Question 1:

(1) No, because $C \to DI$, $D \to GH$, $H \to G$, so, $C \to DI$, $C \to GH$. C can not determine J.

(2) ABJ, AEJ

(3) $F_m = \{AB \to E, D \to H, E \to B, E \to C, C \to D, C \to I, H \to G\}$

(4) For $F_m = \{AB \to E, D \to H, E \to B, E \to C, C \to D, C \to I, H \to G\}$:

From $AB \to E$, derive $R_1\{A, B, E\}$

From $D \to H$, derive $R_2\{D, H\}$

From $E \to B, E \to C$, derive $R_3\{B, C, E\}$

From $C \to D, C \to I$, derive $R_4\{C, D, I\}$

From $H \to G$, derive $R_5\{H, G\}$

None of the relation schemas contains a key of R, add one relation schema $R_6\{A, B, J\}$

Question 2:

(1) There are 96 super keys can be found for R.

List 5 of them: ABJ, AEJ, ABCJ, AECJ, ABCDJ.

(2) The highest normal form of R with respect to F is 1NF.

Because, E → C and {A,E,I} is candidate key, so C is partially dependent on the candidate key, so it can not satisfy 2NF, finally it can only be 1NF

(3) No, the decomposition R_1, R_2, R_3 of R is not dependency-preserving regarding F.

Because: $F_1 = \{AB \to E, C \to D, E \to B, E \to C\}$, $F_2 = \{H \to G\}$

$F_3 = \{E \to I\}$. $F_1 \cup F_2 \cup F_3 \neq F$. So, it is not dependency-preserving.

(4) No, the decomposition R_1, R_2, R_3 of R is not lossless-join regarding F.

Because, Initially:

	A	B	C	D	E	G	H	I	J
R_1	a	a	a	a	a	b	b	b	b
R_2	b	b	b	b	a	a	a	b	b
R_3	b	b	b	b	a	b	b	a	a

Due to $E \to BCD$: $E \to B$, $E \to C$, $E \to D$

	A	B	C	D	E	G	H	I	J
R_1	a	a	a	a	a	b	b	b	b
R_2	b	a	a	a	a	a	a	b	b
R_3	b	a	a	a	a	b	b	a	a

Due to $D \to GH$: $D \to G$, $D \to H$

	A	B	C	D	E	G	H	I	J
R_1	a	a	a	a	a	a	a	b	b
R_2	b	a	a	a	a	a	a	b	b
R_3	b	a	a	a	a	a	a	a	a

Due to ~~CD~~, $C \to DI$, $C \to D$, $C \to I$.

Final table

	A	B	C	D	E	G	H	I	J
R_1	a	a	a	a	a	a	a	a	b
R_2	b	a	a	a	a	a	a	a	b
R_3	b	a	a	a	a	a	a	a	a

So, final table doesn't have any row ~~of~~ that contains entirely a's, so, it is not lossless-join.

If $F_m = \{AB \to E, D \to H, E \to B, E \to C, C \to D, C \to I, H \to G\}$

Due to $AB \to E$: decompose R into:

$R_1 = \{A, B, E\}$ $R_2 = \{A, B, C, D, G, H, I, J\}$

Due to $E \to B$: decompose R_1 into:

$R_{11} = \{A, E\}$ $R_{12} \{B, E\}$

Due to $D \to H$: decompose R_2 into:

$R_{21} = \{D, H\}$ $R_{22} = \{A, B, C, D, G, I, J\}$

Due to $C \to D$: decompose R_{22} into:

$R_{221} = \{C, D\}$. $R_{222} = \{A, B, C, G, I, J\}$

Due to $C \to I$: decompose R_{222} into:

$R_{2221} = \{C, I\}$ $R_{2222} = \{A, B, C, G, J\}$

$R_{2222} = \{A, B, C, G, J\}$ ✓

So, BCNF is: $R_{11} = \{A, E\}$. $R_{12} = \{B, E\}$. $R_{21} = \{D, H\}$. $R_{221} = \{C, D\}$. $R_{2221} = \{C, I\}$

Lossless-join vertify:

	A	B	C	D	E	G	H	I	J
R_{11}	a	b	b	b	a	b	b	b	b
R_{12}	b	a	b	b	a	b	b	b	b
R_{21}	b	b	b	a	b	b	a	b	b
R_{221}	b	b	a	a	b	b	b	b	b
R_{2221}	b	b	a	a	b	b	b	a	b
R_{2222}	a	a	a	b	b	a	b	b	a

Due to:
$E \to B$
$AB \to E$
$C \to D$
$C \to I$
$D \to H$

Final table:

	A	B	C	D	E	G	H	I	J
R_{11}	a	a	b	b	a	b	b	b	b
R_{12}	b	a	b	b	a	b	b	a	b
R_{21}	b	b	b	a	b	b	a	b	b
R_{221}	b	b	a	a	b	b	a	a	b
R_{2214}	b	b	a	a	b	b	a	a	b
R_{2222}	a	a	a	a	a	a	a	a	a

~~So Final table = I~~ Final table has last row that contains entirely a's, so it is lossless-join