Question 1

1. The functional dependency *isrc -> mln* is not implied by *F*. *mln* is a subset of *msin*, and there are no functional dependencies with any attributes that lead to *msin*.

2. *isrc, rep -> end,* is implied by *F*, and here is why:
    i. *Artist, label -> end, rep (to get end, we need artist & label)*
    ii. *Isrc -> artist, genre*
    iii. *Rep -> label*
    iv. ∴ *isrc, rep -> artist, label -> end, rep*
    v. *Isrc, rep -> end (Transitive Rule on 4)*

3. *Label, msin, artist -> inst, mfn, rep,* is implied by *F*, and here is why:
    i. *Artist, label -> end, rep (rep is covered)*
    ii. *Msin -> mln, inst (inst is covered)*
    iii. *Msin, mln -> msin, mfn (mfn is covered)*
    iv. ∴ *Label, msin, artist -> inst, mfn, rep (Union on all)*

4. *wsin, artist -> genre, royalty,* is not implied by *F*. *royalty* is only implied by *isrc, wsin, title -> royalty, title album.* By default we have *wsin*, meaning we only need *isrc* and *title.* There is no implication that implies *isrc*, therefore *royalty* cannot be implied, which collapses the dependency *wsin, artist -> genre, royalty*.

Question 2

1. *(msin, wsin)+ = {msin, wsin, wfn, wln, mln, inst, mfn}*

2. *(isrc, label)+ = {isrc, label, artist, genre, lcity, country, members, end, rep, title, album, syear}*

3. *(isrc, wsin, msin, rep)* would be valid minimal superkeys for the entire set of attributes *R*.

Question 3

F_c = {

artist **->** *members*, *genre*
msin **->** *mln*, *inst, mfn*
wsin **->** *wfn*, *wln*
artist, *label* **->** *end*, *rep*
rep **->** *label*
label **->** *lcity*, *lcountry*
isrc, *wsin* **->** *royalty*
isrc **->** *artist, title, album, syear*
}

Question 4

1. This schema would satisfy lossless join decomposition
2. The schema does not satisfy dependency preservation because *artist, label* **->** *end, rep* is not preserved.
3. This schema would satisfy BCNF
4. This schema would satisfy 3NF

Question 5

1. This schema would satisfy lossless join decomposition
2. This schema does not satisfy dependency preservation because it does not preserve *isrc -> artist, genre*.
3. This schema does not satisfy BCNF. The *Artist* schema has a candidate key {artist, msin}, not all FD's in F^+ satisfy the two rules, specifically, "X is a superkey for R"
4. This schema does not satisfy 3NF. The *Artist* schema has a candidate key {artist, msin}. In the FD *artist -> members, genre,* it does not satisfy the rule where FD X -> A, X is a superkey or A is part of some key for R.

Question 6

1. This schema does not satisfy lossless join decomposition because the rule Att(R1) ∩ Att(R2) ≠ ∅ is violated. Att(Musician) ∩ Att(*x*) = ∅, where *x* is equal to any other schema.
2. This schema does not satisfy dependency preservation because it does not preserve *isrc, wsin, title -> royalty, title, album*.
3. This schema does not satisfy BCNF. The *Publishes* schema has a candidate key {artist, rep}, not all FD's in F^+ satisfy the two rules, specifically, "X is a superkey for R", referring to the FD *rep -> label*.
4. This schema would satisfy 3NF.