



INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR  
Mid-Autumn Semester Examination 2023-24

Date of Examination: 18/09/2023 Session: AN Duration: 2 Hrs Full Marks: 50  
Subject No. AI61005 Subject: Artificial Intelligence: Foundations and Applications  
Department/Center/School: Centre of Excellence in Artificial Intelligence  
Specific charts, graph paper, log book etc., required NO  
Special Instructions (if any) : Answer all the parts of a question in same place

- 1) [5] Given a maximization problem, prove that the tree-search version of  $A^*$  is optimal, if the heuristic function is admissible.
- 2) [5 + (3+2+5+5)]
  - a) Discuss the key differences between  $A^*$  search and the 'Depth First Branch and Bound (DFBB)' strategy?
  - b) You are given a set of  $n$  coins having denominations:  $c_1, c_2, \dots, c_n$ , and you wish to give a change of sum  $S$  using a minimum number of coins. You need to design a DFBB solution strategy for this problem. [Example: Suppose, you are given four coins having denominations: Re. 1, Rs. 2, Rs. 2 and Rs. 10. To give a change of  $S = 5$ , you will need three coins]
    - i) Describe how you can represent a 'state' in this problem.
    - ii) Define the 'start' and 'goal' states.
    - iii) Define your 'state transformation rules' to explore the whole state space.
    - iv) Propose an efficient heuristic in order to prune the state space.
- 3) Prove the following goal (G) from the given premises (F1, F2, F3, F4, F5, F6) using Resolution-Refutation. Show the steps in detail. [6]

F1: Anyone who rides Harley is a rough character  
F2: Every biker rides either Harley or BMW  
F3: Anyone who rides BMW is a yuppie  
F4: Every yuppie is a lawyer  
F5: Any nice girl does not like anyone who is a rough character  
F6: Mary is a nice girl and John is a biker

G: If John is not a lawyer then Mary does not like John
- 4) Convert the following logic formula to CNF. Show step by step computations: [6]
$$\forall x (P(x) \rightarrow (\forall y (P(y) \rightarrow P(f(x,y))) \wedge \neg \forall y (Q(x,y) \rightarrow P(y))))$$
- 5) Write a Prolog program to count the number of times an integer element appears in a list of integers. Explain execution with an example. [5]
- 6) Prove logical equivalence in the following formula using proposition logic without truth table. [3]
$$P \leftrightarrow Q \equiv (P \wedge Q) \vee (\sim P \wedge \sim Q)$$
- 7) Convert following sentences in predicate logic [2+2+1]
  - a) At most one Republican candidate can win the election.
  - b) Some boys in the class are taller than all the girls.
  - c) No person is perfect.