CSC343 A3 Part 2

1-

(a)

A^+ = AE, which means A is not a superkey thus A➔E violates BCNF.
BC^+ = BCAFE, for the same reasoning BC➔AE also violates BCNF.
C^+ = CAFE, C➔ACF also violates BCNF.
DE^+ = DEA, DE➔A also violates BCNF.
EFG^+ = EFGABE, EFG➔AB also violates BCNF.
I^+ = IJAE, I➔J also violates BCNF.
J^+ = JAIE, J➔AI also violates BCNF.

(b)

- Decompose R using FD A➔E. A^+ = AE, so this yields two relations: R1 = AE, R2 = ABCDFGHIJ
- Project FDs onto R1 = AE:

A	E	Closure	FDs
X		A^+ = AE	A➔E
	X	E^+ = E	

- Project FDs onto R2 = ABCDFGHIJ

A	B	C	D	F	G	H	I	J	Closure	FDs
X									A+ = A	none
	X								B+ = B	none
		X							C+ = ACF	C➔AF

C➔AF violates BCNF, so we abort projection. We must decompose R2 further.

-Decompose R2 using FD C➔AF. This yields two relations: R3 = CAF and R4 = BDGHIJ.

-Project FDs onto R3 = CAF

C	A	F	Closure	FDs
X			$C^+ = CAF$	C➔AF ,C is a superkey
	X		$A^+ = A$	Nothing
		X	$F^+ = F$	Nothing
Supersets of C			Irrelevant	Can only generate weaker FDs
	X	X	$AF^+ = AF$	Nothing

This relation satisfies BCNF.

-Project FDs onto R4 = BDGHIJ

B	D	G	H	I	J	Closure	FDs
X						$B^+=B$	Nothing
	X					$D^+=D$	Nothing
		X				$G^+=G$	Nothing
			X			$H^+=H$	Nothing
				X		$I^+=IJ$	I➔J

I➔J violates BCNF, so we abort the projection.
-Decompose R4 using I➔J. This yields two relations R5 = IJ and R6 = BDGH.
-Project the FDs onto R5 = IJ

I	J	Closure	FDs
X		$I^+ = IJ$	I➔J
	X	$J^+ = JI$	J➔I

This relation satisfies BCNF.

-Project the FDs onto R6 = BDGH

B	D	G	H	Closure	FDs
X				$B^+=B$	Nothing
	X			$D^+=D$	Nothing
		X		$G^+=G$	Nothing
			X	$H^+=H$	Nothing

This relation satisfies BCNF.

Result

1. R3: ACF with C➔AF
2. R1: AE with A➔E
3. R6: BDGH with no FDs
4. R5: IJ with I➔J and J➔I

(c) No it’s not dependency preserved because BC➔AE is not preserved.

2-

(a) FH is in every key because they never appear on the right hand side.
D is not in any key. We have to check the others.

AFH^+ = AFHB (not a key)
BFH^+ = BFH (not a key)
CFH^+ = CFHBAEGD (CFH is a key)
EFH^+ = EFHCGABD (EFH is a key)
GFH^+ = GFHABCDE (GFH is a key)

(b)
- We have to first simplify to singleton right-hand sides and call this set T1.

1. A➔B
2. BC➔A
3. BC➔C
4. BC➔E
5. C➔B
6. EF➔C
7. EF➔G
8. EFG➔A
9. EFG➔B
10. EFG➔C
11. EFG➔D
12. GH➔A
13. GH➔B
14. GH➔C
15. GH➔D

-Look for redundant FDs to eliminate

FD	Exclude these from T1 when computing closure	Closure	Decision
1	1	A^+=A	Keep
2	2	BC^+=BCE	Keep
3	3	BC^+=BC/	Discard
4	3,4	BC^+=BC	Keep
5	3,5	C^+=C	Keep
6	3,6	EF^+ =EFGC/	Discard
7	3,6,7	EF^+ = EF	Keep
8	3,6,8	EFG^+=EFGBCDA/	Discard
9	3,6,8,9	EFG^+=EFGCDB/	Discard
10	3,6,8,9,10	EFG^+=EFGD	Keep
11	3,6,8,9,11	EFG^+=EFGCB	Keep
12	3,6,8,9,12	GH^+=GHBCDA/	Discard
13	3,6,8,9,12,13	GH^+=GHCDB/	Discard
14	3,6,8,9,12,13,14	GH^+=GHD	Keep
15	3,6,8,9,12,13,15	GH^+=GHCBEA	Keep

-Let’s call the remaining FDs T2:

1 A➔B
2 BC➔A
4 BC➔E
5 C➔B
7 EF➔G
10 EFG➔C
11 EFG➔D
14 GH➔C
15 GH➔D

-Let’s try reducing the left hand side of any FDs with multiple attributes on the left hand side.

2 BC➔A

B^+ = B we can't reduce left hand side.
C^+ = CBA so we can reduce the left hand side to C.

4 BC➔E
C^+ = CBE so we can reduce left hand side to C.

7 EF➔G
E^+ = E we can't reduce.
F^+ = F we can't reduce.

10 EFG➔C
E^+ = E we can't reduce.
F^+ = F we can't reduce.
G^+ = G we can't reduce.
EF^+ = EFGC we can reduce left hand side to EF.

11 EFG➔D
EF^+ = EFGD we can reduce the left hand side to EF.

14 GH➔C
G^+ = G we can't reduce left hand side.
H^+ = H we can't reduce left hand side.

15 GH➔D can't reduce

-Let's call the set of FDs that we have after reducing left hand side T3:

1 A➔B
2' C➔A
4' C➔E
5 C➔B
7 EF➔G
10' EF➔C
11' EF➔D
14 GH➔C
15 GH➔D

-We must look again in case any of changes we made allow further simplification.

FD	Exclude from T3 when computing closure	Closure	Decision
1	1	$A^+ = A$	Keep
2’	2’	$C^+ = CEB$	Keep
4’	4’	$C^+ = CAB$	Keep
5	5	$C^+ = CAE$	Keep
7	7	$EF^+=EFCDAB$	Keep
10’	10’	$EF^+=EFGD$	Keep
11’	11’	$EF^+=EFGCAB$	Keep
14	14	$GH^+ = GHD$	Keep
15	15	$GH^+=GHCAEB$	Keep

- So the following set T4 is a minimal basis:

1 A➔B
2’ C➔A
4’ C➔E
5 C➔B
7 EF➔G
10’ EF➔C
11’ EF➔D
14 GH➔C
15 GH➔D

(b)–Let’s call the revised FDs T5:

A➔B, C➔AEB, EF➔GCD, GH➔CD

- The set of relations that would result would have these attributes:

R1(A,B), R2(C,A,E,B), R3(E,F,G,C,D), R4(G,H,C,D)

-Since attributes AB occur within R2, we don’t need to keep the relation R1.

R2(C,A,E,B), R3(E,F,G,C,D), R4(G,H,C,D)

(c) $A \rightarrow B$ will project onto relation R2 and $A+ = AB$ is not a super key of this relation. It violates BCNF therefore allows redundancy. So, the answer is yes, this schema allows redundancy.