that involved a new type of force and could not be described appropriately by the mechanistic model. The important step was taken by Michael Faraday and completed by Clerk Maxwell – the first one of the great experimenters in the history of science, the second a brilliant theorist. Faraday and Maxwell not only studied the effects of the electric and magnetic forces but made the forces themselves the primary object of their investigation. By replacing the concept of a force with the much subtler concept of a force with the much subtler concept of a force field they were the first to go beyond Newtonian physics, showing that the fields had their own reality and could be studied without any reference to material bodies.

(i). Explain briefly the main features of Newtonian physics which is considered to be the crowning achievement of the 17th century science that dominated well into the 20th century.

(ii). Explain briefly how Newton unified the two opposing trends in the 17th century science and developed the methodology of upon which science has been based ever since.

(iii). Explain briefly the main features of the mechanistic view of nature propagated by Isaac Newton.

(iv). What were the new discoveries and new ways of thinking that highlighted the limitations of the Newtonian model and prepared the way for the scientific revolution of the 20th century?

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