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 $\mathcal{ALC}$ to English language and vise versa. Suppose that the concept names are `Kid` and `Ice-Cream` and the role name is `likes`.

- $\exists like.Ice - Cream \sqsubseteq Kids$
- 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

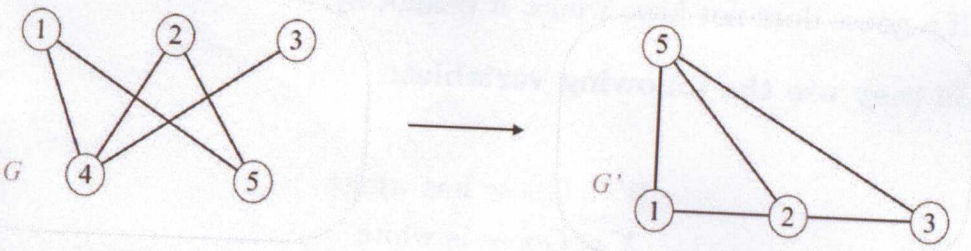
a. Give a pseudocode description of the GSAT procedure.
b. Explain the advantages and disadvantages of short and long restart intervals.

Question 5 .10 points

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

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

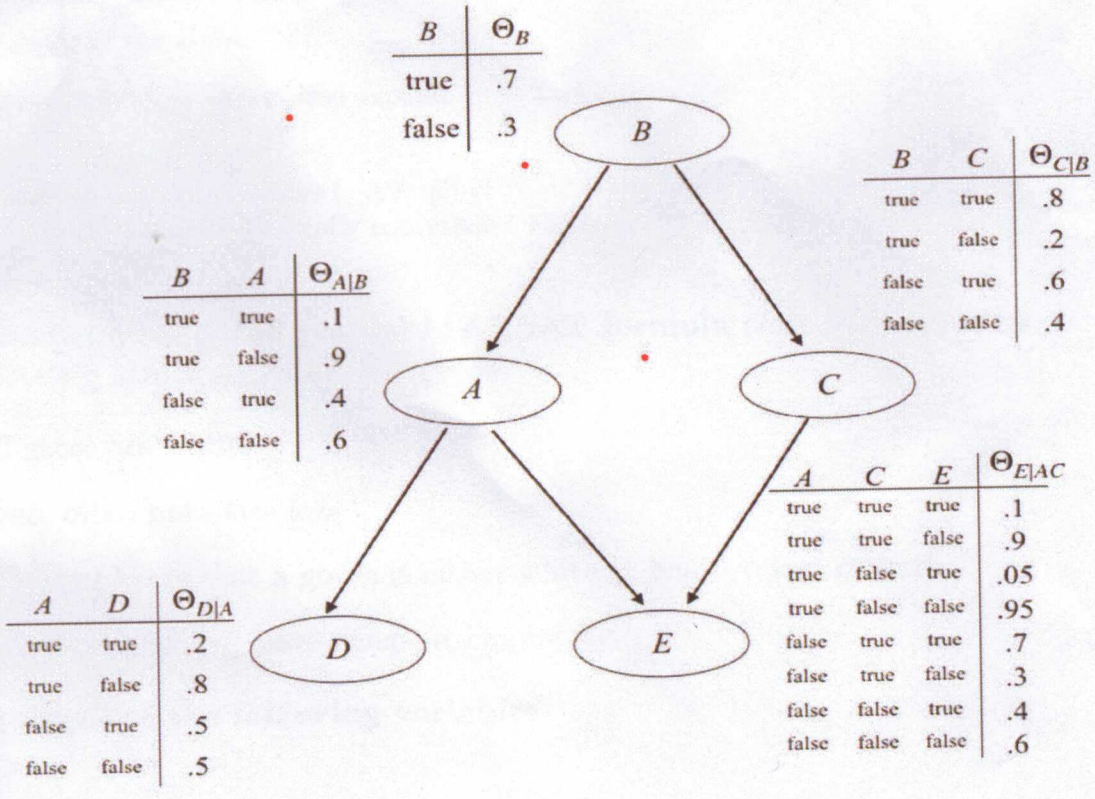
c) In the interaction graph G below, if we eliminate 4, we get G'



d) 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.



B	Θ_B
true	.7
false	.3

B	C	$\Theta_{C\|B}$
true	true	.8
true	false	.2
false	true	.6
false	false	.4

B	A	$\Theta_{A\|B}$
true	true	.1
true	false	.9
false	true	.4
false	false	.6

A	C	E	$\Theta_{E\|AC}$
true	true	true	.1
true	true	false	.9
true	false	true	.05
true	false	false	.95
false	true	true	.7
false	true	false	.3
false	false	true	.4
false	false	false	.6

A	D	$\Theta_{D\|A}$
true	true	.2
true	false	.8
false	true	.5
false	false	.5

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

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

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

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

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

b) 1. Calculate the probability Pr(A=true, B=false, E=true).

2. Calculate the probability Pr(A=false, B=true | C = true).