Problem 1

1) $A \to B$, $B \to C$, $A \to C$

1. Transitivity - If $A \to B$ and $B \to C$, then $A \to C$

- Given $X \to Y$ on a schema R, for any valid instance r conforming to R, and any two records t_1 and t_2 from r, by definition we know that $\pi_A(t_1) = \pi_A(t_2)$, $\pi_B(t_1) = \pi_B(t_2)$ and $\pi_Z(t_1) = \pi_Z(t_2)$.

We also know that $\pi_A(t_1) = \pi_A(t_2)$ implies $\pi_B(t_1) = \pi_B(t_2)$, $\pi_B(t_1) = \pi_B(t_2)$ implies $\pi_C(t_1) = \pi_C(t_2)$

By the rule of Transitivity we know $\pi_A(t_1) = \pi_A(t_2)$ implies $\pi_C(t_1) = \pi_C(t_2)$

From the above we can concur that: Given $A \to B$ and $B \to C$, then $A \to C$.

2)

$A \to B$, $C \to D$, then $AC \to BD$

With Augmentation we can multiply $A \to B$ by C and get $AC \to BC$.

Since $C \to D$ we get $AC \to BD$.

3)

$AB \to C$ implies we do not have $A \to C$ NOR $B \to C$

By Reflexivity $AB \to ABC$

By Augmentation we have $ABC \to C$

No rules bring us to the implication that $A \to C$ and $B \to C$, therefore we do not have $A \to C$ Nor $B \to C$.

Problem 2

W = EHJRD F = {EJ → H, EJD → R, E → J}

L	M	R
ED	J	HR

E^+ = E → J, E → EJ, EJ → EJH

*superkey

D^+ = D → D EJD → REJDH

EJ^+ = EJ → EJH

DJ^+ = DJ → DJ

*key

ED^+ = ED → EJHDR

1) False, because: given an employee, a job and hours are implied, meaning each employee has one job and a set amount of hours. E → EJH, EJ → H
E → J

2) False, as before, an employee implies a job and hours associated with that job. E → J

3) False, an employee is given a rating each day they work. EJD → R

4) True, a job never implies an employee, only employees imply Jobs.

5) ED is a key and EJD is a superkey

6) Not in BCNF form, not all FD's are keys or superkeys.

7)

R$_1$(EH)
R$_2$(EJ)
R$_3$(ERD)

$X = E\cancel{J}HRD$

$(X-EJ) = HRD^+ = HRD$
$(X-EH) = JRD^+ = JRD$
$(X-ER) = JHD^+ = JHD$
$(X-ED) = JHR^+ = JHR$
$(X-J\cancel{H}) = ERD^+ = EJ\cancel{H}RD$

$Y = EJRD$
$(Y-EJ) = RD^+ = RD$
$(Y-ER) = JD^+ = JD$
$(Y-ED) = JR^+ = JR$
$(Y-JR) = ED^+ = EJHRD$
$(Y-JD) = ER^+ = EJHR$
$(Y-RD) = EJ^+ = EJH$
$(Y-\cancel{J}RD) = E^+ = E\cancel{J}H$

$X = E\cancel{H}RD$

$(X-\cancel{H}RD) = EJ\cancel{H}$

$X = ERD$

*cant do anymore

It is dependency preserving because everything is derivable between the tables due to E.

E	J	H	R	D
1	2	3	4	5
6	7	8	9	10
11	12	13	14	15

E	H
1	3
6	8
11	13

E	J
1	2
6	7
11	12

E	R	D
1	4	5
6	9	10
11	14	15

EHJ⋈ERD

E	H	J	E	R	D
1	3	2	1	4	5
~~1~~	~~3~~	~~2~~	~~6~~	~~9~~	~~10~~
~~1~~	~~3~~	~~2~~	~~11~~	~~14~~	~~15~~
~~6~~	~~8~~	~~7~~	~~1~~	~~4~~	~~5~~
6	8	7	6	9	10
~~6~~	~~8~~	~~7~~	~~11~~	~~14~~	~~15~~
~~11~~	~~13~~	~~12~~	~~1~~	~~4~~	~~5~~
~~11~~	~~13~~	~~12~~	~~6~~	~~9~~	~~10~~
11	13	12	11	14	15

EH⋈EJ

E	H	E	J
1	3	1	2
~~1~~	~~3~~	~~6~~	~~7~~
~~1~~	~~3~~	~~11~~	~~12~~
~~6~~	~~8~~	~~1~~	~~2~~
6	8	6	7
~~6~~	~~8~~	~~11~~	~~12~~
~~11~~	~~13~~	~~1~~	~~2~~
~~11~~	~~13~~	~~6~~	~~7~~
11	13	11	12

E	H	J
1	3	2
6	8	7
11	13	12

E	H	J	R	D
1	3	2	4	5
6	8	7	9	10
11	13	12	14	15

Lossless!

8)

$F = \{JD \rightarrow H\}$

We only need to worry about Job and Day implying hours, everything else doesn't matter.

Problem 3

1)

$R \begin{cases} R_1 = R - Z \\ R_2 = WZ \end{cases}$ $\quad W \cap Z = \emptyset$

$R_1 \cap R_2 = (R-Z) \cap WZ$
$= W$

*R-Z leaves only W and doing on intersect on W∩WZ leaves only W, making it lossless.

2)

$W \to Z = W'A \to CZ' = W'C \to Z'$
$= W \to Z'$

This gives us $W \cap Z' = \emptyset$

so your new decomposition would be:

$R_1 = R - Z'$
$R_2 = WZ'$

Problem 4

Hourly_Emps(ssn, name, lot, rating, wage_per_hr, hrs_per_wk)

T = SNLRWH

F = {S → SNLRWH, R → W}

1) Not in BCNF because not all FD's are superkeys or keys

In 3NF because in R → W; W is part of the key

2) R_1(SNLRH) R_2(RW)

lossless!

In BCNF form because each R has an FD in them.

S	N	L	R	W	H
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18

S	N	L	R	H
1	2	3	4	6
7	8	9	10	12
13	14	15	16	18

R	W
4	5
10	11
16	17

S	N	L	R	H	R	W
1	2	3	4	6	4	5
~~1~~	~~2~~	~~3~~	~~4~~	~~6~~	~~10~~	~~11~~
~~1~~	~~2~~	~~3~~	~~4~~	~~6~~	~~16~~	~~17~~
~~7~~	~~8~~	~~9~~	~~10~~	~~12~~	~~4~~	~~5~~
7	8	9	10	12	10	11
~~7~~	~~8~~	~~9~~	~~10~~	~~12~~	~~16~~	~~17~~
~~13~~	~~14~~	~~15~~	~~16~~	~~18~~	~~4~~	~~5~~
~~13~~	~~14~~	~~15~~	~~16~~	~~18~~	~~10~~	~~11~~
13	14	15	16	18	16	17

S	N	L	R	H	W
1	2	3	4	6	5
7	8	9	10	12	11
13	14	15	16	18	17

3) The decomposition of T into R_1 and R_2 is dependency preserving because we can derive W from R_1 to R_2 and everything else is also derivable just from R_1.

Problem 5

$R = ABC$

$F = \{A \rightarrow B, B \rightarrow C, C \rightarrow A\}$

1) $R_1(AC)$ $R_2(BC)$

ABC
1 2 3
4 5 6
7 8 9

AC
1 3
4 6
7 9

BC
2 3
5 6
8 9

Not Dependency Preserving because we can't check $A \rightarrow B$ without a join.

ACBC
1323
~~1356~~
~~1389~~
~~4623~~
4656
~~4689~~
~~7923~~
~~7956~~
7989

ACB
1 3 2
4 6 5
7 9 8

lossless!

2) $F = \{A \rightarrow B, C \rightarrow B\}$ $R_1(AC)$ $R_2(BC)$

ABC
1 2 3
4 5 6
7 8 9

AC
1 3
4 6
7 9

BC
2 3
5 6
8 9

Not dependency preserving because we cant check $A \rightarrow B$ without a join.

ACBC
1323
~~1356~~
~~4613~~
4656
~~4689~~
~~7913~~
~~7956~~
7989
~~1389~~

ABC
1 2 3
4 5 6
7 8 9

Lossless!