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Department of Examinations, Sri Lanka Department of **Department of Examinations, Sri Lanka** ns, Sri Lanka Department of Examinations, Sri Lanka
ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව
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අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2018 අගෝස්තු
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2018 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2018

08.08.2018 / 1300 – 1500

තර්ක ශාස්ත්‍රය හා විද්‍යාත්මක ක්‍රමය I		පැය දෙකයි
අளவையியலும் விஞ்ஞானமுறையும் I	**24 E I**	இரண்டு மணித்தியாலம்
Logic and Scientific Method I		**Two hours**

Instructions:

* Answer **all** questions.
* Write your **Index Number** in the space provided in the answer sheet.
* Instructions are given on the back of the answer sheet. Follow those carefully.
* In each of the questions **1** to **50**, pick one of the alternatives from (1), (2), (3), (4), (5) which is **correct** or **most appropriate** and **mark your response on the answer sheet with a cross** (×) **on the** number of the correct option in accordance with the instructions given on the back of the answer sheet.
* Each question carries **02** marks making a total of **100** marks.

N.B.

* Logical constants used in this paper are the following:

Negation: ~, Implication: →, Conjunction: ∧, Disjunction: ∨, Biconditional: ↔
Universal quantifier : ∧, Existential quantifier : ∨

1. Aristotelian logic is based on,
   (1) term analysis.
   (2) propositional analysis.
   (3) term as well as propositional analysis.
   (4) mathematical analysis.
   (5) inductive analysis.

2. Galileo made observations of the irregular surface of the Moon
   (1) with his naked eye.
   (2) through his telescope.
   (3) both with his naked eye and through the telescope.
   (4) during an eclipse of the Sun.
   (5) on a Full-moon day.

3. Which of the following sentence express the logical meaning, in terms of traditional logic, of the proposition, 'There are honest teachers.'?
   (1) Teachers are honest.
   (2) Some teachers are honest.
   (3) All teachers are honest.
   (4) Honest persons are teachers.
   (5) This teacher is honest.

4. Natural observations differ from experiments as
   (1) natural observations cannot be repeated.
   (2) measurement is not possible in natural observations.
   (3) instruments cannot be used in natural observations.
   (4) in natural observations, the observed phenomena are observed in their natural state only.
   (5) natural observations are not made to test theories.

5. The argument
   "All cats are wild animals.
   Some horses are wild animals.
   Therefore horses are cats."
   (1) is valid.
   (2) commits the fallacies of illicit minor and illicit major.
   (3) commits the fallacy of undistributed middle.
   (4) commits the fallacies of undistributed middle and illicit minor.
   (5) commits the fallacies of undistributed middle and illicit major.

[see page two

6. Patient *X* is admitted to the hospital and a nurse using a mercury thermometer recorded that *X* had high fever with the thermometer reading at 105 °F. After treatment the next day the thermometer reading came down to 102 °F. On the third day it recorded 98.4 °F and *X* was discharged. The basis of this fever determinations is
   (1) the specialist training of nurses to diagnose fever.
   (2) that mercury is able to identify different types of fever.
   (3) that mercury expands when heated.
   (4) that mercury expands when heated and contracts when the temperature falls.
   (5) the prevalence of the influenza virus in the neighbourhood at the time.

7. The ground of all factual or contingent truth, according to Leibniz is the
   (1) law of identity.   (2) law of non-contradiction.
   (3) law of sufficient reason.   (4) law of double negation.
   (5) law of excluded middle.

8. Together with measurement and mathematization, instruments lead to scientific data being predominantly and increasingly expressed in
   (1) observational terms.   (2) empirical terms.
   (3) rational terms.   (4) quantitative terms.
   (5) qualitative terms.

9. In general, when one qualifies a term more and more, its
   (1) denotation increases.
   (2) connotation increases and denotation decreases.
   (3) connotation decreases and denotation increases.
   (4) both connotation and denotation increase.
   (5) connotation increases only.

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10. In a correct inductive inference, if the premises are true then the conclusion is
    (1) true.   (2) certain.   (3) probable.   (4) valid.   (5) false.

11. Which of the following statements about 'Inversion' is true?
    (1) The inverse of an 'O' proposition is an 'I' proposition.
    (2) The inverse of an 'I' proposition is an 'E' proposition.
    (3) The inverse of an 'A' proposition is an 'E' proposition.
    (4) The inverse of an 'E' proposition is a particular proposition.
    (5) The inverse of an 'I' proposition is a particular proposition.

12. In the traditional square of opposition, the sentences are contradictory, if
    (1) their quality is different.   (2) their quantity is different.
    (3) both their quality and quantity are different. (4) they are 'A' and 'E' propositions.
    (5) they are 'I' and 'O' propositions.

13. The microscope and the telescope were instruments that revolutionized early scientific knowledge. The characteristic/s of the propagation of light which were utilized by those instruments for the revolutionary discoveries was/were
    (1) refraction.   (2) reflection.
    (3) refraction and reflection.   (4) the constant unsurpassable velocity of light.
    (5) diffraction.

14. The mean deviation of the five values 3, 5, 6, 7, 10 is
    (1) 1.90   (2) 1.84   (3) 2.10   (4) $\sqrt{3}$ (5) 1.56

15. The symbolic sentences $(P \wedge Q)$ and $\sim(\sim P \vee \sim Q)$ are
    (1) tautologically equivalent.   (2) contradictory.
    (3) having no determinable relation.   (4) contrary.
    (5) neither tautologically equivalent nor contradictory.

16. A novel prediction by Copernicus which Galileo verified was that
    (1) Jupiter has four moons.
    (2) Moon has craters.
    (3) Venus has phases.
    (4) All bodies dropped at the same height reach the ground simultaneously.
    (5) The acceleration of a freely falling body near the surface of the Earth is a constant.

17. What is the number of ways in which five people may be seated round a table?
    (1) 24   (2) 60   (3) 96   (4) 120   (5) 180

18. If A, B, C are non-empty classes and $AB = \phi$, $BC = \phi$, $AC \neq \phi$ then
    (1) $ABC = \phi$ (2) $A\bar{B} = \phi$ (3) $B\bar{C} = \phi$ (4) $A\bar{C} \neq \phi$ (5) $\bar{A}\,B\bar{C} \neq \phi$

19. The syllogism
    "Aeroplanes do not have life.
    Aeroplanes fly in the sky.
    Therefore nothing which flies in the sky has life."
    (1) is valid.
    (2) commits the fallacy of illicit major.
    (3) commits the fallacy of illicit minor.
    (4) commits the fallacy of the undistributed middle.
    (5) commits the fallacy of four terms.

20. Dalton introduced the Atomic theory of matter as an explanation of a certain experimental observation. This observation was that
    (1) chemical elements combine in constant, simple whole number numerical ratios by weight when they combine to form chemical compounds.
    (2) water is not an element but a compound.
    (3) molecules consist of atoms.
    (4) in gases, particles are in constant motion.
    (5) atoms of different elements have different weights.

21. Two dice are thrown. What is the probability of getting 1 up only from one dice?
    (1) $\frac{10}{36}$ (2) $\frac{1}{36}$ (3) $\frac{1}{3}$ (4) $\frac{1}{6}$ (5) $\frac{5}{36}$
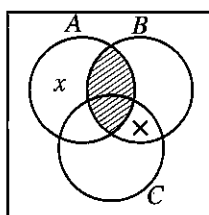
22. If A, B, C are three classes such the $AB = \phi$, $C \neq \phi$ and $x \in A\bar{C}$, which of the following Venn diagrams would represent these correctly?
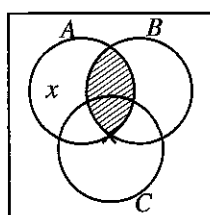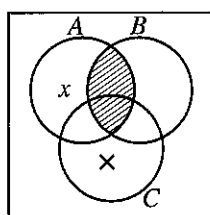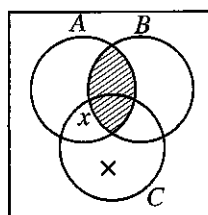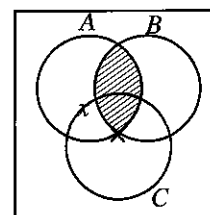

    (1)   (2)   (3)   (4)   (5)

23. Which of the following is the correct truth tree for the argument $(P \leftrightarrow Q) \cdot (Q \rightarrow R) \therefore (P \rightarrow R)$?

    (1)   (2)   (3)   (4)   (5)

24. What is the mode of the range of the following sequences of numbers?

7,	13,	1,	38,	110
67,	52,	11,	17,	89
46,	20,	21,	37,	120
21,	80,	57,	18	
1,	7,	21,	63	

(1) 60   (2) 62   (3) 82   (4) 89   (5) 103

25. In "Two of five the Hawaiian women were not wearing flower garlands."
  (1) no term is distributed.
  (2) the subject is distributed.
  (3) only the predicate is distributed.
  (4) neither the subject nor the predicate is distributed.
  (5) both the subject and the predicate are distributed.

26. Galileo discovered that a projectile has a parabolic path by
  (1) dropping metal balls from the leaning tower of Pisa.
  (2) observations of the path taken by gunshots.
  (3) observing the movement of the hands of the clock at the Pisa church.
  (4) observing the path taken by stones thrown by him.
  (5) mathematical analysis.

27. No A are B. Therefore
  (1) some B are A.   (2) some B are not A.
  (3) no B are A.   (4) all A are B.
  (5) only some B are A.

28. Karl Poppers' falsificationist methodology is based on
  (1) inductive generalization.   (2) induction by enumeration.
  (3) casual analysis.   (4) modus ponens.
  (5) modus tollens.

29. An expression equivalent to $\sim (P \leftrightarrow Q)$ which uses only negation and disjunction would be
  (1) $((\sim P \vee Q) \vee (\sim Q \vee P))$ (2) $((P \vee Q) \vee (\sim P \vee \sim Q))$
  (3) $((P \vee Q) \vee \sim (\sim P \vee \sim Q))$ (4) $\sim (\sim (\sim P \vee Q) \vee \sim (\sim Q \vee P))$
  (5) $(\sim (\sim P \vee Q) \vee \sim (\sim Q \vee P))$

30. A theory is considered to explain
  (1) the observed phenomena.
  (2) laws in its field.
  (3) both observed phenomena and laws in its field.
  (4) the causes of phenomena.
  (5) the initial conditions used.
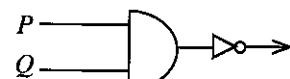
31. Which of the following logic gates could be taken as a representation of $\sim (P \rightarrow \sim Q)$?

(1)   (2)   (3)

(4)   (5)

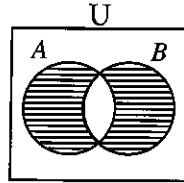**32.** Marx's economic analysis is characterized by basing value on
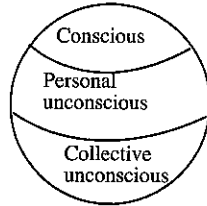 (1) Capital.   (2) Price.   (3) Labour.   (4) Use.   (5) Technology.

33.

The classes A and B shown in the diagram are
(1) empty. (2) null class. (3) identical.
(4) together exhaust the universe. (5) disjoint.

34. Which of the following psychologists considered the psyche to be structured as shown in the diagram?

(1) Jean Piaget
(2) Sigmuad Freud
(3) Anna Freud
(4) Carl Jung
(5) Alfred Adler

35. On the basis of the scheme of abbreviation,
$\quad F : a$ is a student,
$\quad G : a$ throws stones,
$\quad H : a$ is caught.
'Many students threw stones but not all of them were caught.'
(1) $\Lambda x \ (Fx \rightarrow Gx) \land (Vx \ (Fx \land {\sim}Gx) \rightarrow {\sim}Hx)$
(2) $Vx \ (Fx \land Gx) \land ({\sim}Vx \ (Fx \land {\sim}Gx) \lor {\sim} Vx \ Hx)$
(3) $Vx \ (Fx \land Gx) \land {\sim}\Lambda x \ ((Fx \land Gx) \rightarrow Hx)$
(4) $\Lambda x \ (Fx \rightarrow Gx) \land \Lambda x \ ((Fx \land Gx) \rightarrow {\sim}Hx)$
(5) $Vx \ (Fx \land {\sim}Gx) \land (Vx \ (Fx \land {\sim}Gx) \land Hx)$

36. Lucasian Professor of Mathematics at Cambridge, Mathematical physicist, cosmologist, the first scientist to show that black holes could emit radiation, author of 'A Brief History of Everything', addict of Wagner's music:
To which of the following scientists does all the attributes given above?
(1) Lord Rutherford (2) Sir Isaac Newton
(3) Stephen Hawking (4) Abdus Salam
(5) P.A.M. Dirac

37. Karl Popper cited the cases of Freudian Psychoanalysis and Marxism as non-sciences which appear as sciences, as they are non-testable (or non falsifiable) due to
(1) no experiments being possible in the social sciences.
(2) the unclarity, wideness, indefiniteness of their concepts.
(3) their field of application being too wide.
(4) the impossibility of having crucial tests in the social sciences.
(5) the impossibility of objective tests in the social sciences.

38. "Phlogiston is what makes substances burn. Therefore Phlogiston is the cause of combustion." The above argument commits the fallacy of
(1) ignoratio elenchi.
(2) appeal to authority.
(3) fallacy of division.
(4) circular argument (petitio principii).
(5) after this, therefore because of this (post hoc ergo propter hoc).

39. Crucial tests between two successive paradigms are **not** possible according to relativists because
    (1) the succeeding paradigm encompasses the earlier paradigm.
    (2) the two paradigms are incommensurable and they have no invariant observation language.
    (3) the results of crucial tests could agree.
    (4) paradigm change is based more on conversion than on logic.
    (5) anything goes as method.

40. Which of the following formulae follow, from the formula ($Fx \rightarrow Gx$) by existential generalisation?
    (1) ∇y ($Fy \rightarrow Gy$)
    (2) ∇y ($Fy \rightarrow Gx$)
    (3) ∇y ($Fx \rightarrow Gx$)
    (4) ∇y $Fy \rightarrow \nabla y$ Gy
    (5) ∇x $Fx \rightarrow Gy$

41. In the Covering Law Model of Explanation an event is explained by a covering law when
    (1) they event implies the law.
    (2) the covering law is true and the event is in the field of the covering law.
    (3) the covering law, together with the initial conditions and auxiliary hypotheses, implies the event.
    (4) the event is the cause of the covering law.
    (5) when there is a one-one relationship between cause and event.

42. Which of the following is a theorem?
    (1) ∇x ($Fx \wedge Gx$)
    (2) ($P \leftrightarrow Q$)
    (3) (($\sim P \vee Q$) $\rightarrow$ ($\sim Q \rightarrow \sim P$))
    (4) (Λx $Fx \leftrightarrow \sim \Lambda y$ Fy)
    (5) ($P \rightarrow Q$)

43. The study of light (optics) before Isaac Newton's work is categorized by Thoman Kuhn as
    (1) normal science.
    (2) science in a different paradigm.
    (3) pre-science.
    (4) mature science.
    (5) revolutionary science.

44. The expression 'x is brave,' where x is a variable, is
    (1) true.
    (2) false.
    (3) a valid statement.
    (4) neither true nor false.
    (5) a symbolic formula.

45. An outstanding example of a successful use of models in scientific research was
    (1) Einstein's General Theory of Relativity.
    (2) Lavoisier's Oxidation theory of combustion.
    (3) Darwin's Theory of Evolution.
    (4) Louis Pasteur's development of a method of treating hydrophobia.
    (5) The discovery of the structure of the DNA molecule

46. Considering 'All men are not mortal.' to be ambiguous, the usual two meanings given it can be expressed in symbolic form, (F: a is a man G: a is mortal) by
    (1) Λx ($Fx \rightarrow \sim Gx$) and ∇x ($Fx \wedge Gx$)
    (2) $\sim \Lambda x$ ($Fx \rightarrow Gx$) and Λx ($Fx \rightarrow Gx$)
    (3) ∇x ($Fx \wedge Gx$) and ∇x ($Fx \wedge \sim Gx$)
    (4) Λx ($Fx \rightarrow \sim Gx$) and ∇x ($Fx \wedge \sim Gx$)
    (5) $\sim \nabla x$ ($Fx \wedge Gx$) and ∇x ($Fx \wedge Gx$)

47. Use of ad hoc hypotheses in scientific method is advocated by
    (1) Popper.
    (2) Francis Bacon.
    (3) Lakatos.
    (4) Kuhn.
    (5) Feyerabend.

48. Which of the following is the correct truth table line for the determination of the validity/invalidity of the argument,

$$(P \wedge Q) \cdot (R \rightarrow \sim Q) \quad \therefore \quad \sim Q$$

by the indirect truth table method?

(1) TTT   FFFF   FFTT
(2) FFF   TTTT   FTTT
(3) FTF   TFTF   FFFT
(4) TTT   TFTF   TFFT
(5) TTT   TTFF   FFFT

49. Feyerabend says that Lakatos is a disguised anarchist because
   (1) Feyerabend is an anarchist and Lakstos has been his friend.
   (2) Lakatos does not give a clear cut means of choosing between competing programmes or rejecting a programme.
   (3) Lakatos' method is not realistic.
   (4) negative heuristic is a vague concept.
   (5) the given method of developing the protective belt is only a skeletal.

50. A social scientist studying the outcome of the February 10, 2018 Local Government Council elections in Sri Lanka bases his study on data gathered through e-mail communication by him. His sample for this study is
   (1) small.   (2) fair.   (3) not fair.
   (4) giving correct predictions.   (5) stratified.

✳✳✳

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව **ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව** විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව
இலங்கைப் பரீட்சைத் திணைக்களம் இலங்கைப் பரீ**ட்சைத் திணைக்களம்** இ**லங்கைப் பரீட்சைத் திணைக்களம்** இலங்கைப் பரீட்சைத் திணைக்களம்
Department of Examinations, Sri Lanka Department o**f Examinations**, Sri Lanka Department of Examinations, Sri Lanka Department of Examinations, Sri Lanka
ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙ**Department of Examinations, Sri Lanka** දෙපාර්තමේන්තුව ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව
இலங்கைப் பரீட்சைத் திணைக்களம் இலங்கைப் பரீ**ட்சைத் திணைக்களம்** இலங்கைப் பரீட்சைத் திணைக்களம் இலங்கைப் பரீட்சைத் திணைக்களம்

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2018 අගෝස්තු
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2018 ஓகஸ்ட்
General Certificate of Education (Adv. Level) Examination, August 2018

තර්ක ශාස්තුය හා විද්‍යාත්මක කුමය	**II**			
அளவையியலும் விஞ்ஞானமுறையும்	**II**	24 E II		10.08.2018 / 1400 – 1710
Logic and Scientific Method	**II**			

පැය තුනයි / மூன்று மணித்தியாலம் / ***Three hours***	අමතර කියවීම් කාලය - මිනිත්තු 10 යි / மேலதிக வாசிப்பு நேரம் - 10 நிமிடங்கள் / **Additional Reading Time - 10 minutes**

Use **additional reading time** to go through the question paper, select the questions and decide on the questions that you give priority in answering.

Instructions:

* Answer only **eight** questions selecting **four** questions from each of the Parts **I**, and **II**.

N.B.

* Logical constants used in this paper are the following:
  Negation: ~, Implication: →, Conjunction: ∧, Disjunction: ∨, Biconditional (Equivalence): ↔
  Universal quantifier : ∧, Existential quantifier : V

* Candidates are advised **not** to use any other logical constants.

* Candidates should **not** use theorems (**e.g.** De Morgan's theorem) in the derivations except when the theorem itself has been proved by the candidate.

Part I

1. (a) What is obversion? What is the obverse of the proposition 'Some men are non-beaf eaters'?   *(04 marks)*

   (b) What is the sub-altern of the sentence 'No men are mortal'?   *(02 marks)*

   (c) Identify terms of the sentence 'Rivers with blue water flow smoothly' and state their distribution.   *(04 marks)*

2. (a) Determine whether the following syllogisms are valid or invalid. When a syllogism is invalid state the rule/rules violated and the resulting fallacy/fallacies.

   (i) Some birds sing sweetly.
   The cuckoo sings sweetly.
   Therefore, the cuckoo is a bird.   *(03 marks)*

   (ii) All girls are pretty.
   Some girls speak Tamil.
   Therefore, some who speak Tamil are pretty.   *(03 marks)*

   (b) Symbolize the following arguments in terms of classes and determine their validity using Venn diagrams.

   (i) All men are mortal. Therefore some men are mortal.   *(02 marks)*

   (ii) Women are attractive.
   Parrots are attractive.
   There are women. There are parrots.
   Therefore women are parrots.   *(02 marks)*

3. (a) "Each and every sense perception is not a scientific observation. Only when a sense perception is related to a scientific problem or hypothesis, it becomes a scientific observation." Elucidate. *(05 marks)*

   (b) Discuss, bringing in examples, the factors that could cause non-observation and mal-observation. *(05 marks)*

4. (a) Show that, if the square root expressing the standard deviation is taken to the nearest integer, the mean deviation of the numbers 1, 3, 7, 10, 14 is 80% of their standard deviation. *(05 marks)*

   (b) What is the probability of drawing a heart, a spade and a diamond, when three cards are drawn from a pack of 52 playing cards without replacing the cards drawn? *(05 marks)*

5. (a) Draw the logic gate to represent $(\sim Q \rightarrow P) \rightarrow (P \rightarrow Q)$, expressing implications in terms of conjunctions. *(04 marks)*

   (b) Prove the following theorems.
      (i) $(((P \rightarrow Q) \rightarrow P) \rightarrow P)$ *(03 marks)*
      (ii) $(((P \lor Q) \land ((P \rightarrow R) \land (Q \rightarrow R))) \rightarrow R)$ *(03 marks)*

Part II

6. (a) Indicate how
      (i) the case study method, *(03 marks)*
      (ii) use of samples *(04 marks)*
      are useful in social scientific investigation.

   (b) (i) "Statistical analysis is predominantly used in social sciences but not in natural sciences." How far is this statement justifiable? *(04 marks)*
      (ii) 'The ability to predict is what social science lacks.' Discuss. *(04 marks)*

7. (a) Symbolize the following arguments giving your scheme of abbreviation and show them to be valid by the method of derivation.
      (i) Given that labour is cheap foreign investments will flow, if there are no strikes. But, the foreign investments do not flow. Therefore either labour is not cheap or there are strikes. *(05 marks)*
      (ii) Not both the Minister and the Secretary will go. The Minister goes. Therefore the Secretary will not go or if the Secretary protests the conference will not be held. *(05 marks)*

   (b) Symbolize the following argument giving your scheme of abbreviation and determine its validity/invalidity using the indirect method of truth tables.
      If Chanakya enjoys conflict, just in case conflict helps Chandragupta, then Chanakya divides the country. But he does not divide the country. Therefore it is not the case that if Chanakya enjoys conflict then conflict helps Chandragupta.
      (Any values given to variables in your working should be clearly indicated.) *(05 marks)*

8. "Methodology of science is rational reconstruction of the method of the scientist. In that context, it appears that the deductive verificationist methodology is the methodology that best reflects the activity of the scientist." Discuss. *(15 marks)*

9. (a) Determine the validity of the arguments $\sim Q \therefore ((P \rightarrow Q) \rightarrow (\sim P \rightarrow Q))$ using the method of truth trees.

(05 marks)

(b) Symbolize the following arguments, using predicate calculus and giving your schemes of abbreviation and show them to be valid by derivation.

(i) If all Indians got trapped but Vijaya did not get trapped, then Vijaya was not an Indian.

(04 marks)

(ii) No non-beautiful things are flowers.
This (object) is a rose and it is a flower.
Therefore this (object) is beautiful or the Schliemann's dream gave the correct directions to Troy.

(Where appropriate, you may also use variables in propositional calculus).

(06 marks)

10. Write notes on the following:

(i) Successive paradigms in a science are incommensurable and inconsistent

(ii) Feyerabend's Methodology of Science

(iii) Social Responsibility of Electronic Media

(05 × 3 = 15 marks)

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