CSC343 Assignment 3 Part 2: Functional Dependencies, Decompositions, Normal Forms

1.

(a) By looking at each relation in the schema:

(i) BH^+=BHADGEFC, thus BH is a superkey and BH->AD doesn't violate BCNF

(ii) D^+=DBHAGEFC, thus D is also a superkey and D->BH doesn't violate BCNF

(iii) BCE^+=BCEF, therefore BCE->F violates BCNF

(iv) F^+=FC, therefore F->C violates BCNF

(v) A^+=AGEFC, therefore A->GEF violates BCNF

(b)

(i)Decompose R using A->GEF where A^+=AGEFC

This yields R1=ACEFG and R2=ABDH

Project the FDs onto R1=ACEFG

A	C	E	F	G	Closure	FDs
✓					A^+=ACEFG	A->CEFG
	✓				C^+=C	Nothing
		✓			E^+=E	Nothing
			✓		F^+=CF	F->C violates BCNF

(ii)Decompose R1 using F->C. This yields R3=CF and R4=AEFG

(iii)Project the FDs onto R3=CF

C	F	Closure	FDs
✓		C^+=C	Nothing
	✓	F^+=CF	F->C. F is a superkey of R3
✓	✓	CF^+=CF	Nothing

This relation satisfies BCNF.

(iv)Project the FDs onto R4 = AEFG

A	E	F	G	Closure	FGs
✓				A^+=AGEFC	A->GEF. A is a superkey of R4
	✓			E^+=E	nothing
		✓		F^+=FC	nothing
			✓	G^+=G	nothing
Supersets of A				Irrelevant	Can only generate weaker FDs than what we have already
	✓	✓		EF^+=EFC	nothing
	✓		✓	EG^+=EG	nothing
		✓	✓	FG^+=FGC	nothing
	✓	✓	✓	EFG^+=EFGC	nothing

This relation satisfies BCNF.

(v) R2=ABDH, project the FDs onto R2=ABDH

A	B	D	H	Closure	FDs
✓				A^+=ACGEF	Nothing
	✓			B^+=B	Nothing
		✓		D^+=DBHA	D->ABH. D is a superkey of R2
			✓	H^+=H	Nothing
✓	✓			AB^+=ABGEF C	Nothing
✓			✓	AH^+=AHGEF C	Nothing
	✓		✓	BH^+=BHADG EFC	BH->AD. BH is a superkey of R2
Supersets of D				Irrelevant	Can only generate weaker FDs than what we have already.

This relation satisfies BCNF

(vi) Final decomposition:

R2=ABDH with FDs D->ABH, BH->AD
R3=CF with FD F->C
R4=AEFG with A->GEF

2.

(a)

Left	Middle	Right
	ABCDF	EG

A^+=A
B^+=B
C^+=C

D^+=ABCDEFG (key)
F^+= F
AB^+=AB
AC^+=AC
AD^+=ABCDEFG (key)
AF^+=AF
BC^+=BC
BD^+=ABCDEFG (key)
BF^+=BF
CD^+=ABCDEFG (key)
CF^+=CF
DF^+=ABCDEFG (key)
ABC^+=ABC
ABD^+=ABCDEFG (key)
ABF^+=ABF
BCD^+=ABCDEFG (key)
BCF^+=BCF
CDF^+=ABCDEFG (key)
$ABCD^+$=ABCDEFG (key)
$ABCF^+$=ABCF
$BCDF^+$=ABCDEFG (key)
$ABCDF^+$=ABCDEFG (key)

Therefore the keys are D, AD, BD, CD, DF, ABD, BCD, CDF, ABCD, BCDF, and ABCDF.

(b)
(i)Set S1 (Simplify to singleton RHS):

FD	Closure	Decision
DBE->F	DBE^+=DBECAGF	discard
DBE->C	DBE^+=DBEAGCF	discard
CD->A	CD^+=CDFABGE	discard
CD->F	CD^+=CDABGFE	discard
D->A	D^+=DBGF, there is no way to get A without this FD.	keep
D->B	D^+=DGAF, there is no way to get B without this FD	keep
D->G	D^+=DABFE	keep
BADE->C	$BADE^+$=BADEFB	keep
ABD->E	ABD^+=ABDFG	keep
D->F	D^+=ABDGEC	keep
EF->B	EF^+=EF	keep

(ii) Remaining FDs S2

1.D->A
2.D->B
3.D->G
4.BADE->C
5.ABD->E
6.D->F
7.EF->B

4.BADE->C

D^+=ABCDEFG so we can reduce the LHS to D.

5.ABD->E

D^+=ABCDEFG so we can reduce the LHS to E

7.EF->B

We saw that E^+=E and F^+=F, so this FD remains as it is.

(iii) Remaining FDs S3

1. D->A
2. D->B
3. D->G
4. D->C
5. D->E
6. D->F
7. EF->B

FD	Closure	Decision
D->A	There is no way to get A without this FD.	keep
D->B	D^+=ADGCEFB	discard
D->G	There is no way to get G without this FD.	keep
D->C	There is no way to get C without this FD.	keep
D->E	There is no way to get E without this FD.	keep
D->F	There is no way to get F without this FD.	keep
EF->B	There is no way to get B without this FD.	keep

(iv) No further simplifications are possible, so the following set S4 is a minimal basis.

Remaining FDs S4

1. D->A
2. D->C
3. D->E
4. D->F
5. D->G
6. EF->B

(c)
D->ACEFG, EF->B
R1(A, C, D, E, F, G), R2(B, E, F)
D is a key of R, thus there is no need to add another relation that includes a key.
Therefore the final set of relations is:

R1(A, C, D, E, F, G), R2(B, E, F)

(d)
No because there are no FDs that violate BCNF, thus redundancy is not allowed.