1. a.   A = Restaurant   B = Address   C = Cuisine
        D = Rating   E = Rank   F = User-name
        G = User-reviews H = Date   I = Stars
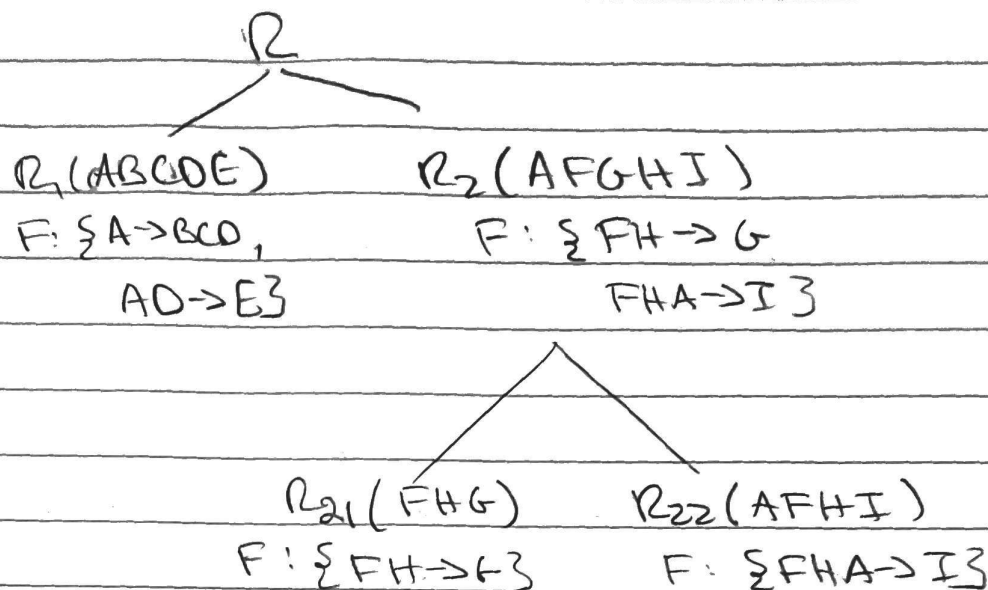
   $F = \{ A \rightarrow BCD, \quad AD \rightarrow E, \quad FH \rightarrow G, FHA \rightarrow I \}$

   b. $A^+ = \{ ABCDE \}$
        $AD^+ = \{ ABCDE \}$
        $FH^+ = \{ FHG \}$
        $FHA^+ = \{ ABCDEFGHI \}$

        FHA is a key for this scheme

   c. $A \rightarrow BCD$
        $AD \rightarrow ABCDE$
        $FH \rightarrow G$
        $FHA \rightarrow ABCDEFGHI$

d.

$$R$$

$$R_1(ABCDE) \qquad R_2(AFGHI)$$
$$F: \{A \to BCD, \qquad F: \{FH \to G$$
$$AD \to E\} \qquad FHA \to I\}$$

$$R_{21}(FHG) \qquad R_{22}(AFHI)$$
$$F: \{FH \to G\} \qquad F: \{FHA \to I\}$$

BCNF: $R_1(ABCDE)$, $R_{21}(FHG)$, $R_{22}(AFHI)$

e.

	A	B	C	D	E	F	G	H	I	
$R_1(ABCDE)$	a_1^a	b_1^b	c_1^c	d_1^d	e_1^e	f_1	g_1	h_1	i_1	
$R_{21}(FHG)$	a_2	b_2	c_2	d_2	e_2	f_2^f	g_2^g	h_2^h	i_2	
$R_{22}(AFHI)$	a_2^a	b_3^b	c_3^c	d_3^d	e_3^e	f_3^f	g_3^g	h_3^h	i_3^i	

Tuple $R_{22}(AFHI)$ has all of its placeholders replaced with actual values, therefore the BCNF is lossless

2. $R = \{ABCDE\}$

$F = \{A \to B, B \to C, C \to D, CD \to E, D \to A\}$

Pre processed: $F = \{A \to BCDE, B \to CDEA, C \to DAB,$
$CD \to E, D \to ABC\}$

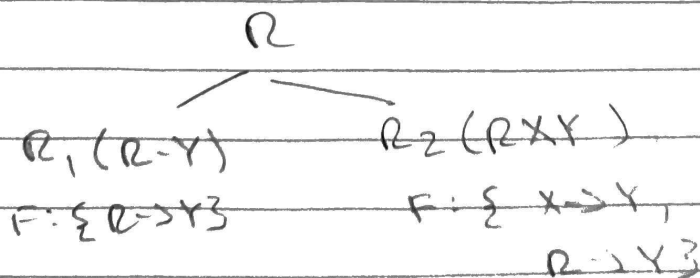ACD $F = \{A \to CD, C \to DA, D \to AC\}$
Yes, it is in BCNF. All keys are superkeys.

3. In general, N attributes with each being a candidate
key means the number of possible superkeys
are $2^N - 1$.

$R = \{ABCDEF\}$ has 6 attributes.

$2^6 - 1 = 63$.
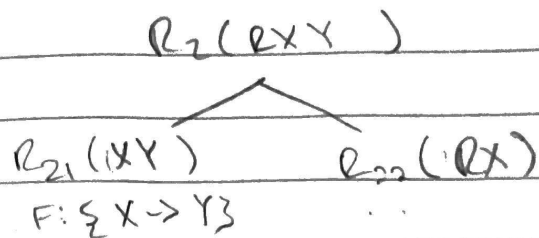
There are 63 possible superkeys.

4. $R = \{R, X, Y\}$

R
$R_1 (R-Y)$ $R_2 (RXY)$
$F : \{R \to Y\}$ $F : \{X \to Y,$
$R \to Y\}$

X-Y violates BCNF

$$R_2(RXY)$$

$$R_{21}(XY) \qquad R_{22}(RX)$$
$$F: \{X \rightarrow Y\}$$

	R	X	Y
$R_1(RY)$	a_1^r	x_1	$y_1 Y$
$R_{21}(XY)$	r_2	$x_2 X$	$y_2 Y$
$R_{22}(RX)$	r_2^r	$y_1 X$	$y_3 Y$

R_{22} is tuple t that all placeholders
are replaced with actual values,
so lossless.

S The consequences of deleting a beer from the
table Beers will automatically delete all
corresponding types in the sells table.

Deleting a tuple from the Sells table
is not much of an issue as corresponding
data in other tables are not deleted.

Inserting a tuple into Sells can be an issue
because we can only add topless with pre-existing
corresponding data in Beers.

(6. a.) $R_1(X)$

                                    $R_3(Y)$
                        $R_2(Y)$
                            $\hookrightarrow W_3(Y)$
                            $R_3(X)$ Precedence Graph
                        $R_2(Z)$
        $W_1(X)$

                        $W_2(Z)$

        $R_1(Z)$
        $W_1(Z)$
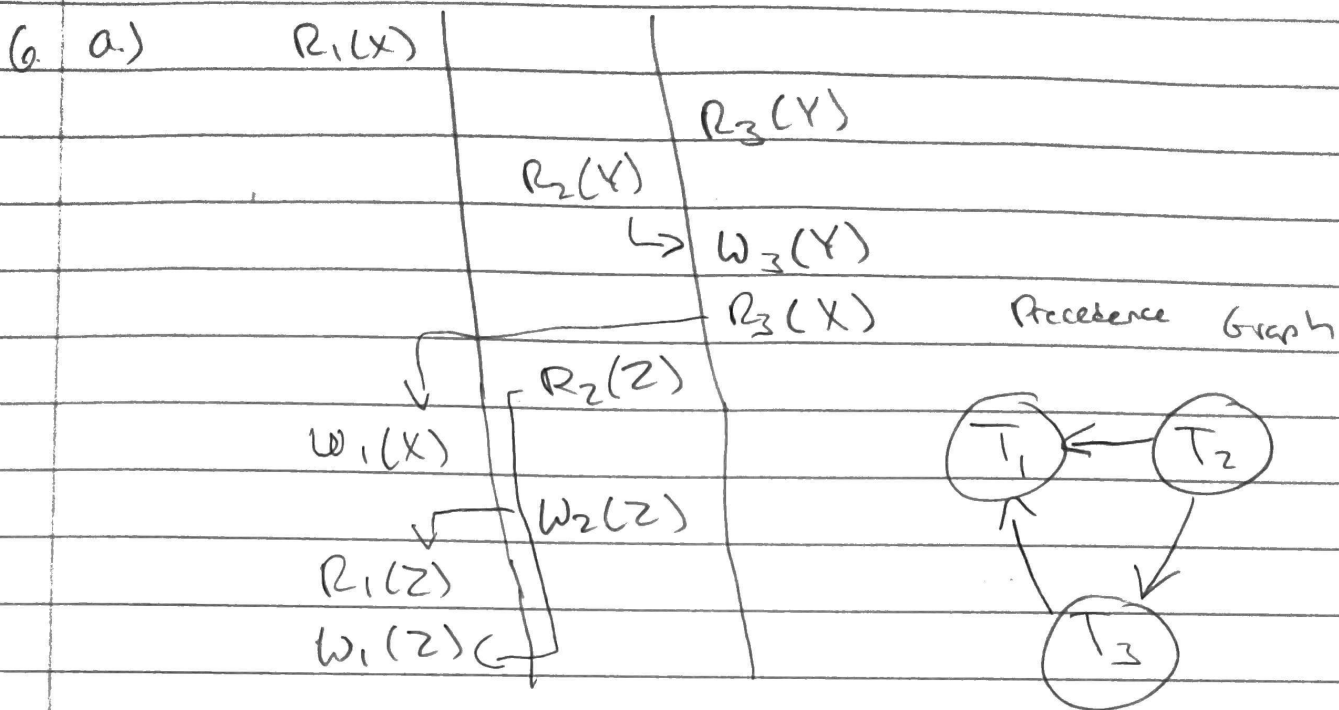
No Cycle between any vertices, so
Conflict Serializable

Serial schedules: T_2, T_3, T_1
                        T_2, T_1, T_3

b.

1	2	3
$r_1(x)$		
	$r_2(y)$	
		$r_3(y)$
		$w_3(y)$
	$r_2(z)$	
$w_1(x)$		
		$r_3(x)$
$r_1(z)$		
	$w_2(z)$	
$w_1(z)$		
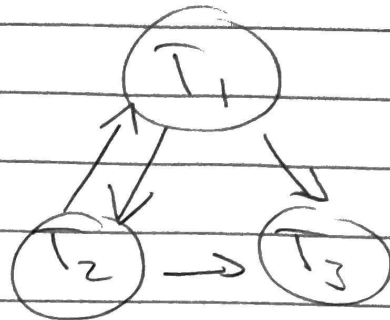
Not Conflict Serializable because T_1 & T_2 are cyclic.

c.

1	2	3
$r_1(x)$		
$w_1(x)$		
		$r_3(y)$
$r_1(z)$		
		$w_3(y)$
	$r_2(y)$	
	$r_2(z)$	
		$r_3(x)$
$w_1(z)$		
	$w_2(z)$	
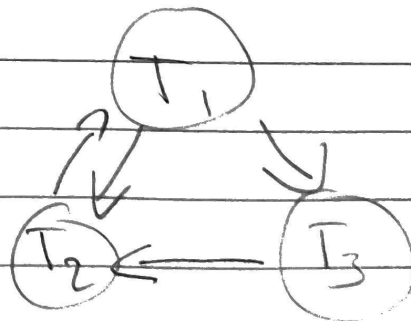
Not Conflict Serializable because T_1 & T_2 are cyclic

d.

1	2	3
$W_1(X)$		
		$r_3(Y)$
$r_1(Z)$		
		$W_3(Y)$
	$r_2(Y)$	
	$r_2(Z)$	
		$r_3(X)$
	$W_2(Z)$	
	$W_2(Y)$	
$W_1(Z)$		
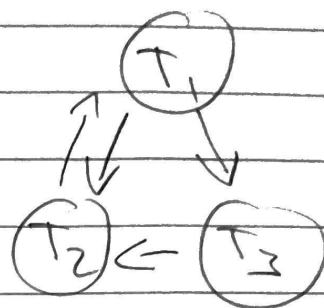
T_2 and T_1 are cyclic, so not conflict serializable