Ref. No. : **Ex/PG/CSE/T/114A/2024**

M.E. COMPUTER SCIENCE AND ENGINEERING 1st Year 1st Semester EXAMINATION 202024

Advances in Artificial Intelligence

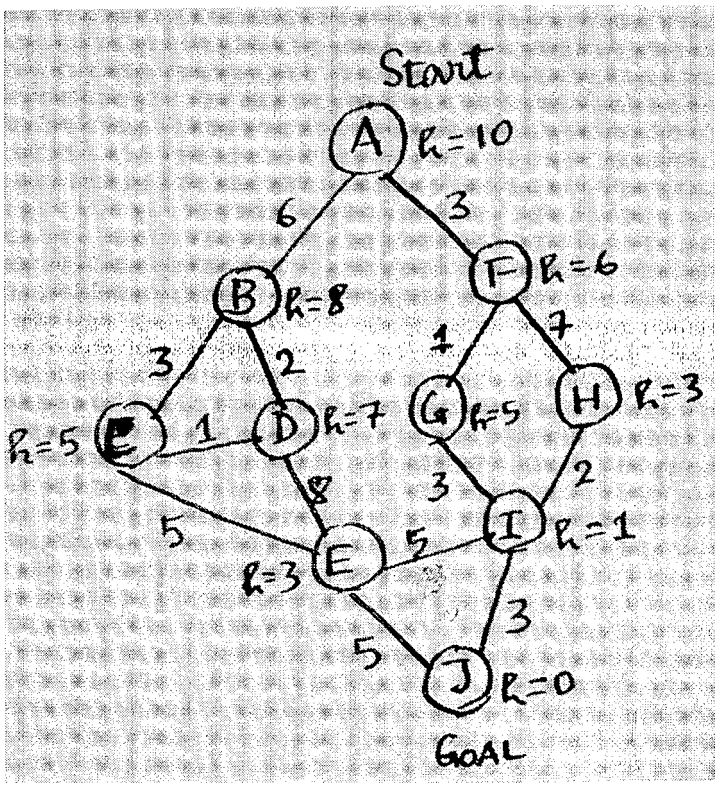
All questions carry equal marks

Answer any FIVE

Time: Three hours **Full Marks: 100**

1(a) Consider the following graph representing the State Space of some problem with the heuristic values of node n, i.e., h(n), provided in the following Table:

Node(n)	h(n)
A	10
B	8
C	5
D	7
E	3
F	6
G	5
H	3
I	1
J	0



Let A be the start node and J be the goal node. Apply A* algorithm on the graph to find the least costly path from node A to node J.

Draw the search tree, produced as a result of this search process. Label the nodes in the tree with numbers to indicate the order in which the nodes are expanded. Also label all the nodes in the search tree with their respective f values and finally highlight the least costly path from A to J in the tree through bold lines.

(b) Assume that A* is admissible. On this assumption, prove that for any node n selected for expansion by A*, $f(n) \leq f^*(s)$.

(c) Let A_1 and A_2 be two versions of A^* algorithm. What is the precondition for A_2 being more informed than A_1. What advantage can A_2 provide being more informed than A_1.

(d) Briefly discuss how a weighted heuristic function may be used to enhance the power of an Evaluation function.

8+4+4+4

2(a) What are the problems that may arise if State space search is applied for generating plans in real world? How can Sense/Plan/Act Architecture developed by Nilsson be of help in such situations?

(b) Describe Island Driven Search. How can this be helpful in dealing with scarcity of resources and the practical constraint on the time for plan generation?

10+10

3(a) How temporal difference learning can be employed to learn suitable weight values for a heuristic function expressed as the weighted sum of different sub functions? Give some idea on how this learning algorithm can be extended when we have no prior knowledge about the effects of the agent's actions. Or in other words, can temporal learning take place in the actual world?

(b) Define an optimal action policy π^* for an agent. Describe how an optimal policy can be learnt.

10+10

3(a) To solve what kind of problems Genetic Algorithms (GAs) are applied? Give description of the Simple Genetic algorithm. What are the advantages of GAs over traditional methods?

(b) Consider the problem of finding the shortest route through several cities, such that each city is visited only once and in the end return to the starting city (the Travelling Salesman problem). Suppose that in order to solve this problem we use a genetic algorithm, in which genes represent links between pairs of cities. For example, a link between London and Paris is represented by a single gene 'LP'. Let also assume that the direction in which we travel is not important, so that LP = PL.
i) How many genes will be used in a chromosome of each individual if the number of cities is 10?
ii) What is the maximum number of genes that may be present in a population?

(3+7+4)+(3+3)

4(a) Convert the following Well formed formula into clauses:

$(\forall x)\ [\sim(\forall y)\ \{P(f(x,y)) \wedge (\exists z)\ (\sim Q(y,z) \Rightarrow P(g(z)))\} \wedge P(x)]$

(b) Find a most general unifier (mgu) of $\{P[f(x),y,g(y)],\ P[f(x),z,g(x)]\}$

(c) Prove the validity of the following Well formed formula using the method of resolution refutation:

$(\exists x)\{[P(x) \Rightarrow P(A)] \wedge [P(x) \Rightarrow P(B)]\}$

10+4+6

5(a) Justify the working principle of the resolution refutation system that finds proofs by contradiction.

(b) Consider the following sentences:

Anyone passing BE and studying ME is happy. Anyone who is genius or is intelligent can pass all his/her exams. John is not genius but he is intelligent. Anyone who is intelligent studies ME.

Using resolution refutation, answer "Is John happy?" Also mention the Control strategy, used here.

(c) What is the major limitation of the Resolution refutation system, applied on real world problems? How and at what cost automatic reasoning can be made efficient?

4+12+4

6(a) Explain the working principle of a perceptron as a linear classifier with a geometric interpretation.

(b) Mention one major limitation of the perceptron as pointed out by Minsky and Papert (1969).

(c) Describe Back Propagation learning algorithm giving its major steps of operation.

(d) Define training set, validation set and test set.

(e) What is Overfitting in neural networks? How can you manage this problem while training a Multi Layer Perceptron?

3+2+7+3+5

7(a) Mention few sources of uncertainty in real world knowledge. Why Predicate calculus is not sufficient for reasoning under uncertainty?

(b) State and prove the Bayes' theorem for two complementary hypotheses H and ~H, and evidence E.

Using Bayes' theorem, answer the following:

Hunter says that she is itchy. There is a test for Allergy to cats. But this test is not always right.

The people who really do have the allergy test positive 80% of the time.

The people who really do not have the allergy tests positive 10% of the time.

1% of the population have the allergy.

If Hunter tests positive, what is the chance that she really has allergy?

(c) Let **A** stands for **Alllergy, F** for **Flu, C** for **Cold** and **P** for **Pneumonia.** For some patient, the focus of diagnosis is restricted within the set **U= {A, F, C, P}.** Two different sources of evidence support the following beliefs, denoted by m_1 and m_2:

m_1{F,C}=0.48, m_1{A,F,C}=0.32, m_1{F,C,P}=0.12, m_2{A}=0.9.

Use Dempster-Shafer theory to find the combined beliefs for **Allergy** or **A**

3+11+6