1.

a. L1 = { w ∈ {0, 1}∗ | w contains at least three 1s }

S->A1A1A1

A->0A|1A| λ

b. L2 = { w ∈ {0, 1}*| w = wR and |w| is even }

S-> 0S0|1S1| λ

C. L3 = { ai bj ck | i, j, k ≥ 0, and i = j or i = k }

S->AB|D

A->aAb| λ

B->cB| λ

D->aDc| λ

E->bE| λ

2.

By the rules we can know:

S->∅|a|b, S->SS, S->S+S, S->(S), S->S^*

Then S->a|b|(S)|S+S|SS|S^*

Therefore, CFG, G=(V,T,S,P) T={a,b,(,),+,*,∅} V={S}

Where

S = starting valiable

P = production set

Derivation of $(a+b)^*$:

S->$S^* \Rightarrow (S)^* \Rightarrow (S+S)^* \Rightarrow (a+S)^* \Rightarrow (a+b)^*$

3.

a.

because S->SS | AAA |λ and A->aA | Aa | b

so $(\mathrm{a}^*\mathrm{ba}^*\mathrm{ba}^*\mathrm{ba}^*)^*$

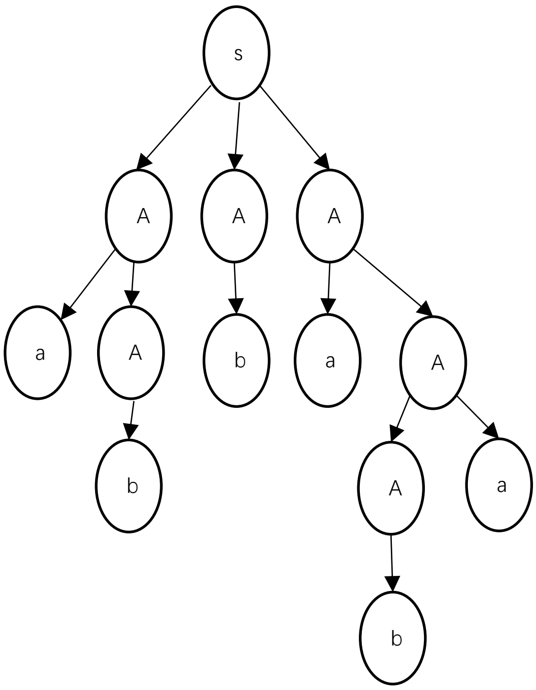
b.

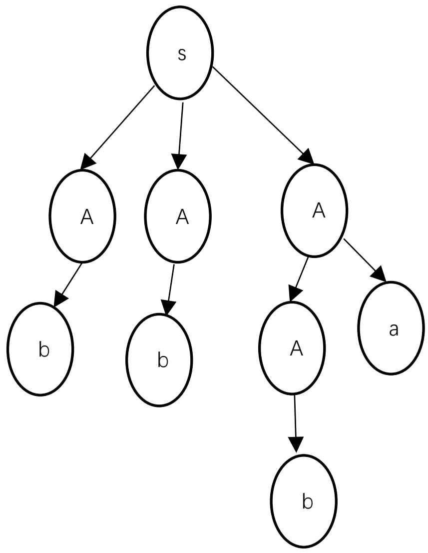
because require left-most derivation strings is abbaba.

S->abbaba, left most derivation:

S->AAA⇒aAAA⇒abAAA⇒abbA⇒abbaAa⇒abbaba

c.





d. S->A|λ

A->aA|bB

B->aB|bC

C->aC|bD

D->aD|A| λ

4.

Because n>=1

S->aAb

A->aAb

A->b

5.

a.

L={$a^{\mathrm{n}}b^{\mathrm{n}}$:$n \geq 0$}

Then $L^2 = \{a^{\mathrm{n}}b^{\mathrm{n}}a^{\mathrm{n}}b^{\mathrm{n}}: n \geq 0\}$

G=(V,T,S,P) with set of variables

V = {S,A}, where S is the start variable; set terminals T = {a,b}

S->SS

S->aSb

S->λ

Therefore,L^2 is a context-free language.

b.

L=$\{a^{n}b^{n}: n \geq 0\}$

Then $L^{*} = \{(a^{n}b^{n})^{*}: n \geq 0\}$

G=(V,T,S,P) with set of variables

V = {S,A}, where S is the start variable; set terminals T = {a,b}

S->S^{*}

S->aSb

S-> λ

Therefore, L^{*} is a context-free language