Зад. 1:

R(A, B, C, D)

AB -> C

C -> D

D -> A

X={A}

{A}+ = {A}

X={B}

{B}+ = {B}

X={C} и C -> D

X={C,D} и D -> A

X={A,C,D}

{C}+ = {A,C,D}

X={D} и D -> A

X={A,D}

{D}+ = {A,D}

X={A,B} и AB -> C

X={A,B,C} и C -> D

X={A,B,C,D}

{A,B}+ = {A,B,C,D}

{A,B} е ключ

AB -> D

X={A,C} и C -> D

X={A,C,D}

{A,C}+ = {A,C,D}

AC -> D

X={A,D}

{A,D}+ = {A,D}

X={B,C} и C -> D

X={B,C,D} и D -> A

X={A,B,C,D}

{B,C}+ = {A,B,C,D}

{B,C} е ключ

BC -> A

BC -> D

X={B,D} и D -> A

X={A,B,D} и AB -> C

X={A,B,C,D}

{B,D}+ = {A,B,C,D}

{B,D} е ключ

BD -> A

BD -> C

X={C,D} и D -> A

X={A,C,D}

{C,D}+ = {A,C,D}

CD -> A

{A,B,C}+ = {A,B,C,D}

{A,B,C} е ключ

ABC -> D

{A,B,D}+ = {A,B,C,D}

{A,B,D} е ключ

ABD -> C

X={A,C,D}

{A,C,D}+ = {A,C,D}

{B,C,D}+ = {A,B,C,D}

{B,C,D} е ключ

BCD -> A

{A,B,C,D} е суперключ

Зад. 2:

S(A,B,C,D)

A -> B

B -> C

B -> D

X={A} и A -> B

X={A,B} и B -> C

X={A,B,C} и B -> D

X={A,B,C,D}

{A}+ = {A,B,C,D}

{A} е ключ

A -> C

A -> D

X={B} и B -> C

X={B,C} и B -> D

X={B,C,D}

{B}+ = {B,C,D}

X={C}

{C}+ = {C}

X={D}

{D}+ = {D}

{A,B}+ = {A,B,C,D}

{A,B} е суперключ

AB -> C

AB -> D

{A,C}+ = {A,B,C,D}

{A,C} е суперключ

AC -> B

AC -> D

{A,D}+ = {A,B,C,D}

{A,D} е суперключ

AD -> B

AD -> C

X={B,C} и B -> D

X={B,C,D}

{B,C}+ = {B,C,D}

BC -> D

X={B,D} и B -> C

X={B,C,D}

{B,D}+ = {B,C,D}

BD -> C

X={C,D}

{C,D}+ = {C,D}

{A,B,C}+ = {A,B,C,D}

{A,B,C} е суперключ

ABC -> D

{A,B,D}+ = {A,B,C,D}

{A,B,D} е суперключ

ABD -> C

{A,C,D}+ = {A,B,C,D}

{A,C,D} е суперключ

ACD -> B

X={B,C,D}

{B,C,D}+ = {B,C,D}

{A,B,C,D}+ = {A,B,C,D}

{A,B,C,D} е суперключ

Зад. 3:

T(A,B,C,D)

AB -> C

BC -> D

CD -> A

AD -> B

{A}+ = {A}

{B}+ = {B}

{C}+ = {C}

{D}+ = {D}

X={A,B} и AB -> C

X={A,B,C} и BC -> D

X={A,B,C,D}

{A,B}+ = {A,B,C,D}

{A,B} е ключ

AB -> D

X={A,C}

{A,C}+ = {A,C}

X={A,D} и AD -> B

X={A,B,D} и AB -> C

X={A,B,C,D}

{A,D}+ = {A,B,C,D}

{A,D} е ключ

AD -> C

X={B,C} и BC -> D

X={B,C,D} и CD -> A

X={A,B,C,D}

{B,C}+ = {A,B,C,D}

{B,C} е ключ

BC -> A

X={B,D}

{B,D}+ = {B,D}

X={C,D} и CD -> A

X={A,C,D} и AD -> B

X={A,B,C,D}

{C,D}+ = {A,B,C,D}

{C,D} е ключ

CD -> B

{A,B,C}+ = {A,B,C,D}

{A,B,C} е суперключ

ABC -> D

{A,B,D}+ = {A,B,C,D}

{A,B,D} е суперключ

ABD -> C

{A,C,D}+ = {A,B,C,D}

{A,C,D} е суперключ

ACD -> B

{B,C,D}+ = {A,B,C,D}

{B,C,D} е суперключ

BCD -> A

{A,B,C,D} е суперключ

R(A, B, C, D)

AB -> C

C -> D

D -> A

X={A}

{A}+={A}

X={B}

{B}+ = {B}

X={C} и C->D

X={C, D} и D -> A

X = {A, C, D}

{C}+ = {A, C, D}

C->A

X={D} и D->A

X={A, D}

{D}+ = {A, D}

X={A, B} и AB->C

X={A, B, C} и C->D

X={A, B, C, D}

{A, B}+ = {A, B, C, D}

{A, B} е ключ

AB->D

X={A, C} и C->D

X={A, C, D}

{A, C}+ = {A, C, D}

AC->D

X={A, D}

{A, D}+ = {A, D}

X={B, C} и C->D

X={B, C, D} и D->A

X={A, B, C, D}

{B, C}+ = {A, B, C, D}

{B, C} е ключ

BC->A

BC->D

X={B, D} и D->A

X={A, B, D} и AB->C

X={A, B, C, D}

{B, D}+ = {A, B, C, D}

{B, D} е ключ

BD->A

BD->C

X={C, D} и D->A

X={A, C, D}

{C, D}+ = {A, C, D}

CD->A

{A, B, C}+ = {A, B, C, D}

{A, B, C} е суперключ

ABC->D

{A, B, D}+ = {A, B, C, D}

{A, B, D} е суперключ

ABD->C

X={A, C, D}

{A, C, D}+ = {A, C, D}

{B,C,D}+ = {A,B,C,D}

{B,C,D} е суперключ

BCD -> A

{A,B,C,D} е суперключ

Декомпозиция:

R1(A,C,D) и R2(A,B,C)

R1(A,C,D)

C -> D

D -> A – нарушител (не съдържа ключ в лявата си страна)

C -> A

AC -> D

CD -> A

Ключове: {C}

R11(A,D) и R12(C,D)

R2(A,B,C)

AB -> C

C -> A

BC -> A

Ключове: {A,B}, {B,C}

R21(A,C) и R22(B,C)

R(A,B,C,D)

B -> C - нарушители

B -> D

{A}+ = {A}

X={B} и B -> C

X={B,C} и B -> D

X={B,C,D}

{B}+ = {B,C,D}

{C}+ = {C}

{D}+ = {D}

{A,B}+ = {A,B,C,D}

{A,B} е ключ

AB -> C

AB -> D

{A,C}+ = {A,C}

{A,D}+ = {A,D}

X={B,C} и B -> D

X={B,C,D}

{B,C}+ = {B,C,D}

BC -> D

X={B,D} и B -> C

X={B,C,D}

{B,D}+ = {B,C,D}

BD -> C

{C,D}+ = {C,D}

{A,B,C}+ = {A,B,C,D}

ABC -> D

{A,B,C} е суперключ

{A,B,D}+ = {A,B,C,D}

ABD -> C

{A,B,D} е суперключ

{B,C,D}+ = {B,C,D}

{A,B,C,D} е суперключ

Декомпозиция:

R1(B,C,D) и R2(A,B,C)

R1(B,C,D)

B -> C

B -> D

BC -> D

Ключове: {B}

R2(A,B,C)

B -> C

AB -> C

Ключове: {A,B}

R21(B,C) и R22(A,B)

T(A,B,C,D)

AB -> C

BC -> D

CD -> A

AD -> B

{A}+ = {A}

{B}+ = {B}

{C}+ = {C}

{D}+ = {D}

X={A,B} и AB -> C

X={A,B,C} и BC -> D

X={A,B,C,D}

{A,B}+ = {A,B,C,D}

{A,B} е ключ

AB -> D

X={A,C}

{A,C}+ = {A,C}

X={A,D} и AD -> B

X={A,B,D} и AB -> C

X={A,B,C,D}

{A,D}+ = {A,B,C,D}

{A,D} е ключ

AD -> C

X={B,C} и BC -> D

X={B,C,D} и CD -> A

X={A,B,C,D}

{B,C}+ = {A,B,C,D}

{B,C} е ключ

BC -> A

X={B,D}

{B,D}+ = {B,D}

X={C,D} и CD -> A

X={A,C,D} и AD -> B

X={A,B,C,D}

{C,D}+ = {A,B,C,D}

{C,D} е ключ

CD -> B

{A,B,C}+ = {A,B,C,D}

{A,B,C} е суперключ

ABC -> D

{A,B,D}+ = {A,B,C,D}

{A,B,D} е суперключ

ABD -> C

{A,C,D}+ = {A,B,C,D}

{A,C,D} е суперключ

ACD -> B

{B,C,D}+ = {A,B,C,D}

{B,C,D} е суперключ

BCD -> A

{A,B,C,D} е суперключ

R(A,B,C,D)

A -> B

B -> C

C -> D

D -> A

X={A} и A -> B

X={A,B} и B -> C

X={A,B,C} и C -> D

X={A,B,C,D}

{A}+ = {A,B,C,D}

{A} е ключ

A -> C

A -> D

X={B} и B -> C

X={B,C} и C -> D

X={B,C,D} и D -> A

X={A,B,C,D}

{B}+ = {A,B,C,D}

{B} е ключ

B -> D

B -> A

X={C} и C -> D

X={C,D} и D -> A

X={A,C,D} и A -> B

X={A,B,C,D}

{C}+ = {A,B,C,D}

{C} е ключ

C -> A

C -> B

X={D} и D -> A

X={A,D} и A -> B

X={A,B,D} и B -> C

X={A,B,C,D}

{D}+ = {A,B,C,D}

{D} е ключ

D -> B

D -> C

{A,B}+ = {A,B,C,D}

{A,B} е суперключ

AB -> C

AB -> D

{A,C}+ = {A,B,C,D}

{A,C} е суперключ

AC -> D

AC -> B

{A,D}+ = {A,B,C,D}

{A,D} е суперключ

AD -> B

AD -> C

{B,C}+ = {A,B,C,D}

{B,C} е суперключ

BC -> D

BC -> A

{B,D}+ = {A,B,C,D}

{B,D} е суперключ

BD -> A

BD -> C

{C,D}+ = {A,B,C,D}

{C,D} е суперключ

CD -> A

CD -> B

{A,B,C}+ = {A,B,C,D}

{A,B,C} е суперключ

ABC -> D

{A,B,D}+ = {A,B,C,D}

{A,B,D} е суперключ

ABD -> C

{A,C,D}+ = {A,B,C,D}

{A,C,D} е суперключ

ACD -> B

{B,C,D}+ = {A,B,C,D}

{B,C,D} е суперключ

BCD -> A

{A,B,C,D} е суперключ

R(A,B,C,D,E)

AB -> C

DE -> C

B -> D

{A}+ = {A}

X={B} и B -> D

X={B,D}

{B}+ = {B,D}

{C}+ = {C}

{D}+ = {D}

{E}+ = {E}

X={A,B} и AB -> C

X={A,B,C} и B -> D

X={A,B,C,D}

{A,B}+ = {A,B,C,D}

AB -> D

{A,C}+ = {A,C}

{A,D}+ = {A,D}

{A,E}+ = {A,E}

X={B,C} и B -> D

X={B,C,D}

{B,C}+ = {B,C,D}

BC -> D

{B,D}+ = {B,D}

X={B,E} и B -> D

X={B,D,E} и DE -> C

X={B,C,D,E}

{B,E}+ = {B,C,D,E}

BE -> D

BE -> C

{C,D}+ = {C,D}

{C,E}+ = {C,E}

X={D,E} и DE -> C

X={C,D,E}

{D,E}+ = {C,D,E}

X={A,B,C} и B -> D

X={A,B,C,D}

{A,B,C}+ = {A,B,C,D}

ABC -> D

X={A,B,D} и AB -> C

X={A,B,C,D}

{A,B,D}+ = {A,B,C,D}

ABD -> C

X={A,B,E} и B -> D

X={A,B,D,E} и DE -> C

X={A,B,C,D,E}

{A,B,E}+ = {A,B,C,D,E}

{A,B,E} е ключ

ABE -> D

ABE -> C

{A,C,D}+ = {A,C,D}

{A,C,E}+ = {A,C,E}

X={A,D,E} и DE -> C

X={A,C,D,E}

{A,D,E}+ = {A,C,D,E}

ADE -> C

{B,C,D}+ = {B,C,D}

X={B,C,E} и B -> D

X={B,C,D,E}

{B,C,E}+ = {B,C,D,E}

BCE -> D

X={B,D,E} и DE -> C

X={B,C,D,E}

{B,D,E}+ = {B,C,D,E}

BDE -> C

{C,D,E}+ = {C,D,E}

{A,B,C,D}+ = {A,B,C,D}

{A,B,C,E}+ = {A,B,C,D,E}

{A,B,C,E} е суперключ

ABCE -> D

{A,B,D,E}+ = {A,B,C,D,E}

{A,B,D,E} е суперключ

ABDE -> C

{A,C,D,E}+ = {A,C,D,E}

{B,C,D,E}+ = {B,C,D,E}

{A,B,C,D,E} е суперключ

Декомпозиция:

BDE -> C

R1(B,C,D,E) и R2(A,B,D,E)

R1(B,C,D,E)

B -> D

DE -> C

BC -> D

BE -> C

BE -> D

BCE -> D

BDE -> C

Ключове: {B,E}

DE -> C

R11(C,D,E) и R12(B,D,E)

R11(C,D,E)

DE -> C

Ключове: {D,E}

В BCNF

R12(B,D,E)

B -> D

BE -> D

Ключове: {B,E}

B -> D

R121(B,D) и R122(B,E)

R2(A,B,D,E)

B -> D

BE -> D

AB -> D

ABE -> D

Ключове: {A,B,E}

BE -> D

R21(B,E,D) и R22(A,B,E)

R21(B,E,D)

B -> D

BE -> D

Ключове: {B,E}

B -> D

R211(B,D) и R(B,E)

R22(A,B,E)

Ключове: {A,B,E}

R(A,B,C,D)

A ->> B

A ->> C

{A,B,C,D} е единствения ключ, защото няма функционални зависимости

Декомпозиция:

A ->> C

R1(A,C) и R2(A,B,D)

R1(A,C)

A ->> C е тривиална

{A,C} е ключ

R2(A,B,D)

A ->> B

{A,B,D} е ключ

A ->> B

R21(A,B) и R22(A,D)

R21(A,B)

A ->> B е тривиална

{A,B} е ключ

R22(A,D)

{A,D} е ключ

R(A,B,C,D,E)

A ->> B

AB ->> C

A -> D

AB -> E

X={A} и A -> D

X={A,D}

{A}+ = {A,D}

{B}+ = {B}

{C}+ = {C}

{D}+ = {D}

{E}+ = {E}

X={A,B} и AB -> E

X={A,B,E} и A -> D

X={A,B,D,E}

{A,B}+ = {A,B,D,E}

AB -> D

X={A,C} и A -> D

X={A,C,D}

{A,C}+ = {A,C,D}

AC -> D

{A,D}+ = {A,D}

X={A,E} и A -> D

X={A,D,E}

{A,E}+ = {A,D,E}

AE -> D

{B,C}+ = {B,C}

{B,D}+ = {B,D}

{B,E}+ = {B,E}

{C,D}+ = {C,D}

{C,E}+ = {C,E}

{D,E}+ = {D,E}

X={A,B,C} и A -> D

X={A,B,C,D} и AB -> E

X={A,B,C,D,E}

{A,B,C}+ = {A,B,C,D,E}

**{A,B,C} е ключ**

ABC -> D

ABC -> E

X={A,B,D} и AB -> E

X={A,B,D,E}

{A,B,D}+ = {A,B,D,E}

ABD -> E

X={A,B,E} и A -> D

X={A,B,D,E}

{A,B,E}+ = {A,B,D,E}

ABE -> D

{A,C,D}+ = {A,C,D}

X={A,C,E} и A -> D

X={A,C,D,E}

{A,C,E}+ = {A,C,D,E}

ACE -> D

{A,D,E}+ = {A,D,E}

{B,C,D}+ = {B,C,D}

{B,C,E}+ = {B,C,E}

{B,D,E}+ = {B,D,E}

{C,D,E}+ = {C,D,E}

{A,B,C,D}+ = {A,B,C,D,E}

{A,B,C,D} е суперключ

ABCD -> E

{A,B,C,E}+ = {A,B,C,D,E}

{A,B,C,E} е суперключ

ABCE -> D

{A,B,D,E}+ = {A,B,D,E}

{A,C,D,E}+ = {A,C,D,E}

{B,C,D,E}+ = {B,C,D,E}

{A,B,C,D,E} е суперключ

Декомпозиция:

ACE -> D

R1(A,C,D,E) и R2(A,B,C,E)

R1(A,C,D,E)

ACE -> D

A -> D

AC -> D

AE -> D

Ключове: {A,C,E}

AE -> D

R11(A,D,E) и R12(A,C,E)

R11(A,D,E)

AE -> D

A -> D

Ключове: {A,E}

A -> D

R111(A,D) и R112(A,E)

R12(A,C,E)

Ключове: {A,C,E}

R2(A,B,C,E)

A ->> B

AB ->> C

AB -> E

ABC -> E

Ключове: {A,B,C}

AB ->> C

R21(A,B,C) и R22(A,B,E)

R21(A,B,C)

AB ->> C

A ->> B – нарушител, защото не е тривиална

Ключове: {A,B,C}

А ->> Б

R211(A,B) и R212(A,C)

R22(A,B,E)

A ->> B

AB -> E

Ключове: {A,B}

A ->> B

R221(A,B) и R222(A,E)