Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL 576104

(Constituent College of Manipal University)

SIXTH SEMESTER B.TECH(IT,CCE) DEGREE MAKE UP EXAMINATION-JULY 2016
SUBJECT:ELECIVE-I ARTIFICIAL INTELLIGENCE & APPLICATION (ICT 328)
(REVISED CREDIT SYSTEM)

TIME: 3 HOURS **-/07/2016** **MAX. MARKS: 50**

Instructions to candidates

- Answer any **FIVE FULL** questions. All questions carry equal marks.
- Missing data if any, may be suitably assumed.

1A. With neat diagram, briefly explain the following agent types

i) Simple reflex agent
ii) Model-based agent
iii) Goal-based agent
iv) Utility-based agent
v) Learning agent

1B. Give the `pseudocode` for the following uninformed search strategies:

i) Uniform-cost search
ii) Depth-limited search.

1C. To what extent are the following computer systems instances of artificial intelligence:

i) Coupon vending machine at MIT food court
ii) Voice activated train enquiry system
iii) Web search engine
iv) Interaction with Apple's Siri or Microsoft's Cortana.

[5+3+2]

2A. Consider the sensorless version of the erratic vacuum world. Draw the belief-state space reachable from the initial belief state {1,2,3,4,5,6,7,8}, and explain why the problem is unsolvable.

2B. In the following, a "max" tree consists only of max nodes, whereas an "expectimax" tree consists of a max node at the root with alternating layers of chance and max nodes. At chance nodes, all outcome probabilities are nonzero. The goal is to find the value of the root with a bounded-depth search. For each of the following, either give an example or explain why this is impossible

i) Assuming that leaf values are finite but unbounded, is pruning (as in alpha-beta) ever possible in a max tree?
ii) Is pruning ever possible in an expectimax tree under the same conditions?
iii) If leaf values are all nonnegative, is pruning ever possible in a max tree? Give an example, or explain why not.

iv) If leaf values are all nonnegative, is pruning ever possible in an expectimax tree? Give an example, or explain why not.

v) If leaf values are all in the range [0, 1], is pruning ever possible in a max tree? Give an example, or explain why not.

vi) If leaf values are all in the range [0, 1], is pruning ever possible in an expectimax tree?

2C. The TREE-CSP-SOLVER (see Figure Q.2C) makes arcs consistent starting at the leaves and working backwards towards the root. Why does it do that? What would happen if it went in the opposite direction?

[5+3+2]

3A. Brown, Jones, and Smith are suspected of a crime. They testify as follows:

- Brown: Jones is guilty and Smith is innocent.
- Jones: If Brown is guilty then so is Smith.
- Smith: I am innocent, but at least one of the others is guilty.

Let b, j, and s be the statements "Brown is innocent, "Jones is innocent, "Smith is innocent.

i) Express the testimony of each suspect as a propositional formula.

ii) Are the three testimonies consistent?

iii) The testimony of one of the suspects follows from that of another. Which testimony follows from which other testimony?

iv) Assuming everybody is innocent, who committed perjury?

v) Assuming all testimony is true, who is innocent and who is guilty?

vi) Assuming that the innocent told the truth and the guilty told lies, who is innocent and who is guilty?

3B. Consider a sentence in predicate logic

$$\neg\exists x(p(x) \wedge \forall y(q(y) \rightarrow r(x, y))).$$

Express the given formula in *conjunctive normal form*.

3C. Consider the argument, "*No books are gaseous. Dictionaries are books. Therefore, no dictionary is gaseous*". Consider the following predicates:

i) $B(x)$: x is a book

ii) $G(x)$: x is gaseous

iii) $D(x)$: x is a dictionary

Express the given argument in a predicate logic sequent.

[5+3+2]

4A. Up to now we have assumed that the plans we create always make sure that an action's preconditions are satisfied. Lets now investigate what propositional successor-state axioms such as $HaveArrow^{t+1} \Leftrightarrow (HaveArrow^t \wedge \neg Shoot^t)$ have to say about actions whose preconditions are not satisfied.

i) Show that the axiom predict that nothing will happen when an action is executed in a state where its preconditions are not satisfied.

ii) Consider a plan p that contains the actions required to achieve a goal but also includes illegal actions. Is it the case that

$$\textit{initial state} \wedge \textit{successor-state axioms} \wedge p \vDash \textit{goal}?$$

iii) With first-order successor-state axioms in situation calculus, is it possible to prove that a plan containing illegal actions will achieve the goal?

4B. Consider a sequent, $p \rightarrow (p \rightarrow q), p \vdash q$.

i) Convert the given sentence into clausal form

ii) Using resolution principle, check whether the given sequent is valid.

4C. This question concern issues with substitution and Skolemization. Suppose that a procedure that converts first-order logic to clausal form incorrectly Skolemizes $\forall x \exists y P(x, y)$ to $P(x, Sk0)$, that is, it replace y by a Skolem constant rather than a Skolem function of x. Show that an inference engine that uses such a procedure will likewise allow $\exists q P(q, q)$ to be inferred from the premise $\forall x \exists y P(x, y)$.

[5+3+2]

5A. Here are two sentences in the language of first-order logic:

ϕ $\forall x \exists y (x \geq y)$

ψ $\exists y \forall x (x \geq y)$

i) Assume that the variables range over all the natural numbers $0, 1, 2, \ldots, \infty$ and that the "$\geq$" predicate means "greater than or equal to." Under this interpretation, translate ϕ and ψ into English.

ii) Is ϕ true under this interpretation?

iii) Is ψ true under this interpretation?

iv) Does ϕ logically entail ψ?

v) Does ψ logically entail ϕ?

5B. Sudoku is introduced as a CSP to be solved by search over partial assignments because that is the way people generally undertake solving Sudoku problems. It is also possible, to attack these problems with local search over complete assignments. How well would a local solver using the min-conflict heuristic do on Sudoku problems?

5C. Is it possible to speed up the performance of classical alpha-beta pruning? If yes, then explain your technique.

[5+3+2]

6A. Consider a knowledge-engineering problem for the circuit given in Figure Q.6A. List the generic steps involved in knowledge engineering, and express the following axioms to your knowledge base in first-order logic

i) An OR gate's output is 1 if and only if any of its inputs is 0.

ii) An XOR gate's output is 1 if and only if its inputs are different.

iii) A NOT gate's output is different from its input.

iv) The gates (except NOT) have two inputs and one output.

v) A circuit has terminals, up to its input and output arity, and nothing beyond its arity.

Consider the same ontology as discussed in the class.

6B. Give a PDDL description of a spare tire problem.

6C. Let c and d be constants, f^1, g^2 and h^3 be function symbols, P^3 and Q^3 are predicate symbols. Which of the following strings are formulas in predicate logic?

i) $\forall x P(f(d), h(g(c, x), d, y))$

ii) $\forall x P(f(d), h(P(x, y), d, y))$

iii) $\forall x Q(g(h(x, f(d), x), g(x, x)), h(x, x, x), c)$

iv) $\exists z(Q(z, z, z) \rightarrow P(z))$

[5+3+2]

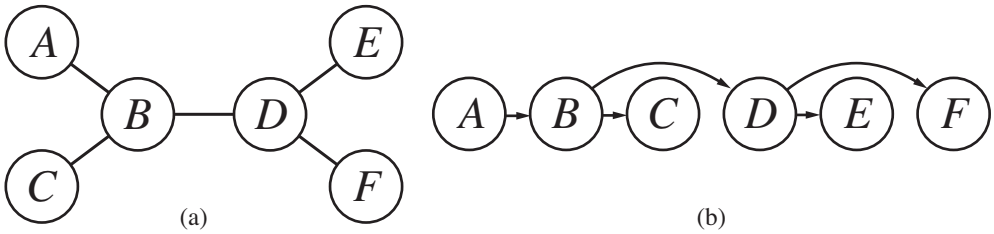

Figure: Q.2C

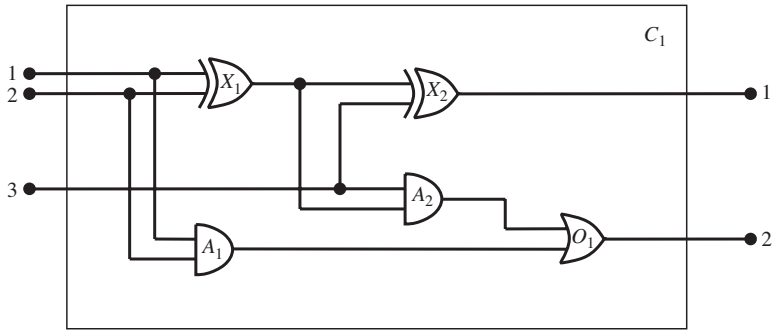

Figure: Q.6A