Do not award half marks.
In all cases give credit for appropriate alternative answers.

Question 1 (Compulsory)

(a) Explain two differences in opinions between those who adopt the connectionist approach and those who adopt the information processing approach to the study of cognition. (Explain from both groups' perspectives.) [4]

- **(IPA) View the mind as if it is a computer, with the brain as the central processor. [1] (CA) View brain as being made up of billions of simple processors (the neurons) without executive control [1].**
- **(IPA) The central processor (the brain) processes data in serial [1]. (CA) The neuron processes data in parallel [1].**

(b) For each of the following situations, state which of the characteristics of human languages (semanticity, iteration, recursion and displacement) is displayed.

(i) The sentence "This examination is easy" can be used as a basis to produce a new sentence like "This examination is ***very*** easy" [1]

(ii) "I spent last night studying for this coming Saturday's examination" [1]

(iii) The sentence "I do not like spicy food" can be used as a basis to produce a new sentence like "I do not like spicy food ***too***" [1]

(iv) "You should be at home studying instead of wasting time here at the cinema." [1]

(i) Recursion
(ii) Displacement
(iii) Iteration
(iv) Displacement

(c) Given that $\mu_A(1.5) = 0.3$ and $\mu_B(12) = 0.5$, work out values for

(i) $A \wedge B$ [1]
(ii) $A \vee B$ [1]
(iii) $\sim A$ [1]
(iv) very A [1]
(v) not so B [1]

(i) 0.3
(ii) 0.5
(iii) 0.7
(iv) between 0 to 0.3
(v) between 0.5 to 1.0

(d) Name *three* activation functions that could be used in an artificial neuron, and state their respective formula. [6]

Step threshold function: output = f(net) = 1 if net>t, 0 if net≤ t
Signum function: output = f(net) = sgn(net) = 1 if net>0, -1 if net≤0
Sigmoid function: output = f(net) = $1/(1+e^{-net})$
[For each function, 1 mark for name and 1 mark for formula]

(e) For each of the following statements, state which of the problem solving techniques were employed: (trial and error, algorithm, heuristics, state space search and reasoning)

(i) The system prompts the user for an input value, accepts the value of a radius from the keyboard, calculates the area of the circle, and displays the result to the user. [1]
(ii) Game states are commonly represented as trees or graphs, and the solution is obtained by traversing the graph or tree. [1]
(iii) Randomly pulling out files in a filing cabinet to find a specific one. [1]
(iv) The system uses rules of inference and facts to derive new facts. [1]

(i) algorithm
(ii) state space search
(iii) trial and error
(iv) reasoning

(f) State *three* strengths and *two* weaknesses of the Turing Test [5]

Strengths

1. **It incorporates objectivity in that a known source of intelligence, a human being, is used as the basis of comparison.[1]**
2. **It avoids unanswerable questions regarding the internal representation and processes of the brain, and whether the machine is actually conscious of its actions. [1]**
3. **It eliminates bias by forcing the interrogator to focus solely on the content of the answers to questions. [1]**

Weaknesses

1. **It is biased toward purely symbolic problem-solving tasks. [1]**
2. **It ignores the possibility of other forms of intelligence. [1]**

(g) Why is it necessary to use 'fuzziness' rather than formal logic for modeling real situations? [2]

Real situations are often not deterministic, but are vague [1]. Formal logic statements can be either true or false, and nothing inbetween [1].

Do not award half marks.
In all cases give credit for appropriate alternative answers.

Question 2

(a) Describe the process of forward reasoning. [4]

The facts are kept in computer memory [1]. The rules are scanned and if the facts match the premise of a rule, the conclusion is stored in the memory [1]. The rules are repeatedly [1 for iteration] scanned until the goal is found, or until no more new facts can be inferred [1].

(b) Given that the rule "a→b" is true and given that "a" is also true, we can confidently conclude that "b" is also true. State if we can confidently conclude that "a" is true given that "b" is true. Explain using an example. [3]

We cannot. Example: "If my glass of water tips over, then my book will get wet". Given that my book is wet, the glass tipping over is only one of the possible reasons, like accidentally dropping it into a bucket of water. [1 mark for negative conclusion, 1 mark for example, 1 mark for an explanation]

(c) Restate each of the following propositional or predicate expressions as English sentences in natural language. (Variables should NOT be used in the sentences)

(i) clever(tom) ∧ successful(tom) [1]
(ii) ~successful(mary) → ~clever(mary) [1]
(iii) ∀X clever(X) → successful(X) [1]
(vi) ~∃X clever(X) ∧ ~successful(X) [1]

(i) Tom is clever and is successful. [1]
(ii) Mary is not successful and therefore is not clever. [1]
(iii) Everyone who is clever is successful. [1]
(vi) There does not exist any clever person who is not successful.[1]

(d) Use the following facts and predicates to answer this question

P = {tom, joe}
T = {may, kate}
S = {CS256, CS211}

student(X): X is a student
teacher(X): X is a teacher
study(X, Y): student X study subject Y
teach(X, Y): teacher X teaches subject Y

$\forall X{:}P\ \forall Y{:}S$ study(X, Y)
$\forall X{:}T\ \exists Y{:}S$ teach(X, Y)
$\sim\exists X{:}T\ \forall Y{:}S$ teach(X, Y)

For each of the following, state the facts that can be inferred, or unknown if the facts cannot be inferred.
(For example the facts that can be inferred from "Who studies all subjects?" is "tom $\wedge$ joe")

(i) Who teaches Tom? [1]
(ii) What subjects does Tom study? [1]
(iii) What subjects does May teach? [2]

(i) May $\wedge$ Kate
(ii) CS256 $\wedge$ CS211
(iii) CS256 $\oplus$ CS211 [2 mark – 1 mark only for CS256 $\vee$ CS211]

Do not award half marks.
In all cases give credit for appropriate alternative answers.

Question 3

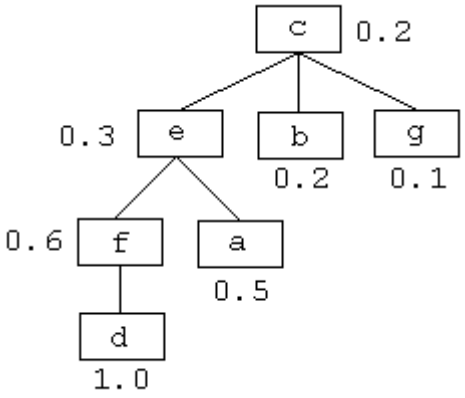
(a) Describe the process of searching a tree using the hill climbing approach. [4]

In the hill climbing approach, the children of the current node are generated [1]. An evaluation function is used to assign a score to each child [1]. The node with the highest score will be explored [1], provided it has a higher score than the current [1].

(b) The algorithms of depth first search, breadth first search and the best first approach differ only in the types of data structures that are used. For each of the search techniques, state the type of data structure used. [3]

DFS – queue, BFS – stack, best first – priority queue

(c) Use the hill climbing approach and the following tree for your answer.



(i) Complete the table. [5]

	Children (score)	Best child	Parent (score)
Initial state	-	-	c(0.2)
Iteration 1			
Iteration 2			
Iteration 3			

Note: the table below is part of the solution, and should not be included in the question paper:

	Children (score)	**Best child**	**Parent (score)**
Initial state	**-**	**-**	**c(0.2)**
Iteration 1	**e(0.3) b(0.2) g(0.1)**	**e (0.3)**	**e (0.3) [2]**
Iteration 2	**f (0.6) a(0.5)**	**f (0.6)**	**f(0.6) [2]**
Iteration 3	**d(0.1)**	**d(0.1)**	**d(0.1) [1]**

(ii) The goal is 'd'. If the goal is obtained, state the path to the goal, and all the nodes that were examined. If the goal is not reached, explain why. [3]

goal path: cefd [1]
traversal: cebgfad [2 for complete; 1 for partial answer]

Do not award half marks.
In all cases give credit for appropriate alternative answers.

Question 4

(a) State the four stages of visual processes. [4]

- **image acquisition [1]**
- **low level processing [1]**
- **immediate level processing [1]**
- **high level processing [1]**

(b) (i) In the context of classifying visual input, describe template matching. [3]

Template matching is the simplest classification technique, using an n-dimensional representation of the object that is used to match against the input. [1] A template is an array of values that represent a pattern that is used for comparison with an object image. [1] This is a simple operation where each pixel of the input image is compared against the template. [1]

(ii) Use an example to illustrate the template matching process for recognizing a letter of the alphabet. [3]

The solution should include an array picture of the letter as an input [1]
The solution should include an array picture of the latter as a template [1]
The solution should describe how these arrays are compared [1]

(c) Given that a pixel has the normalised R,G,B values of (0.4, 0.6, 0.2), calculate the result of each of the following grey-scale operations:

(i) greyscale [1]
(ii) negation [1]
(iii) threshold, where t=0.5 [1]
(iv) decrease brightness by a value of 0.1 [1]
(v) increase brightness by a value of 0.8 [1]

(i) 0.4 [1]
(ii) 0.6 [1]
(iii) 0.0 [1]
(iv) 0.3 [1]
(v) 1.0 [1]

Do not award half marks.
In all cases give credit for appropriate alternative answers.

Question 5

(a) Define the following terms:

(i)	Prosody	[1]
(ii)	Phonology	[1]
(iii)	Morphology	[1]
(iv)	Syntax	[1]
(v)	Semantics	[1]
(vi)	Pragmatics	[1]
(vii)	World knowledge	[1]

(i) Prosody deals with the rhythm and intonation of language.
(ii) Phonology deals with sounds that are combined to form sound patterns in the speech of a language.
(iii) Morphology is concerned with the components, known as morpheme that makes up words.
(iv) Syntax deals with the rules for combining words into legal phrases and sentences.
(v) Semantics deals with the meanings of words, phrases and sentences and the ways in which meaning is conveyed in natural languages.
(vi) Pragmatics is the study of the ways in which language is used and its effects on the listener.
(vii) World knowledge includes knowledge of the physical world, the world of human social interaction and the role of goals and intentions in communications.

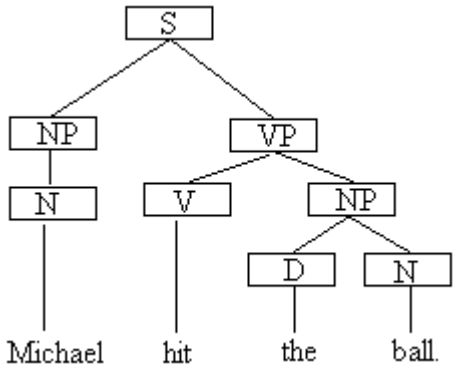
(b) Use the sentence "Michael hit the ball" and the simple grammar below for this question

S (sentence) ← NP, VP
NP (noun phrase) ← N | D, N
VP (verb phrase) ← V, NP
D (determiner)
N (noun/proper noun)
V (verb)

(i) State the lexicon used for this sentence. [4]

N: Michael, ball [2]
D: the[1]
V: hit[1]

(ii) Use a parse tree to show that the sentence is valid. [4]



[1] for the S <- NP, VP rule
[1] for the VP <- V, NP rule
[1] for the NP <- N rule
[1] for the NP <- D,N rule

- END OF PAPER -