Q1. Tick *all* correct answers; Cross *all* wrong answers. Negative marks of 25% will be awarded for each wrongly marked answer.

(i) Either the governor (G) and his lieutenant (L) both run for the re-election or the primary race will be wide open (W) and the party will be torn by dissension (T).

$G \wedge (L \vee W) \wedge T$

$G \vee L \vee W \vee T$

$G \wedge L \vee W \wedge T$

$\neg W \vee \neg T \rightarrow G \wedge L$

[4 points]

(ii) Either the king castles (K) or if the rook is pinned (R) then the exchange is lost (L).

$(K \vee R) \rightarrow L$

$K \vee R \vee L$

$\neg K \vee \neg R \vee L$

$K \vee (R \rightarrow L)$

[4 points]

Q2. Prove using truth-tables: $(A \rightarrow (B \rightarrow C)) \Leftrightarrow ((A \wedge B) \rightarrow C)$ **[10 points]**

Q3. Prove using resolution: $A \rightarrow \neg B, \neg B \rightarrow C \Rightarrow A \rightarrow C$. (Represent a clause with its number.) **[10]**

Clauses being resolved	Substitution required	New resulting clause	Clause number (of new clause)

Q4. Suppose a training set consists of points $x_1, x_2, \ldots, x_n$ and real values y_i associated with each point x_i. We assume there is a function with noise $y = f(x) + \varepsilon$, where the noise ε has a mean of 0 and variance σ^2. Please provide all steps of derivation for

$$E\left[\left(y - \hat{f}(x)\right)^2\right] = \left(Bias\left[\hat{f}(x)\right]\right)^2 + Var\left[\hat{f}(x)\right] + \sigma^2$$

where $\hat{f}(x)$ is the best approximation for $f(x)$ identified by the machine learning algorithm. What would the equation be if the mean of the noise is m_n in general and not 0 (variance remains same). Please provide the steps of derivation to derive the revised equation.

[7+8 points]

Q5. Please answer the following questions:

a. What is supervised learning ? How is it different from unsupervised learning ? Please provide an example domain and the corresponding (synthetic) datasets for this domain containing 6 data points for how the supervised learning is different from unsupervised learning ?

[2+1+4 points]

b. What is the AlphaFold system? Please explain the problem that it tackles and why this problem is important ? What is the technology behind this system ?

[1+2+1 points]

c. If the MSE equation has weights w0, w1, ..., w9 for the terms $(x^0, x^1, \ldots, x^9)$, please answer the following:

(i) If you are aware that the domain needs an order 6 equation (and not 9), how would you design the penalty function for regularization ?

[2 points]

(ii) If you are aware that the domain needs an order 12 equation (and not 9), how would you design the penalty function for regularization ?

[2 points]

Q6. Show the candidates (after pruning) that would be generated by Apriori in each database scan if the frequent itemsets are: F = {A, B, C, D, AB, AC, BC, AD, BD, CD, ABC, ACD} [Available items are A, B, C, D]

[12 points]