1)

a) **Derive C -> B**

First we can see that A -> BC which according to decomposition gives us A -> B & A -> C. After that we also see that C -> A which according to transitivity with A -> B gives us C -> B

b) **AE -> F**

Using DE -> F and pseudo-transitivity we can see that if we find a A such that A -> D we get AE -> F. We know that A->C and C->D, using transitivity we get A -> D which in turn lets us derive DE -> F => AE -> F

2)

a) **Attribute closure of set: X = { A }**

FD1: A -> BC **=>** A -> B & A -> C

X+ = { A, B, C }

FD2: C -> AD **=>** A -> AD which means A -> D

X+ = { A, B, C, D }

FD3: DE -> F **=>** If A -> D then AE -> F which means A -> F

X+ = { A, B, C, D, F }

b) **Attribute closure of set**: X = { C, E }

FD1: A -> BC **=>** Because C -> A then C -> B

X+ = { C, E, B }

FD2: C -> AD **=>** C -> A & C -> D

X+ = { C, E, B A, D}

FD3: DE -> F **=>** C -> D gives us CE -> F

X+ = { C, E, B, A, D, F }

3)

a) **Determine the candidate key(s) for R(A, B, C, D, E, F)**

A is the only value not in RHS. We look at {A}+:

FD1: AB -> CDEF
FD2: E -> F
FD3: D -> B

{A}+ = {A, C, D, E, F, B} which means it is a super key and thus the only CK

b) Note that R is not in BCNF. Which FD(s) violate BCNF condition?

FD2 and FD3 violates BCNF.

3) a) **Determine the candidate key(s) for R(A, B, C, D, E, F)**

Ans:

FD1: AB -> CDEF
FD2: E -> F
FD3: D -> B

Candidate keys for R:

A is not in RHS; must be present in Ck.

F and C are not in LHS; can not be present in a Ck.

X = {A,B},

X+ = {A,B,C,D,E,F} FD1:AB ->CDEF

X+ = {A,D,B,C,E,F} FD2: E->F

X+ = {A,D,B,C,E,F} FD2: D->B

X = {A,D}

X+ = {A,D,B,C,E,F} FD1:AB ->CDEF

X+ = {A,D,B} FD3: D -> B

X = {A,E}

X+ = {A,E,F} FD2:E->F

Candidate key's are {A,B} and {A,E}

b) Note that R is not in BCNF. Which FD(s) violate the BCNF condition?

Ans: FD2 and FD3 do not contain a superkey. Hence, they violate the Boyce Codd Normal Form.

c) Decompose R into a set of BCNF relations, and describe the process step by step (don't forget to determine the FDs and the candidate key(s) for all of the relation schemas along the way).

Ans:

Decompose based on FD3: E->F (as it violates BCNF):

R1: (F,E) with all attributes in X and Y

R2: (A,B,C,D,E) with all attributes in R, without the ones in Y and not in X.

FD4: AB -> CDE ; FD1: AB -> CDEF

FD5: AD -> BCE ; FD1: AB -> CDEF

Decompose based on FD2: D->B (as it violates BCNF)

R1: (D,B) ; FD3 : D-> B ; candidate key: {D}

R2: (A,C,D,E) ; FD9 : AD -> CE; candidate key: {AD}

FD6 -> AD -> AB ; FD3 augmented

FD7: AD -> CDEF ; FD1 and FD4 transitivity

FD8: AD -> CDE; Decomposition of FD7

FD9: AD -> CE; Decomposition of FD8

4) Consider the relation schema R(A, B, C, D, E) with the following FDs

FD1: ABC → DE

FD2: BCD → AE

FD3: C → D

a) Show that R is not in BCNF.

Ans: FD3 violates BCNF, C is not a superkey.

The elements that are not in LHS but are in RHS:

X+ = {B,C}

X+ = {B,C,D} ; FD1: C -> D

X+ = {B,C,D,A,E} ; FD2 : BCD -> AE

Candidate key is {B,C}

b) Decompose R into a set of BCNF relations (describe the process step by step).

Ans:

R1: {C,D} ; FD3: C-> D ; ck = {C}

R2: {A,B,C,E} ;

FD4: C -> CD

FD5: BC -> BCD (Augmentation of FD4)

FD6: BC -> AE (transitivity of FD5)

Decomposing:

BC -> E ; (BC is a candidate key)