

**Question 1** 3x10=30 points

(A) Consider the sentence  $((\neg A \vee \neg B) \Rightarrow (A \Rightarrow \neg B)) \wedge (A \vee B)$

- Is this sentence satisfiable?
- Is this sentence valid?
- Is this sentence a contradiction?
- None of the above

Choose the correct answer and explain.

(B) Consider the pair of sentences  $(\neg A \vee \neg B) \Rightarrow \neg(A \wedge B)$  and  $((A \Rightarrow B) \vee (B \Rightarrow C))$ . Are the sentences logically equivalent? Explain.

(C) Derive a weighted partial MAXSAT formula that incorporates the following statements about geese:

1. All geese are white.
2. Geese often have two legs.
3. It is very likely that a goose is either white or has two legs or both.
4. If a goose does not have wings, it cannot fly.

You may use the following variables:

$W$  = Goose has wings

$X$  = Goose is white

$Y$  = Goose has two legs

$Z$  = Goose can not fly

**Question 2** 2x10=20 points

(A) Translate the following sentences from Description Logic *ALC* to English language and vice versa. Suppose that the concept names are *Kid* and *Ice-Cream* and the role name is *likes*.

- $\exists \text{like}. \text{Ice} - \text{Cream} \sqsubseteq \text{Kids}$
- Every kid likes something
- Everybody likes ice-cream

(B) Use a tableau to prove whether  $(\forall r. A \sqcap \forall r. B) \sqsubseteq \forall r. (A \sqcap B)$  is satisfiable or not.



**Question 3** 10 points

Use the Davis Putnam procedure to prove or disprove satisfiability of the formula  
 $(X \vee Y \vee Z) \wedge (X \vee \neg Y) \wedge (Y \vee \neg Z) \wedge (Z \vee \neg X) \wedge (\neg X \vee \neg Y \vee \neg Z)$   
 Label each step in your derivation with the part of the DP algorithm that you applied.

**Question 4** 2x5= 10

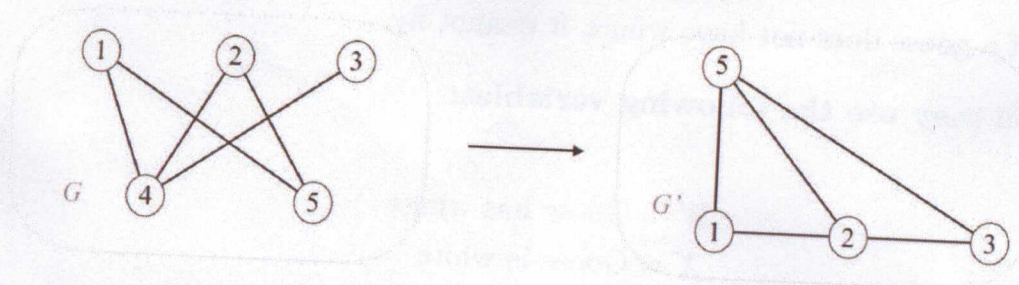
- Give a pseudocode description of the GSAT procedure.
- Explain the advantages and disadvantages of short and long restart intervals.

**Question 5** 10 points

Check out the statements below whether they are true or not, and label them accordingly with either "true" or "false".

- If  $\alpha \models \beta$  and  $\Pr(\alpha)=0$ , then  $\Pr(\beta)=0$ .
- If  $\alpha \models \beta \models \gamma$ , then  $\Pr(\alpha \mid \beta) \geq \Pr(\alpha \mid \gamma)$ .

- In the interaction graph  $G$  below, if we eliminate 4, we get  $G'$

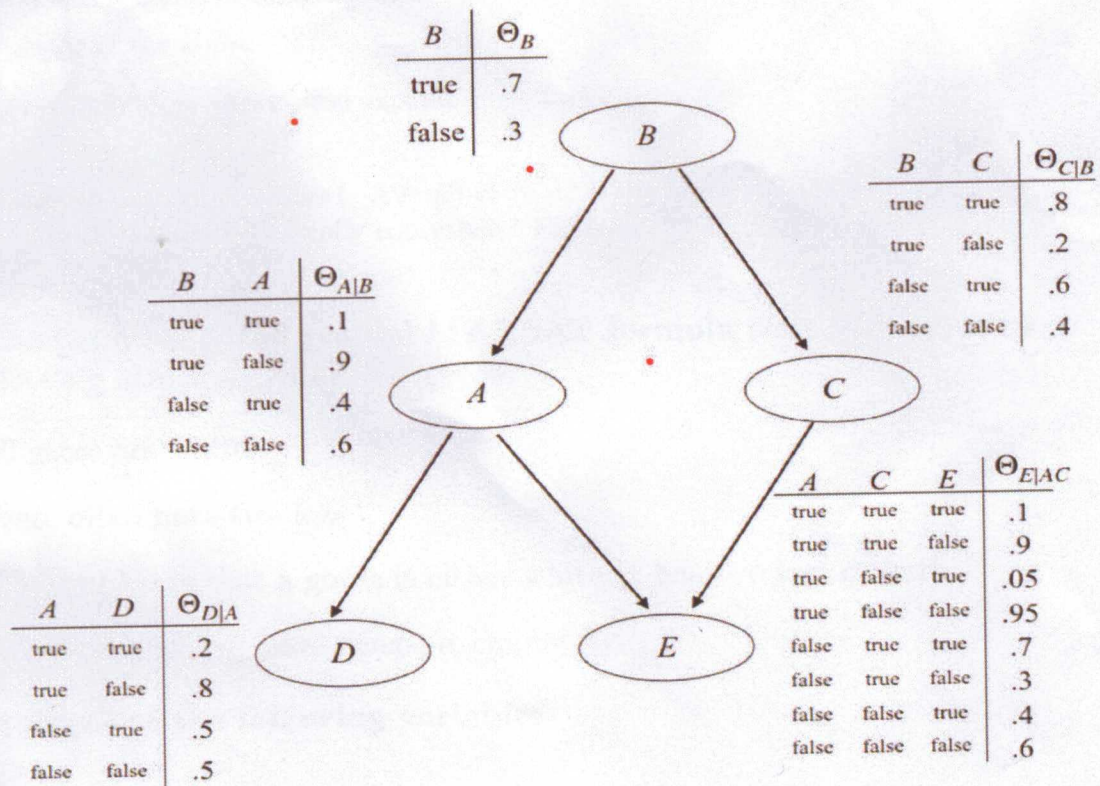


- Assume  $G'$  above, according to the order elimination heuristic of "choosing the node with smallest degree", one possible elimination order is: 1, 5, 3, 2.



**Question 6** 2x10= 20 points

Consider the Bayesian network in the figure, and answer the questions below accordingly.



a) Are the statements below true or false? Cross the correct option:

$\text{IPr}(D, \emptyset, C)$  . [True or False]

$\text{IPr}(E, \{A\}, B)$  . [True or False]

$\text{IPr}(\{BD\}, \{A, C\}, E)$  . [True or False]

$\text{IPr}(C, \{B, E\}, A)$  . [True or False]

b) 1. Calculate the probability  $\text{Pr}(A=\text{true}, B=\text{false}, E=\text{true})$ .

2. Calculate the probability  $\text{Pr}(A=\text{false}, B=\text{true} \mid C = \text{true})$ .