DOCUMENTATION FOR
QUESTION 2:

PART 1:
Converting CFG to PDA :

The PDA will have only one state {q}.
The start symbol of CFG will be the start symbol in the PDA.
All non-terminals of the CFG will be the stack symbols of the PDA and all the terminals of the CFG will be the input symbols of the PDA.

Example :
Suppose the given CFG is :
S -> aSa | bSb | A | bB
A -> a | ^
B -> b | ^

Then its corresponding PDA will be,

d(q,^,S) -> (q,aSa)
d(q,^,S) -> (q,bSb)
d(q,^,S) -> (q,A)
d(q,^,S) -> (q,bB)
d(q,^,A) -> (q,a)
d(q,^,A) -> (q,^)
d(q,^,B) -> (q,b)
d(q,^,B) -> (q,^)
d(q,a,a) -> ^
d(q,b,b) -> ^

Solution approach:
The contents of the file are stored in ‘rules’ & for all the productions of each non-terminal, the corresponding delta function is displayed.
In the end, for all the terminals,popping operation is done.

PART 2:
Converting PDA TO CFG:

Example:

Transition Table for the PDA :

Move number	State	Input	Stack Symbol	Move(s)
1	q0	a	Z	(q0,AZ)

2	q0	b	Z	(q0,BZ)
3	q0	a	A	(q0,AA)
4	q0	b	A	(q0,BA)
5	q0	a	B	(q0,AB)
6	q0	b	B	(q0,BB)
7	q0	c	Z	(q1,Z)
8	q0	c	A	(q1,A)
9	q0	c	B	(q1,B)
10	q1	a	A	(q1,^)
11	q1	b	B	(q1,^)
12	q1	^	Z	(q1,^)

The CFG would be
S -> [q0,Z,xi]
[q0,Z,x0] -> a [q0,A,x1][x1,Z,x0]
[q0,Z,x0] -> b [q0,B,x1][x1,Z,x0]
[q0,A,x0] -> a [q0,A,x1][x1,A,x0]
[q0,A,x0] -> b [q0,B,x1][x1,A,x0]
[q0,B,x0] -> a [q0,A,x1][x1,B,x0]
[q0,B,x0] -> b [q0,B,x1][x1,B,x0]
[q0,Z,x0] -> c [q1,Z,x0]
[q0,A,x0] -> c [q1,A,x0]
[q0,B,x0] -> c [q1,B,x0]
[q1,A,q1] -> a
[q1,B,q1] -> b
[q1,Z,q1] -> ^

The total no. of productions for the above CFG are 35 allowing all combinations of xi.
They are computed as follows :
Productions for start symbol = no. of states in the PDA
= 2
Productions for moves with two terms = 6*(2^2)
Productions for moves with one term = 3*(2^1)
Productions for moves with one term which is ^ = 3*1
Adding all we get, total_num_productions = 2 + 24 + 6 + 3
= 35

Note : Here xi indicates the total no. of states in the PDA. In the above eg. there only 2 states q0 & q1. So, x0 can be q0 & x1 can be q1. And then we consider all of their combinations.

Let P be productions in grammar G = (V,Σ,S,P)
The set P contains the following productions & only these:

1. For every q ∈ Q, the productions S -> [q0,Z,q] is in P.
2. For every q,q1 ∈ Q, if d(q,a,A) contains (q1,^), then the production [q,A,q1] -> a is in P.
3. For every q,q1 ∈ Q, if d(q,a,A) contains (q1,B1,B2,B3……..,Bm), then for every choice of q2………...qm+1 ∈ Q, the production

    [q,A,qm+1] ->a[q1,B1,q2][q2,B2,q3].............[qm,Bm,qm+1]

   is in P.

Solution approach:
The data (pda transition table) is stored from the file in pda 2D vector.
Then for every move, the template is displayed & productions are computed allowing all combinations of the xi.