**Answer any three out of four questions according to the following rule: (1 and 2 and (3 or 4))**

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| 1. | a) Write the following expressions in first order predicate logic.   1. Everyone who sees Mary loves Mary. 2. Everyone who Mary loves, loves someone who is happy. 3. Every student who loves Mary is happy. 4. Every boy who loves Mary hates every boy who Mary loves.   b) Let you have the following knowledge base in FOL:  Mother (Lulu, Fifi)  Alive (Lulu)  ∀x ∀y *Mother* (x, *y*) ⇒ *Parent (x, y)*  ∀x ∀y (Parent (x, *y*) Λ Alive (x) ⇒ *Older (x, y)*   1. Using resolution prove that ***Older (Lulu, Fifi)***   c) Convert the following propositional logic sentence to CNF.  (B1,1 ⇒ (P1,2 ∨ P2,1)) ∧ ((P1,2 ∨ P2,1) ⇒ B1,1 ) | 6  5  4 |
| 2. | a) Let's consider this data of some users visiting ecom websites. Depending on city, job, credit\_limit, age the last column shows whether a user buys a product or not. If you want to build a decision tree based on the ID3 algorithm find the root node. Show all the calculations behind your finding.  https://miro.medium.com/max/653/0*Q7oGLYKuALAAPb0V.png  b) What is entropy? Where and why is it used in building a decision tree? | 10  5 |
| 3. | a) Briefly define F-measure. Why is it important and where is it used?  b) Run through the first step of the training process for a perceptron to calculate the binary AND function on two inputs. | 6  9 |
| 4. | a) Give the algorithm for stopping the neural network learning.  b) For the NN given below do the following: | 6  9 |