Wrong answers to yes/no questions will give half the points negatively, e.g. for a 2-point question this means -1 points. If you are not sure about the answer, it's best to answer 'DontKnow'! Answers to numeric questions 'close enough' will yield full points, and answers a bit off still yield some points.

Question 1 (10.00 pts) Consider the following two games.

	C	D		G	H
A	5, -3	0, 1	E	5,0	2, -4
B	1, -1	4, -4	F	-1, -7	-3,9

Both games have exactly one Nash equilibrium (either in pure or in mixed strategies). Find those Nash equilibria. What are the probabilities of playing the strategies A, C, E and G? Return your answer as the vector (P(A), P(C), P(E), P(G)).

Question 2 (12.00 pts) Consider the following Bayesian network and the CPTs for all nodes.

	P(A)	P(B)			P(C A,B)
AB	0.90	0.10	A	B	0.60
XX			A	$\neg B$	0.80
C			$\neg A$	B	0.40
			$\neg A$	$\neg B$	0.50

Answer the following questions.

- (a) What is the conditional probability $P(B|\neg A, \neg C)$?
- (b) What is the probability P(C)?
- (c) What is the probability $P(\neg A, \neg B, \neg C)$?

Question 3 (8.00 pts) True or false?

- (a) IDA^{*} never performs more search steps than A^* .
- (b) For a network on the Euclidian plane, the Manhattan distance can over-estimate the cost of the shortest path at most by a factor of $\sqrt{2}$.
- (c) The breadth-first search algorithm is guaranteed to find a solution with the lowest possible cost if all arc costs are the same.
- (d) The WA^{*} algorithm with W = 3 performs at most $\frac{1}{3}$ of the expansions performed by A^{*}.

Question 4 (10.00 pts) Consider the following structure.

universe $U = \{1,2,3,4\}$ constant a = 1constant b = 2predicate $Q = \{1\}$ predicate $P = \{(1,2), (2,2), (2,3)\}$

Which of the following formulas are true in this structure?

(a) $\exists x \ (Q(x) \lor \forall y \ P(x, y))$ (b) $\exists y \ \forall x \ P(x, y) \to \forall x \ \exists y \ P(x, y)$

(c) $\forall x \exists y (Q(x) \to Q(y))$

(d) $\forall x (\exists y P(x, y) \lor \exists y P(y, x))$

Question 5 (10.00 pts) The current belief state is (0.40,0.60). It assigns the given probabilities respectively to states s_0 , s_1 . Now we observe *obs1*. The observation probabilities are $P(obs1|s_0) = 0.45$, $P(obs1|s_1) = 0.10$. Compute the new belief state after the observation.

Question 6 (10.00 pts) Which of the following claims hold?

- (a) $(J \to K) \land (\neg J \to L) \land \neg (K \land L)$ is satisfiable.
- (b) $(A \lor \neg B) \land (B \lor \neg A)$ is satisfiable.
- (c) $\neg K \rightarrow L \models L \rightarrow \neg K$
- (d) $K \to (L \to K)$ is valid.
- (e) $E \to F \models G \to (E \to F)$

Question 7 (10.00 pts) Consider the following Markov decision process.

- States: s_0, s_1
- Actions: act1, act2
- Transitions: $P(s_0, \text{act1}, s_1) = 1.00$, $P(s_1, \text{act1}, s_1) = 0.30$, $P(s_1, \text{act1}, s_0) = 0.70$, $P(s_0, \text{act2}, s_1) = 1.00$, $P(s_1, \text{act2}, s_0) = 1.00$
- Rewards: $R(s_0, \text{act}2, s_1) = 3.00$, and rewards for other transitions are 0.0.
- $\gamma = 0.90$

Run the Value Iteration algorithm for 3 rounds starting from the initial value function V_0 in which all states have value 0 (represented by the vector (0,0)). Return the value functions V_1, V_2, V_3 .

Exam Rules

- 1. Any **communication** with other people by any means is **not allowed**.
- 2. You are allowed to use the CS-E4800 course material and general sources such as Wikipedia or the Russell-Norvig textbook.
- 3. Use of calculator is allowed.

Grading

Maximum from the exam is 10.00+12.00+8.00+10.00+10.00+10.00=70.00 points. These points are not directly comparable to the exercise points, and will be scaled and aggregated with the exercise points to determine the course grade.