Q1.

a. ak aj bj ck

S ->aSc | T

T-> aTb| ^

b. ai bi bk ck

S -> PQ

P -> aPb | ^

Q -> bQc | ^

c. ai bi ck or ai bk ck

S -> PC | AQ

P -> aPb | ^ , C -> cC | ^

Q -> bQc | ^, A -> aA | ^

d. aj bj ck or ak bj ck

S -> PC | U

P -> aPb | ^, C -> cC | ^

U -> aUc | B, B -> bB | ^

e. ai bi bm ck or ak am bj ck where m>0

S -> PBC | T

P -> aPb|^

B->bB|b, C -> cC|^

T -> aTc | Q

Q -> AB1

A-> aA|a, B1 -> bB1|^

f. ai bj , i<= 2j,

every b has at most 2 corresponding a's

S-> Sb | aSb | aaSb | ^

g. ai bj , i<2j => i <= 2j-1

every b can have at most 2 corresponding a's except 1

S -> aTb | Tb

T-> Tb | aTb | aaTb | ^

h. ai bj , i<= j <= 2i

every a has at least 1 and at most 2 corresponding b's

S -> aSb | aSbb | ^

Q2.

1. palindrome even length

2. pal odd length

3. equal no. of as and bs

4. non-palindrome string

5. string ending with a

6. string ending with a

7. string starting and ending with b

8. {correction T-> aS/bS} even length strings

Q3.

No, the string aabbcc cannot be obtained from this CFG. If it could, the first production in any derivation would have to be S->aSbScS. The only way aabbcc could be obtained from aSbScS would be for the first S to be eventually replaced by either a or ab, and neither a nor ab has equal no. of as bs and cs.

Q4.

1. no ^ productions, no unit productions

iii) S -> Xa A Xb B

A -> A Xb | b, Xb -> b

B -> B Xa | a, Xa -> a

iv) S -> PQ

P -> Xa A , Q -> Xb B

A -> A Xb | b, Xb -> b

B -> B Xa | a, Xa -> a

2. iii) S -> Xa A | Xb B

A -> Xb A A | a ; Xa -> a

B -> B B Xa | b ; Xb -> b

iv) S -> Xa A | Xb B

A -> Xb P | a ; Xa -> a ; P -> A A

B -> B Q | b ; Xb -> b ; Q -> B Xa

3. iii) S -> Xa AC

A -> Xa B | Xb AB

B -> b , C -> c, Xa -> a , Xb -> b

4. S -> AXBY

X -> AX | A ; A-> 0

Y -> BY | B ; B -> 1

iv) S -> PQ

P ->AX , Q -> BY

X -> AX | A ; A-> 0

Y -> BY | B ; B -> 1

5. S -> abSab | a | aAAb

A -> bS | aAAb | c

iii) S -> Xa Xb S Xa Xb | a | Xa AA Xb

A -> Xb S | Xa AA Xb | c

Xa -> a, Xb -> b

iv ) S -> PQ | a | YZ

Q -> SP , P -> Xa Xb

Y -> Xa A , Z ->A Xb

A -> Xb S | YZ | c

Xa -> a, Xb -> b

Q5.

Q6.

1) S -> ABC | 0

A -> 1

B -> 2 | 0

C -> 2

D -> 2

E -> 2

2) S -> ABCD | 0

A -> BC | 1

B -> d

C -> d

D -> d