FD1: {a, b} -> {c, d}

FD2: b -> {c, e}

FD3: d -> f

FD4: c -> a

For each of the following, calculate the requested closures. List each step you use to add attributes and note the functional dependency, if any, used to add attributes at each step.

1. (10 points) a+

Step 1	a	add self

2. (10 points) {a, d}+

Step 1	a, d	add self
Step 2	a, d, f	FD3

3. (10 points) b+

Step 1	b	add self
Step 2	b, c, e	FD2
Step 3	a, b, c, e	FD4
Step 4	a, b, c, d, e	FD1
Step5	a, b, c, d, e, f	FD3

Part 2

Given R(a, b, c, d, e) with two candidate keys, (a,b) and c and the following functional dependencies:

FD1: {a, b} → {c, d}

FD2: c → {a, b, d, e}

4. (5 points) Is R in 2NF? Justify your answer showing exactly why it is or is not - do not just quote the definition.

   The non-prime attribute "e" cannot be determined by ab and fails at FD1. Therefore, R is not in 2NF

5. (5 points) If R were in 2NF, would R be in 3NF? Justify your answer showing exactly why it is or is not - do not just quote the definition.

   If R were in 2NF, the R would also be in 3NF because a, b is a superkey at FD1. Also on FD1 & FD2, there are prime attributes on the right side.

6. (5 points) Is R in BCNF? Justify your answer showing exactly why it is or is not - do not just quote the definition.

   Yes, R is in BCNF because at both FD1 & FD2 for X ->a, X is a superkey.

Given S(a, b, c, d, e) with a candidate key (a,b) and given the following set of functional dependencies:

FD1: b -> {d, e}

FD2: {a, b} -> {c, d, e}

7. (5 points) Is S in 2NF? Justify your answer showing exactly why it is or is not - do not just quote the definition.

   No, 2NF fails at FD1 because "b" cannot determine the non-prime attributes by itself.

8. (5 points) If S were in 2NF, would R be in 3NF? Justify your answer showing exactly why it is or is not - do not just quote the definition.

   If S were in 2NF, S would not be in 3NF because at FD1 there is no super key and there is no prime attributes on right side.

9. (5 points) Is S in BCNF? Justify your answer showing exactly why it is or is not - do not just quote the definition.

S is not in BCNF because at FD1, X is not a superkey.