1.

1) solution:

$$\pi_{movieID}(AppearsIn \bowtie_{actorID=actorID} (\sigma_{name=\text{"Leonardo DiCaprio"}}(Actors)))$$

2) solution:

$$\pi_{name}(Actors \bowtie_{(actorID),(actorID)} (AppearsIn \div \pi_{movieID}(AppearsIn \bowtie_{actorID=actorID} (\sigma_{name=\text{"Leonardo DiCaprio"}}(Actors)))))$$

3) solution:

$$S \leftarrow (\pi_{movieID}(AppearsIn \bowtie_{actorID=actorID} (\sigma_{name=\text{"Leonardo DiCaprio"}}(Actors))))$$

$$T1 \leftarrow \pi_{actorID}(AppearsIn)$$

$$T2 \leftarrow \pi_{actorID}((S \times T1) - AppearsIn)$$

$$T \leftarrow T1 - T2$$

$$\pi_{name}(Actors \bowtie_{(actorID),(actorID)} T)$$

2.

1) solution:

$F_m = \{A \to H, G \to A, E \to D, D \to G, E \to I, AB \to C, AB \to E, CD \to K\}$ or

$F_m = \{A \to H, G \to A, E \to D, D \to G, E \to I, AB \to C, AB \to E, AB \to K\}$

2) solution:

ABJ, BDJ, BEJ, BGJ (any one is correct)

3) solution:

No.

Decomposition	A	B	C	D	E	K	G	H	I	J
$R_1(A, B, C)$	a	a	a	b	b	b	b	b	b	b
$R_2(D, E, K, G)$	b	b	b	a	a	a	a	b	b	b
$R_3(H, I, J)$	b	b	b	b	b	b	b	a	a	a

4) solution:

1NF.

Partial dependency: $A \overset{P}{\to} H$

5) solution:

$F_m = \{A \to H, G \to A, E \to D, D \to G, E \to I, AB \to C, AB \to E, CD \to K\}$

From $A \to H$, derive $R_1(A, H)$

From $G \to A$, derive $R_2(A, G)$

From $E \to D, E \to I$, derive $R_3(E, D, I)$

From $D \to G$, derive $R_4(D, G)$

From $AB \to C, AB \to E$, derive $R_5(A, B, C, E)$

From $CD \to K$, derive $R_6(C, D, K)$

None of the relation schemas contains a key of R, add one relation schema $R_7(A, B, J)$

6) solution:

$F_m = \{A \to H, G \to A, E \to D, D \to G, E \to I, AB \to C, AB \to E, CD \to K\}$

Consider $A \to H$ for F_m： $R_1(A, H), R_2(A, B, C, D, E, K, G, I, J)$

Consider $G \to A$ for R_2： $R_2(A, G), R_3(B, C, D, E, K, G, I, J)$

Consider $E \to D$ for R_3： $R_3(E, D), R_4(B, C, E, K, G, I, J)$

Consider E → I for R_4： $R_4(E, I), R_5(B, C, E, K, G, J)$

One of the possible lossless-join decompositions is： $R_1 \sim R_5$

3.

(1) solution:

Consider the capacity of the buffer pool is 4 and the request frame sequence is 1,2,3,4,5,4,5,4…

(2) solution:

Consider the capacity of the buffer pool is 4 and the request frame sequence is 1,2,3,4,1,5,1