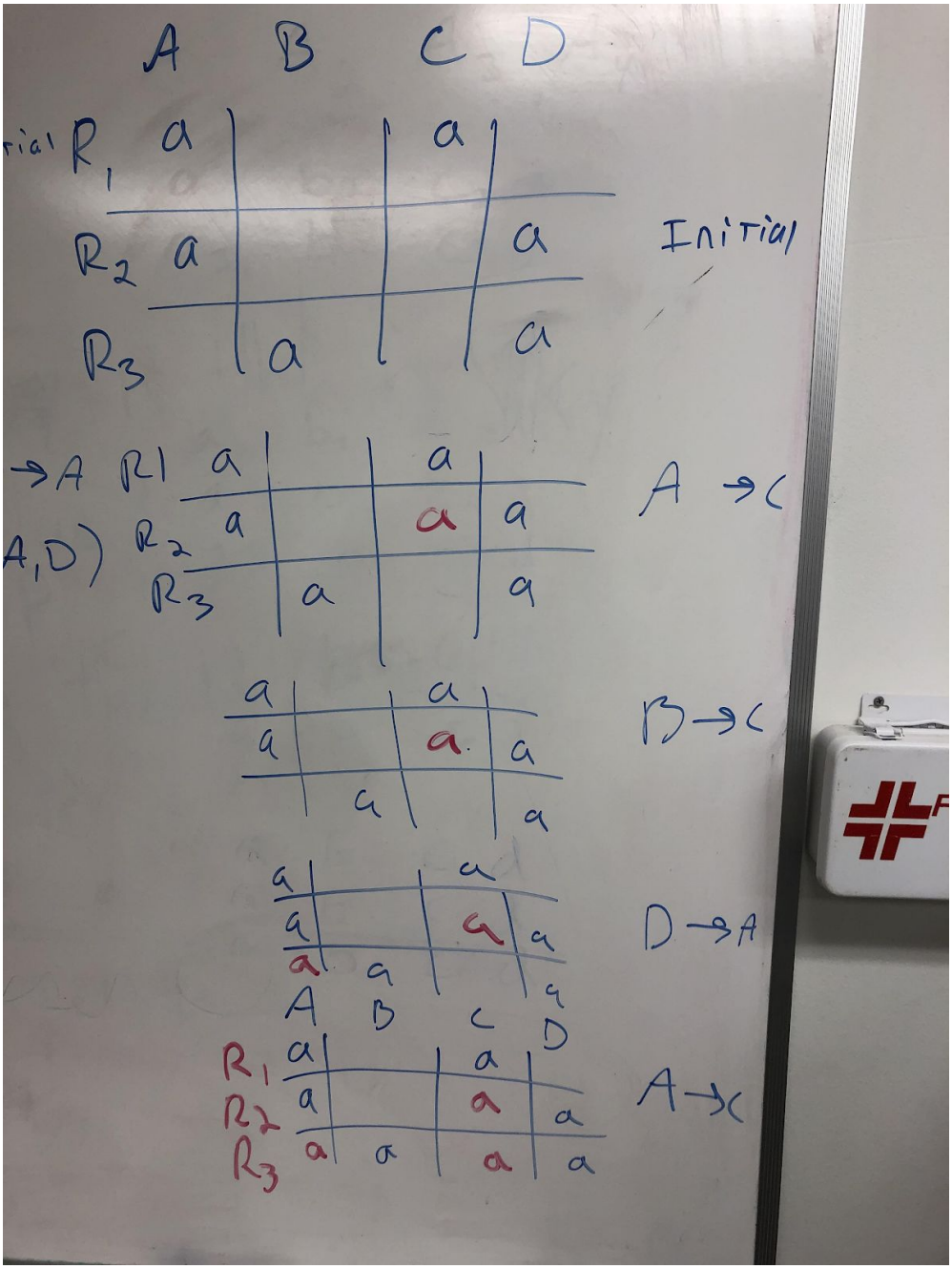
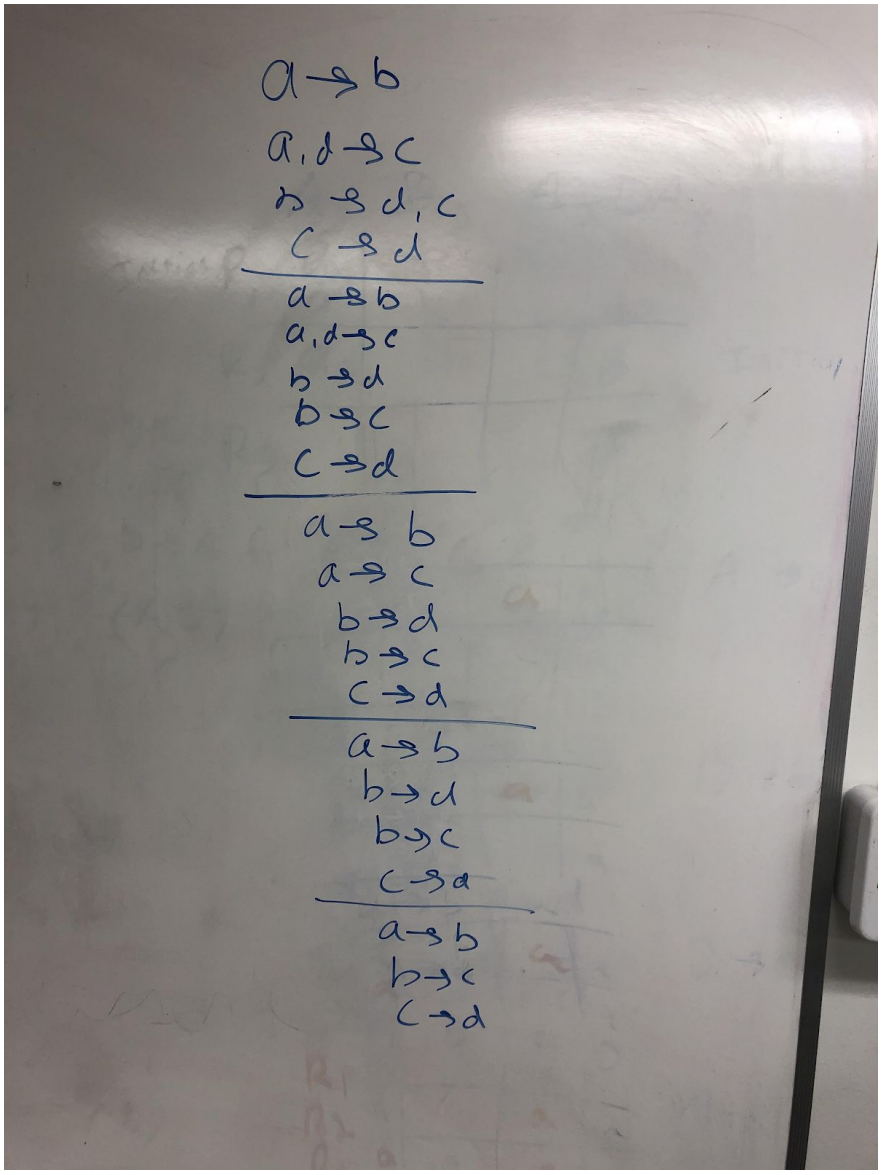
1.

a.



(For reference, A = a1, B = a2, C = a3, D = a4,

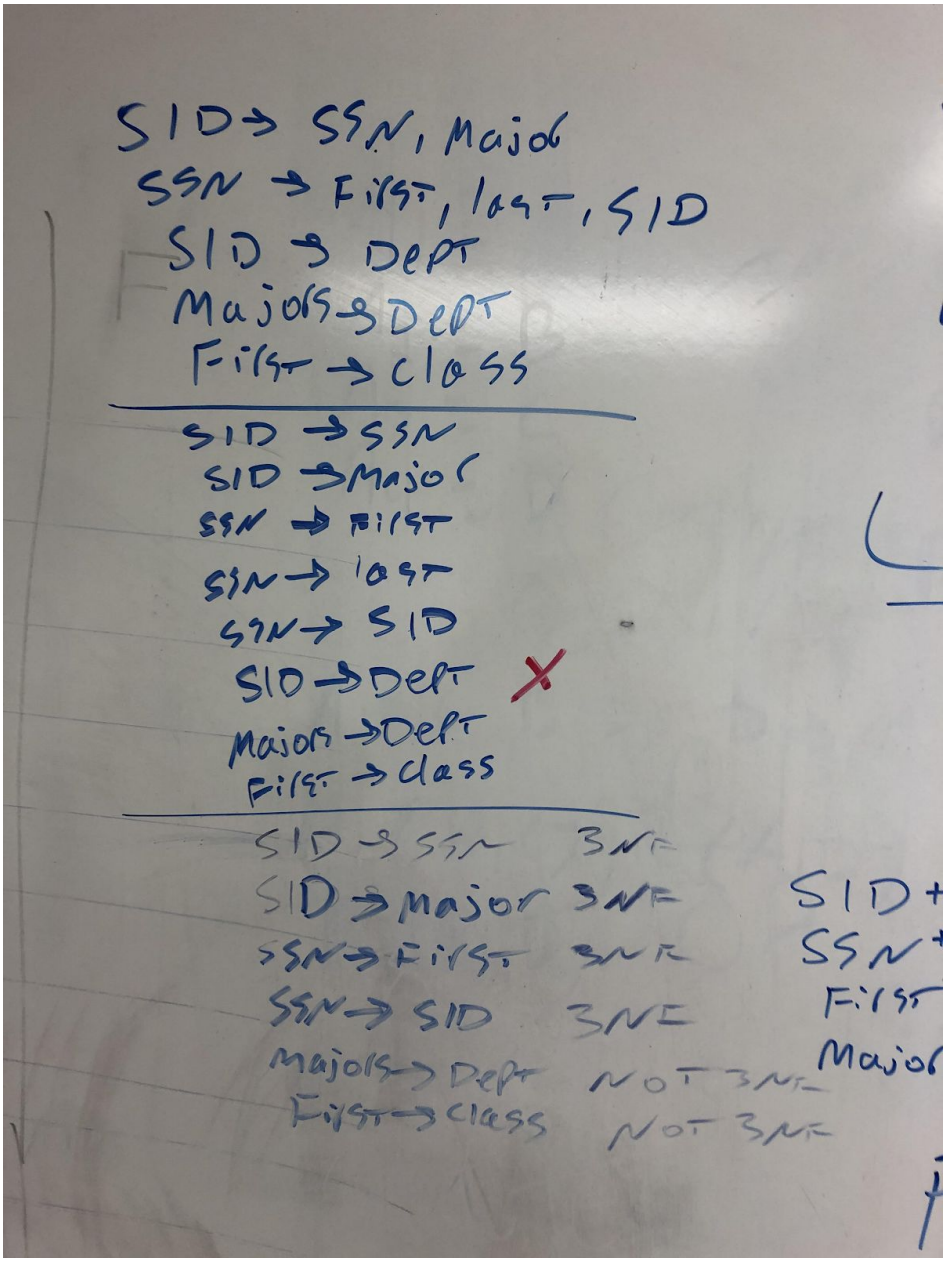
b. Yes decomposition D has the lossless join property because in the final state of the matrix, R3 has distinguished variables for every attribute, showing that it has the property.

2. 

3.

a. SID and SSN are candidate keys
b. STUDENT is not in 3NF because of the functional dependency First -> Class. Class is a non-prime attribute and First is not a superkey, thus breaking 3NF.

c.


SID → SSN, Major
SSN → First, last, SID
SID → Dept
Majors → Dept
First → class
SID → SSN
SID → Major
SSN → First
SSN → last
SSN → SID
SID → Dept
Majors → Dept
First → class
SID → SSN 3NF
SID → major 3NF
SSN → First 3NF
SSN → SID 3NF
Majors → Dept NOT 3NF
First → class NOT 3NF
SID +
SSN +
First
Major