End Semester Examination

PHI455: Philosophical Logic

HSS, IIT Kanpur

General Instructions: Read carefully each question. Fill in your with a pen and circle the correct answer on paper as well. All your work must be done in these pages.

- You have up to 180 minutes.
- You must attach rough work with your answers.
- Extra 45 minutes will be given for uploading answers and scanned copies.
- For each Wrong answer 0.5 marks will be deducted.
- Please ensure that you keep a copy of your rough work and save it somewhere for future reference. Save it with the course number and and your roll number. You need to attach scanned copy of your rough work.
- Every item on the test of part-A awards 2 points for each correct answer, PartB is for 40M. for a maximum possible score of 80 points.
- Multiple choice questions may have more than one answer. Circle each of the correct answer. Rough work needs to be attached.
- Each Question in part-B consists of 10 marks each. For each wrong answer 1.5 M will be deducted.

SIDE A

Part I. True or False Questions. 20M

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1. The following argument is valid in Epistemic Logic- $KTD4$. $K_a\,(A \wedge B) \rightarrow K_a \wedge K_a B$

   A. True B. False

2. In Epstemic Logic *b sees a* is represented as $K_b(K_a B \vee K_a \neg B)$.

   A. True B. False

3. An instance of paradox of material implication, i.e., $p \rightarrow (q \rightarrow p)$, does not hold in Luckasewicz's three valued logic (L_3^s)

   A. True B. False

4. Let a_p is an assertion or truth operator in Bochvar's semantics. Then the following formula is a tautology: $a_P P \vee a_P \neg P$

   A. True B. False

5. Let ϕ, ψ be formulas in LK, and let Ka be an epistemic operator for $a \in A$. Let M be the set of all Kripke models, and $S5$ the set of Kripke models in which the accessibility relation is an equivalence. The following is an instance of Logical omniscience: $M \models (Ka\,\phi \wedge Ka\,\psi) \rightarrow Ka\,(\phi \wedge \psi)$

   A. True B. False

6. We will say that a formula is a *quasi tautology* if it is never false. Based on this definition, $(A \vee \neg A) \rightarrow (B \wedge \neg B)$ is a quasi tautology in `LP` Logic.

   A. True B. False

7. If roses are red and violets are blue, then roses are not red. The above statement interpreted in RM3: $(R \wedge B) \rightarrow \neg R$ is a quasi contradiction.

   A. True B. False

8. In Bochvar's internal three valued Logic, the statement *Either roses are red(p) and violets are blue(q), or roses are red only if violets aren't blue.* has a value 1/2 when both p and q takes value 1/2.

   A. True B. False

9. The following argument is invalid. *I know he is either in his room or in the library.* It follows from this that *Either I know he in his room or I know he is in the library.*

   A. True B. False

10. In any three valued logic, we say that a set of formulas (Γ) entails a formula P, whenever all of the formulas in Γ are true, P is true as well. It means, there is no truth value assignment on which all the formulas in Γ have the value T, while P has the value F or N. So If $\Gamma \models_{K_3^s} P$, then $\Gamma \models P$.

    A. True B. False

11. In Epistemic logic the following wff is valid. $E_G(\phi \wedge C_G\,\phi) \rightarrow C_G\,\phi$.

    A. True B. False

12. The well formed formula $[p \to (q \to p)] \to p \to q$ is a tautology in Bochvar's three valued logic (B_3^I).

    A. True B. False

13. The well formed formula $p \to (q \to p)$ is not a tautology in Kleene's weak three valued Logic (K_3^w).

    A. True B. False

14. If there is a convention among a group that ϕ, then everyone knows ϕ , everyone knows that everyone knows ϕ, everyone knows that everyone knows that everyone knows ϕ, and so on ad- infinitum. In such a case, we say that the group has common knowledge of ϕ.

    A. True B. False

15. *A student thinks that he can secure A in PHI455 course*can be interpreted in Kripke semantics as $(M, w) \models K_i\phi$ iff$(M, w_i) \models \phi$ for all $w1$ such that $w\, R_i w1$.

16. $p, q \to \neg p \models \neg q$ holds(valid) in LP but not in $RM3$.

    A. True B. False

17. Let $W = \{w, v\}$ and $Ri = \{(w, v), (w, w), (v, v), (v, w)\}$ and p is true in w where as it is false in v. The following well formed formula is true in w, i.e., $M, w \models \neg Ki\, p$.

    A. True B. False

18. Every one knows ϕ is represented as $\bigcap_{i \in A} K_i\, A$.

    A. True B. False

19. The following example is an instance of distributive knowledge. If a knows that every political leader is interested in nationalism, and b knows that ND Modi is a political mass leader, then there is distributed knowledge among a and b that ND Modi is interested in Nationalism, even if none of the agents needs to know this.

    A. True B. False

20. Not every entailment that holds in classical propositional logic holds in $B3^I$ as well.

    A. True B. False

21. The following instances of paradox of material implication

    1. $\neg p \models (p \to q)$
    2. $q \models (p \to q)$ are valid in

    A. L3

    B. L3, K3, but not B_3^I

    C. K3, B_3^I

    D. None of the above.

    E. All systems mentioned above.

22. Which of the following well formed formulas are Quasi tautologies or Quasi contradictions in the three valued logic: LP and RM3:

    1. $p \wedge \neg p$
    2. $p \vee \neg p$
    3. $p \leftrightarrow \neg p$
    4. $p \to (q \to p)$

    A. RM3

    B. LP

    C. neither of them

    D. Both LP, RM3

    E. Your Answer (if any)

23. Let P be a set of atomic propositions and A a set of agents (both enumerable). An epistemic model $M = \{W, Ri, V\}$, is defined as where $W = \{w, u, v\}$ is the non-empty set of possible worlds, $Ri \subseteq (WxW)$ is agent i's indistinguishability relation, and Rj is agent's j's indistinguishability relation. V is a valuation function. For both i, j the following are true in state w, u, v.

    1. $M, w \models \{p, q\}$ and $M, u \models \{\neg p, q\}$ and $M, v \models \{p, \neg q\}$
    2. Accessibility relations for i, j are as follows:
       (a) $R_i = \{(w, w), (u, u), (w, u), (u, w)\}$
       (b) $R_j = \{(w, w), (v, v), (w, v), (v, w)\}$

    Which of the following wffs are ture in a state w.

    1. $K_i\, p \vee \neg\, K_i\, p$
    2. $K_j\, p \vee K_j\, p$
    3. $K_i\, (p \vee \neg p)$
    4. $K_j\, p \vee \neg\, K_a\, \neg\, p$
    5. $E_G\, (p \vee \neg p)$
    6. $C_G\, [(p \wedge \neg p) \to q]$

    A. 1

    B. 3

    C. 1,3,5

    D. 5

E. 6

F. Your Answer (in case you dont find any answer).

24. The following inference is valid in the following three valued logic.

$$\{p \to q,\ (p \to \neg p) \to q\} \models q$$

A. L3

B. K3(Weak)

C. B3 (internal)

D. B3 external

E. All

F. None of the above.

Part III. Rough Work

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Part I11. Rough Work