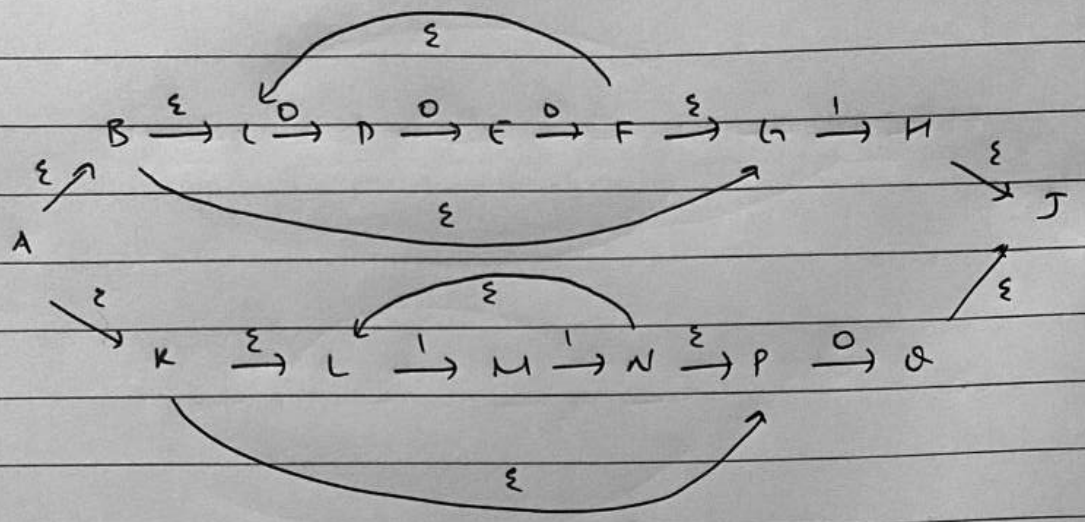
Question 1

$(000)^*1 + (11)^*0$

a.



b. $\varepsilon\text{-cl}(A) = \{A, B, C, G, K, L, P\} = a$

$Dtran(a, 0) = \varepsilon\text{-cl}(move(a, 0))$

$= \varepsilon\text{-cl}(D, Q)$

$= \{D, Q, J\} = b$

$Dtran(a, 1) = \varepsilon\text{-cl}(move(a, 1))$

$= \varepsilon\text{-cl}(H, M)$

$= \{H, M, J\} = c$

$Dtran(b, 0) = \varepsilon\text{-cl}(move(b, 0))$

$= \varepsilon\text{-cl}(E)$

$= \{E\} = d$

$Dtran(b, 1) = \varepsilon\text{-cl}(move(b, 1))$

$= \varepsilon\text{-cl}(\emptyset)$

$= \emptyset$

$Dtran(c, 0) = \varepsilon\text{-cl}(move(c, 0))$

$= \varepsilon\text{-cl}(\emptyset)$

$= \emptyset$

Dtran(c,1) = ε-cl(move(c,1))

= ε-cl(N) = {N, L, P}

= {N} = e

Dtran(d,0) = ε-cl(move(d,0))

= ε-cl(F)

= {F, G, J} = f

Dtran(d,1) = ε-cl(move(d,1))

= ε-cl(∅)

= ∅

Dtran(e,0) = ε-cl(move(e,0))

= ε-cl(Q)

= {Q, J} = g

Dtran(e,1) = ε-cl(move(e,1))

= ε-cl(M)

= {M} = h

Dtran(f,0) = ε-cl(move(f,0))

= ε-cl(D)

= {D} = i

Dtran(f,1) = ε-cl(move(f,1))

= ε-cl(H)

= {H, J} = j

Dtran(g,0) = ε-cl(move(g,0))

= ε-cl(∅)

= ∅

Dtran(g,1) = ε-cl(move(g,1))

= ε-cl(∅) = ∅

Dtran(h, 0) = ε-cl(move(h, 0))

= ε-cl(∅) = ∅

Dtran(h, 1) = ε-cl(move(h, 1))

= ε-cl(N)

= {N, L, P} = e

Dtran(i, 0) = ε-cl(move(i, 0))

= ε-cl(E)

= {E} = d

Dtran(i, 1) = ε-cl(move(i, 1))

= ε-cl(∅) = ∅

Dtran(j, 0) = ε-cl(move(j, 0))

= ε-cl(∅)

= ∅

Dtran(j, 1) = ε-cl(move(j, 1))

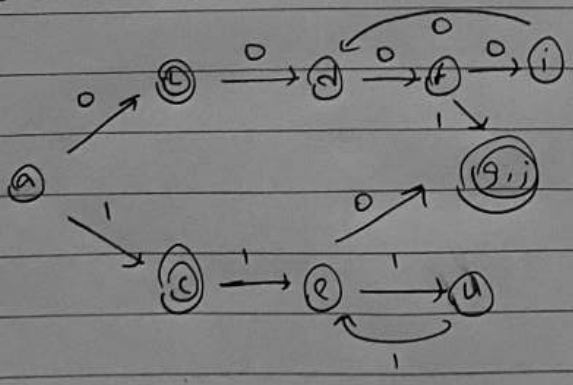
= ε-cl(∅) = ∅

c. Transition Table

	State	0	1
→	a	b	c
*	b	d	ϕ
*	c	ϕ	e
	d	f	ϕ
	e	g	h
	f	i	j
*	g	ϕ	ϕ
	h	ϕ	e
	i	d	ϕ
*	j	ϕ	ϕ

	a	b	c	d	e	f	g	h	i	j
a	X									
b	✓	X								
c	✓	✓	X							
d	✓	✓	✓	X						
e	✓	✓	✓	✓	X					
f	✓	✓	✓	✓	✓	X				
g	✓	✓	✓	✓	✓	✓	X			
h	✓	✓	✓	✓	✓	✓	✓	X		
i	✓	✓	✓	✓	✓	✓	✓	✓	X	
j	✓	✓	✓	✓	✓	✓		✓	✓	X

∴ States are {a, b, c, d, e, f, h, i, {g, j}}



d. $(000)*1 \mid (11)*0$

~~$S \rightarrow 000S \mid A \mid 1$~~

~~$A \rightarrow 11A \mid 0$~~

$S \rightarrow A \mid B$

$A \rightarrow 000A \mid 1$

$B \rightarrow 11B \mid 0$

e. Creating CNF

$S \rightarrow 000A \mid 1 \mid 11B \mid 0$

$A \rightarrow 000A \mid 1$

$B \rightarrow 11B \mid 0$

$S \rightarrow PQ \mid 1 \mid YB \mid 0$

$P \rightarrow ZZ$

$Z \rightarrow 0$

$Y \rightarrow XX$

$X \rightarrow 1$

$Q \rightarrow 0A = ZA$

$A \rightarrow PQ \mid 1$

$B \rightarrow YB \mid 0$

This is now in CNF

Question 2

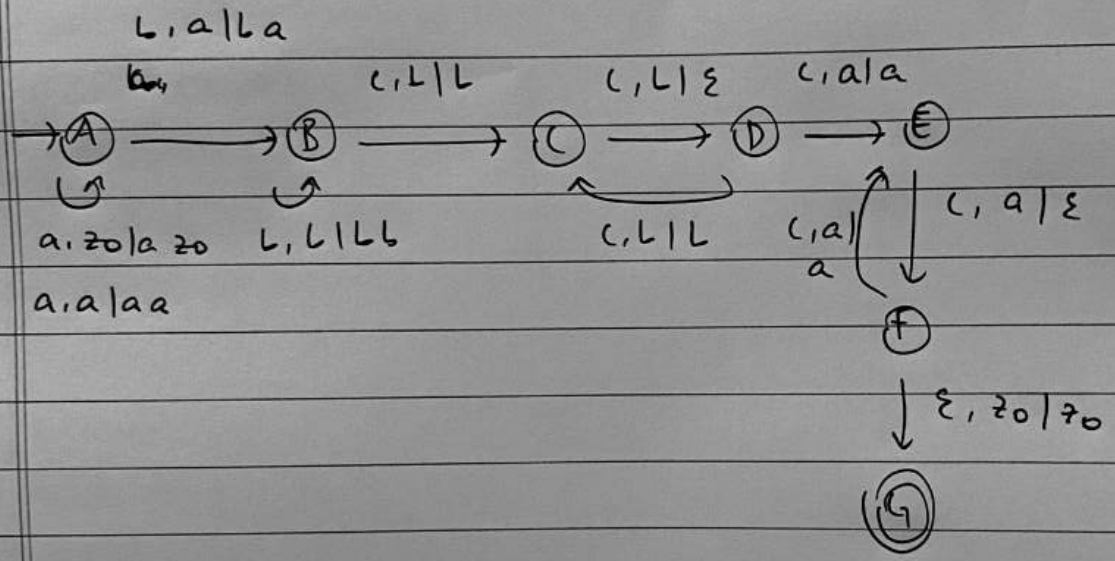
$L = \{ a^n L^m c^{2(m+n)} \mid m, n \geq 0 \}$

Grammar:

$S \rightarrow aSccc \mid A \mid \varepsilon$

$A \rightarrow LAcc \mid \varepsilon$

PDA:



Question 3

Let R = a

G = b

B = c

$L = \{(ab^2c^3)^n \mid n \geq 1\}$