School Of Computing

LAB MANUAL

III Year / VI SEM (CSE -CYS) 20CYS315 –

AUTOMATA THEORY AND

COMPILER DESIGN

Amrita Vishwa Vidyapeetham Chennai – 601 103,
Tamil Nadu, India.

BONAFIDE CERTIFICATE

University Register Number: CH.EN.U4CYS22026

This is to certify that this is a bonafide record work done by Mr.Kiruthik Pranav P V studying B.Tech Computer Science Engineering in Cyber Security in 2022-26 in Amrita Vishwa Vidyapeetham, Chennai Campus.

Date: 19-03-2025
Examiner

List of Experiments

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6	Write a program to Convert the Epsilon NFA to DFA
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9	Write a Python program to construct a Pushdown Automaton (PDA) for the following Language L={wCw^r|w belongs to (a+b)^*}
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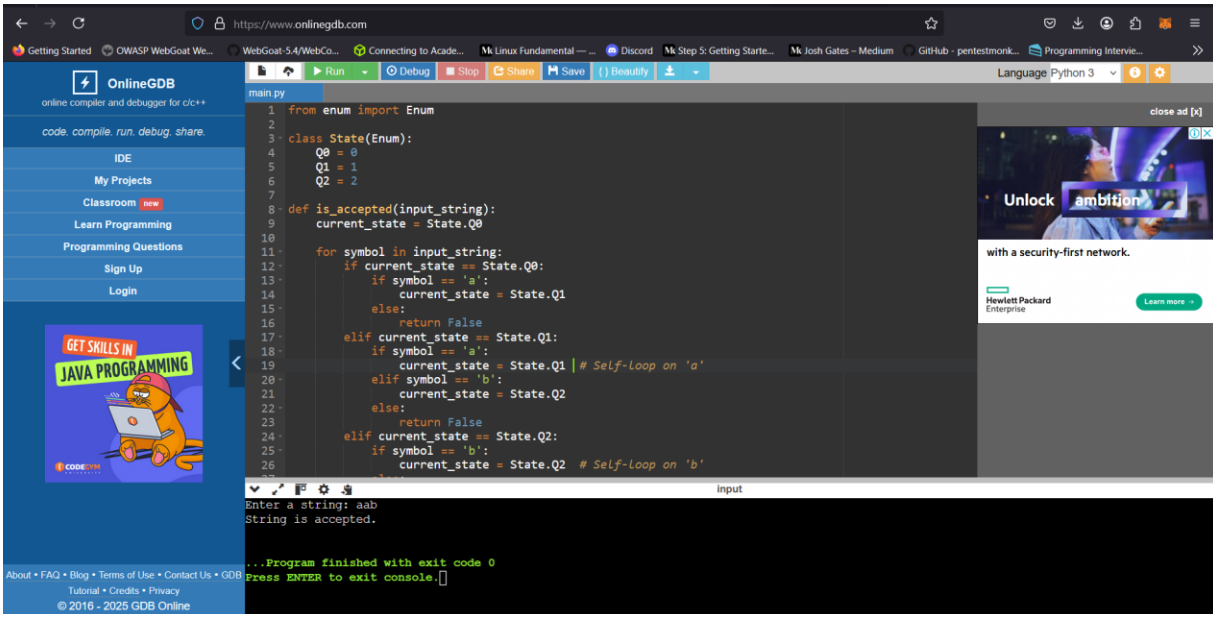
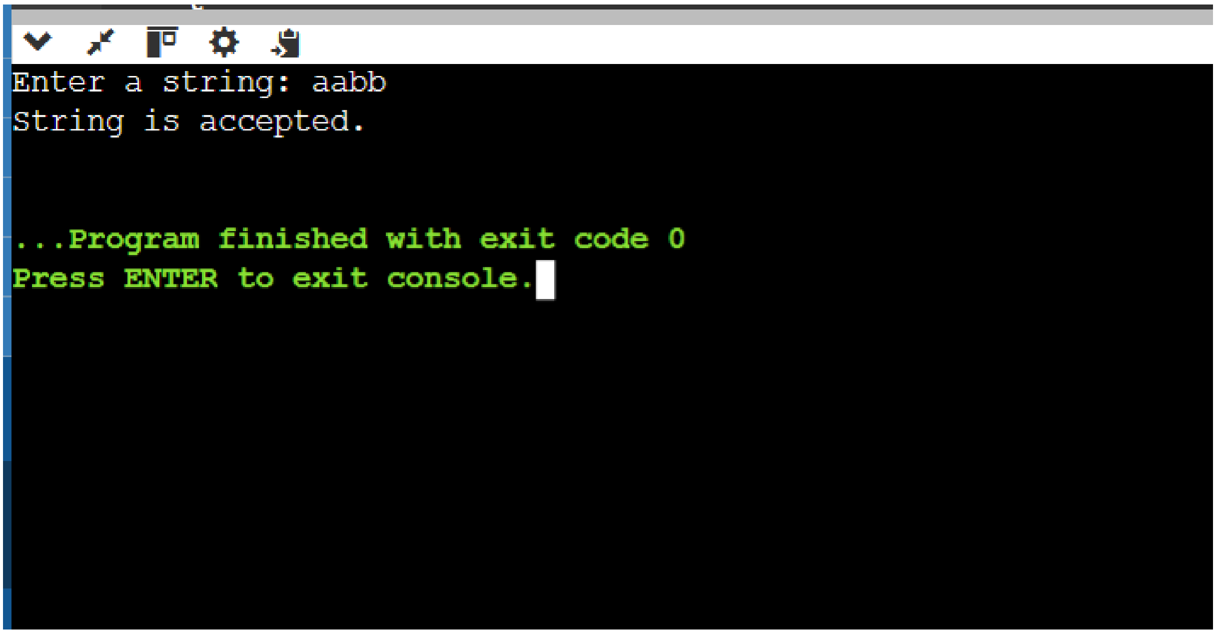
1. Write a program to construct the DFA for the given Strings.

CODE:

```
from enum import Enum

class State(Enum):
    Q0 = 0
    Q1 = 1
    Q2 = 2

def is_accepted(input_string):
    current_state = State.Q0

    for symbol in input_string:
        if current_state == State.Q0:
            if symbol == 'a':
                current_state = State.Q1
            else:
                return False
        elif current_state == State.Q1:
            if symbol == 'a':
                current_state = State.Q1  # Self-loop on 'a'
            elif symbol == 'b':
                current_state = State.Q2
            else:
                return False
        elif current_state == State.Q2:
            if symbol == 'b':
                current_state = State.Q2  # Self-loop on 'b'
            else:
                return False

    return current_state == State.Q2

if __name__ == "__main__":
    input_string = input("Enter a string: ")
    if is_accepted(input_string):
        print("String is accepted.")
    else:
        print("String is not accepted.")
```

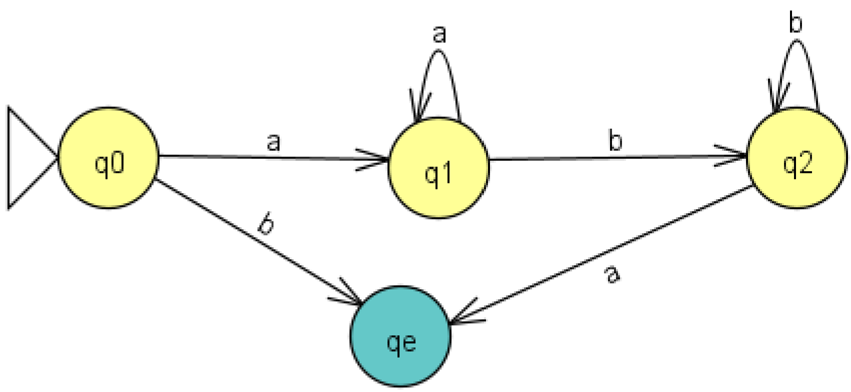
OUTPUT:


OnlineGDB
online compiler and debugger for c/c++
code. compile. run. debug. share.
IDE
My Projects
Classroom
Learn Programming
Programming Questions
Sign Up
Login
main.py
from enum import Enum
class State(Enum):
Q0 = 0
Q1 = 1
Q2 = 2
def is_accepted(input_string):
current_state = State.Q0
for symbol in input_string:
if current_state == State.Q0:
if symbol == 'a':
current_state = State.Q1
else:
return False
elif current_state == State.Q1:
if symbol == 'a':
current_state = State.Q1 # Self-loop on 'a'
elif symbol == 'b':
current_state = State.Q2
else:
return False
elif current_state == State.Q2:
if symbol == 'b':
current_state = State.Q2 # Self-loop on 'b'
Enter a string: aab
String is accepted.
...Program finished with exit code 0
Press ENTER to exit console.


Enter a string: aabb
String is accepted.
...Program finished with exit code 0
Press ENTER to exit console.

```
Enter a string: abab
String is not accepted.


...Program finished with exit code 0
Press ENTER to exit console.
```

DIAGRAM:



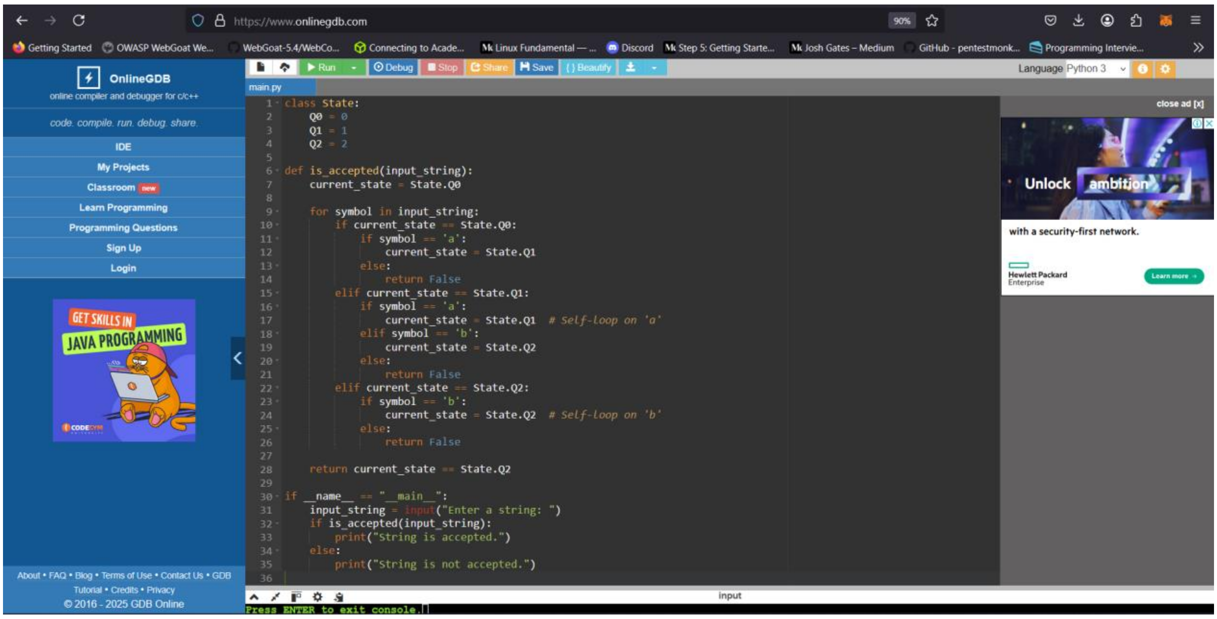
2. Write a program to construct the NFA for the given Strings.

CODE:

```python
class State:
    Q0 = 0
    Q1 = 1
    Q2 = 2

def is_accepted(input_string):
    current_state = State.Q0

    for symbol in input_string:
        if current_state == State.Q0:
            if symbol == 'a':
                current_state = State.Q1
            else:
                return False
        elif current_state == State.Q1:
            if symbol == 'a':
```

```python
                current_state = State.Q1  # Self-loop on 'a'
            elif symbol == 'b':
                current_state = State.Q2
            else:
                return False
        elif current_state == State.Q2:
            if symbol == 'b':
                current_state = State.Q2  # Self-loop on 'b'
            else:
                return False

    return current_state == State.Q2

if __name__ == "__main__":
    input_string = input("Enter a string: ")
    if is_accepted(input_string):
        print("String is accepted.")
    else:
        print("String is not accepted.")
```

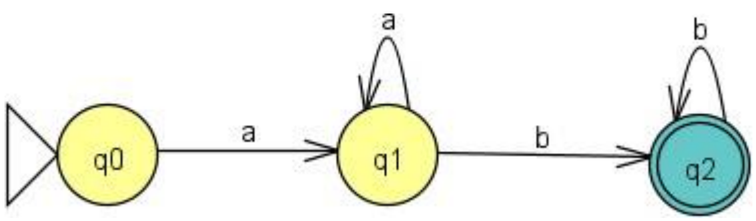
OUTPUT:



```
Enter a string: abbba
String is not accepted.


...Program finished with exit code 0
Press ENTER to exit console.
```

```
Enter a string: aab
String is accepted.


...Program finished with exit code 0
Press ENTER to exit console.
```

DIAGRAM:

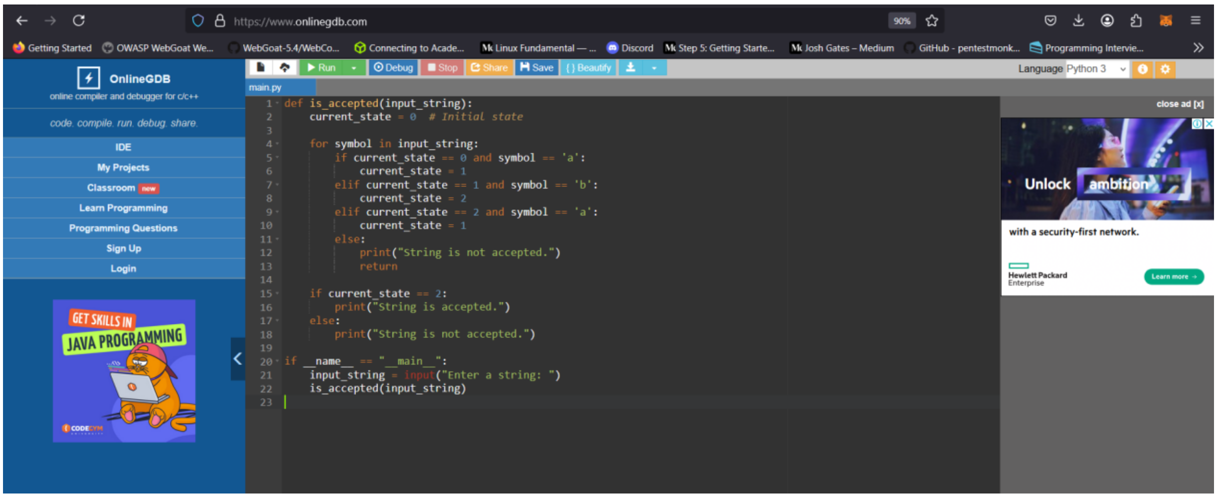


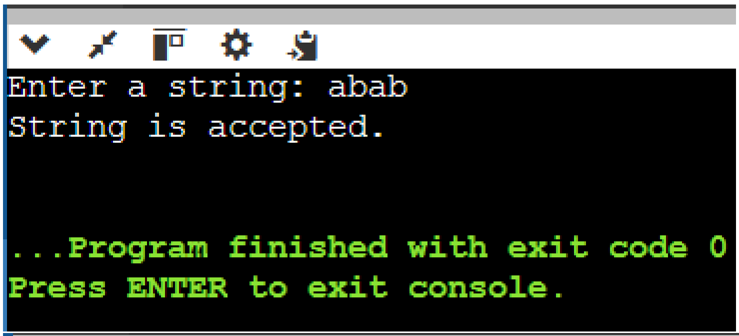
3. Write a program for String Acceptance using NFA or DFA.

CODE:

```python
def is_accepted(input_string):
    current_state = 0  # Initial state

    for symbol in input_string:
        if current_state == 0 and symbol == 'a':
            current_state = 1
        elif current_state == 1 and symbol == 'b':
            current_state = 2
        elif current_state == 2 and symbol == 'a':
            current_state = 1
        else:
            print("String is not accepted.")
            return

    if current_state == 2:
        print("String is accepted.")
    else:
        print("String is not accepted.")

if __name__ == "__main__":
    input_string = input("Enter a string: ")
    is_accepted(input_string)
```

OUTPUT:




Enter a string: abab
String is accepted.
...Program finished with exit code 0
Press ENTER to exit console.

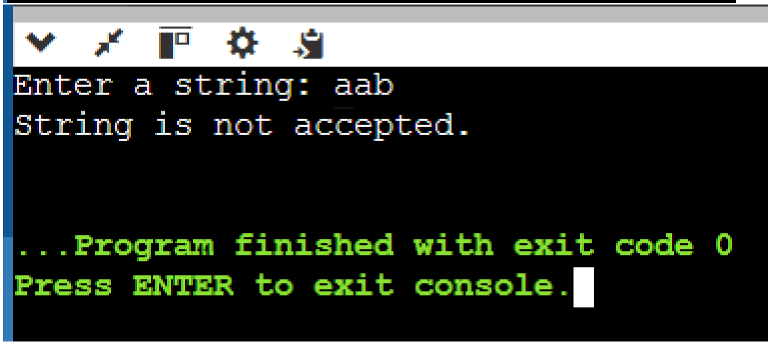
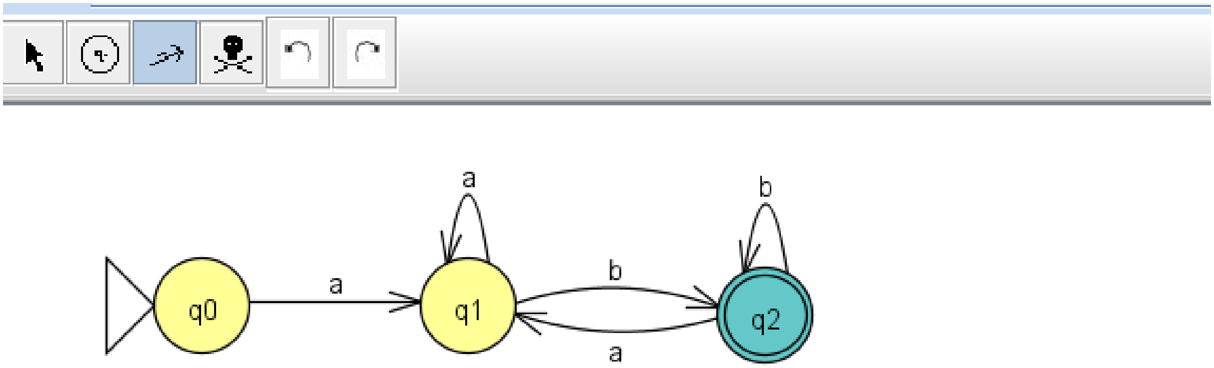

Enter a string: aab
String is not accepted.
...Program finished with exit code 0
Press ENTER to exit console.

DIAGRAM:


q0
a
q1
a
b
a
q2
b

4. Write a program to Convert the NFA into DFA.

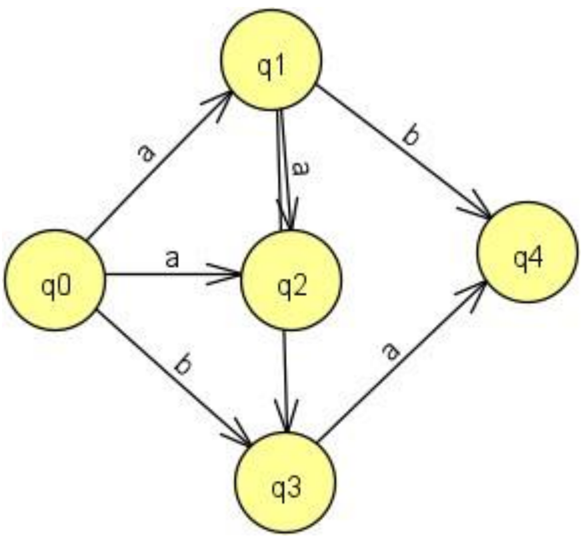
CODE:

```
def fillStates(nfa, state_set, input_symbol):
    next_state_set = set()
    for sub_state in state_set:
        if (sub_state, input_symbol) in nfa:
            next_state_set.update(nfa[(sub_state, input_symbol)])

    return frozenset(next_state_set)  # Ensure unique state representation

# Read NFA transitions
nfa = {}
n = int(input("Enter number of states in NFA: "))

for i in range(n):
    for symbol in [0, 1]:
        key = ('q' + str(i), symbol)
        nfa[key] = input(f"Enter transition for state {key}: ").split()

# Print NFA transition diagram
print("\nTransition Diagram for NFA:")
for key, value in nfa.items():
    print(key, ":", value)

# Convert NFA to DFA
dfa = {}
new_states = set()
queue = []

start_state = frozenset(['q0'])
queue.append(start_state)
new_states.add(start_state)

while queue:
    current_state = queue.pop(0)

    dfa[current_state] = {}

    for symbol in [0, 1]:
        next_state = fillStates(nfa, current_state, symbol)
        dfa[current_state][symbol] = next_state

        if next_state and next_state not in new_states:
            new_states.add(next_state)
            queue.append(next_state)

# Print DFA transition diagram (cleaned output)
print("\nTransition Diagram for DFA:")
for state, transitions in dfa.items():
```

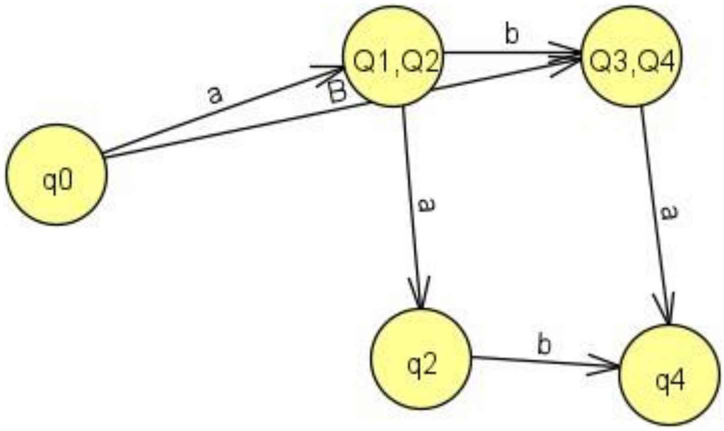
```
        state_name = "{" + ", ".join(state) + "}"
    print(f"{state_name} -> { {symbol: '{' + ', '.join(transitions[symbol]) +
'}' for symbol in transitions} }")
```

DIAGRAM:

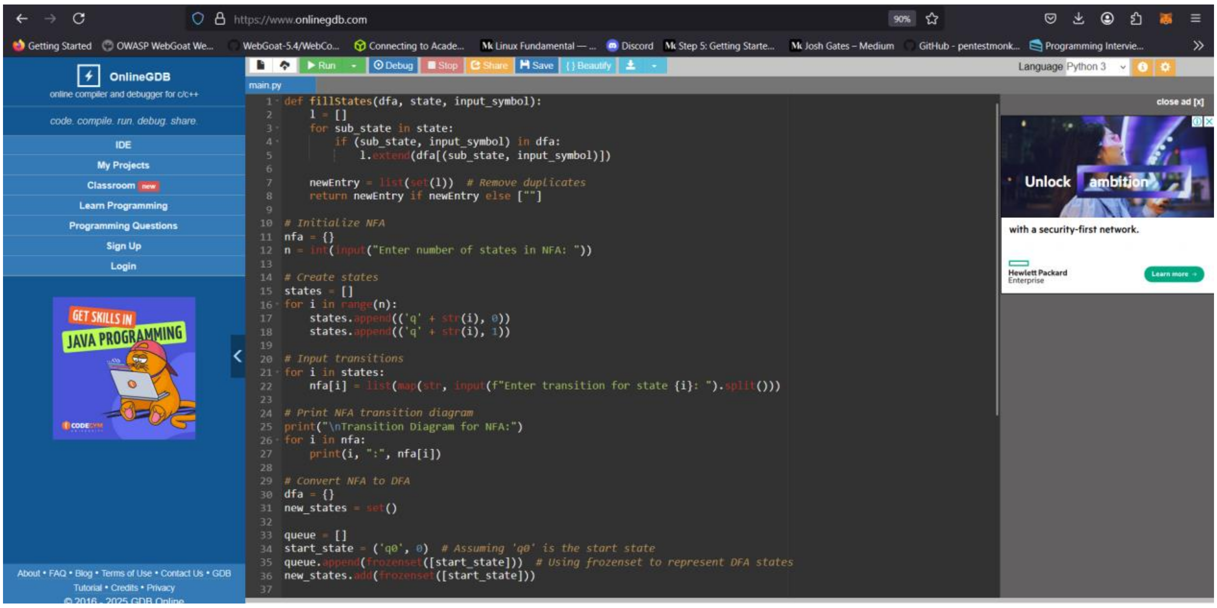
STATE DIAGRAM FOR NFA:



DFA STATE TABLE:



OUTPUT:



input

```
Enter number of states in NFA: 3
Enter transition for state ('q0', 0): q1
Enter transition for state ('q0', 1): q2
Enter transition for state ('q1', 0): q1
Enter transition for state ('q1', 1): q2
Enter transition for state ('q2', 0): q2
Enter transition for state ('q2', 1): q1

Transition Diagram for NFA:
('q0', 0) : ['q1']
('q0', 1) : ['q2']
('q1', 0) : ['q1']
('q1', 1) : ['q2']
('q2', 0) : ['q2']
('q2', 1) : ['q1']

Transition Diagram for DFA:
{q0} -> {0: '{q1}', 1: '{q2}'}
{q1} -> {0: '{q1}', 1: '{q2}'}
{q2} -> {0: '{q2}', 1: '{q1}'}


...Program finished with exit code 0
Press ENTER to exit console.
```

5. Write a program to Convert the Epsilon NFA into NFA

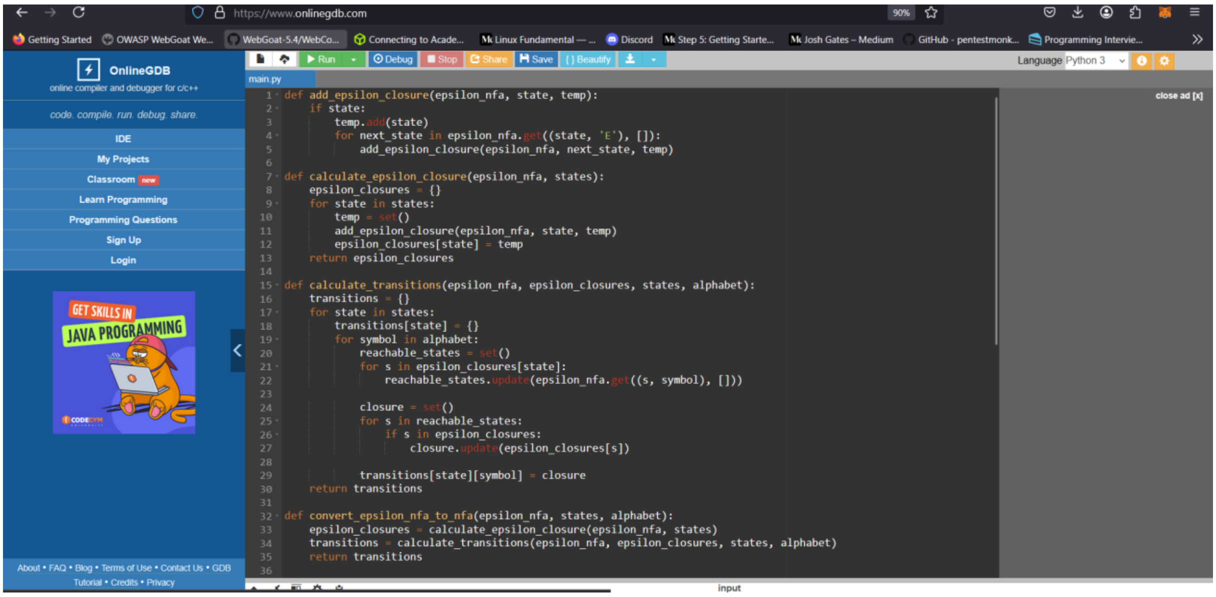
CODE:

```
def add_epsilon_closure(epsilon_nfa, state, temp):
    if state:
        temp.add(state)
        for next_state in epsilon_nfa.get((state, 'E'), []):
            add_epsilon_closure(epsilon_nfa, next_state, temp)

def calculate_epsilon_closure(epsilon_nfa, states):
    epsilon_closures = {}
    for state in states:
        temp = set()
        add_epsilon_closure(epsilon_nfa, state, temp)
        epsilon_closures[state] = temp
    return epsilon_closures
```

```python
def calculate_transitions(epsilon_nfa, epsilon_closures, states, alphabet):
    transitions = {}
    for state in states:
        transitions[state] = {}
        for symbol in alphabet:
            reachable_states = set()
            for s in epsilon_closures[state]:
                reachable_states.update(epsilon_nfa.get((s, symbol), []))

            closure = set()
            for s in reachable_states:
                if s in epsilon_closures:
                    closure.update(epsilon_closures[s])

            transitions[state][symbol] = closure
    return transitions

def convert_epsilon_nfa_to_nfa(epsilon_nfa, states, alphabet):
    epsilon_closures = calculate_epsilon_closure(epsilon_nfa, states)
    transitions = calculate_transitions(epsilon_nfa, epsilon_closures, states,
alphabet)
    return transitions

# Input Section
alphabet = ['0', '1']
epsilon_nfa = {}

n = int(input("Enter number of states in Epsilon-NFA: "))
states = ['q' + str(i) for i in range(n)]

state_transitions = []
for i in range(n):
    state_transitions.append(('q' + str(i), 'E'))
    state_transitions.append(('q' + str(i), '0'))
    state_transitions.append(('q' + str(i), '1'))


for state in state_transitions:
    transitions = list(map(str, input(f"Enter transitions for state {state} :
").split()))
    epsilon_nfa[state] = transitions

# Display Epsilon-NFA
print("\nEpsilon-NFA Transition Table:")
for key, value in epsilon_nfa.items():
    print(key, ":", value)

# Convert Epsilon-NFA to NFA
nfa = convert_epsilon_nfa_to_nfa(epsilon_nfa, states, alphabet)

# Display NFA Transition Table
print("\nTransition Table for NFA:")
```

```python
for state, trans in nfa.items():
    print(f"State {state}: {trans}")
```

OUTPUT:



```
Enter transitions for state ('q0', '0') : q0
Enter transitions for state ('q0', '1') :
Enter transitions for state ('q1', 'E') : q2
Enter transitions for state ('q1', '0') :
Enter transitions for state ('q1', '1') : q1
Enter transitions for state ('q2', 'E') :
Enter transitions for state ('q2', '0') : q0
Enter transitions for state ('q2', '1') : q1

Epsilon-NFA Transition Table:
('q0', 'E') : ['q1']
('q0', '0') : ['q0']
('q0', '1') : []
('q1', 'E') : ['q2']
('q1', '0') : []
('q1', '1') : ['q1']
('q2', 'E') : []
('q2', '0') : ['q0']
('q2', '1') : ['q1']

Transition Table for NFA:
State q0: {'0': {'q2', 'q0', 'q1'}, '1': {'q2', 'q1'}}
State q1: {'0': {'q2', 'q0', 'q1'}, '1': {'q2', 'q1'}}
State q2: {'0': {'q2', 'q0', 'q1'}, '1': {'q2', 'q1'}}


...Program finished with exit code 0
Press ENTER to exit console.
```

6. Write a program to Convert the Epsilon NFA to DFA

CODE:

```
def add_epsilon_closure(epsilon_nfa, state, temp):
    if state:
        temp.add(state)
        for next_state in epsilon_nfa.get((state, 'E'), []):
            add_epsilon_closure(epsilon_nfa, next_state, temp)

def calculate_epsilon_closure(epsilon_nfa, states):
    epsilon_closures = {}
    for state in states:
        temp = set()
        add_epsilon_closure(epsilon_nfa, state, temp)
        epsilon_closures[state] = temp
    return epsilon_closures

def calculate_transitions(epsilon_nfa, epsilon_closures, states, alphabet):
    transitions = {}
    for state in states:
        transitions[state] = {}
        for symbol in alphabet:
            reachable_states = set()
```

```
            for s in epsilon_closures[state]:
                reachable_states.update(epsilon_nfa.get((s, symbol), []))

            closure = set()
            for s in reachable_states:
                if s in epsilon_closures:
                    closure.update(epsilon_closures[s])

            transitions[state][symbol] = closure
    return transitions

def convert_epsilon_nfa_to_nfa(epsilon_nfa, states, alphabet):
    epsilon_closures = calculate_epsilon_closure(epsilon_nfa, states)
    transitions = calculate_transitions(epsilon_nfa, epsilon_closures, states,
alphabet)
    return transitions

def fillStates(dfa, state, input_symbol):
    new_entry = set()
    for i in dfa[state]:
        if (i, input_symbol) in dfa:
            new_entry.update(dfa[(i, input_symbol)])
    return new_entry

def convert_to_tuple_dict(input_dict):
    result = {}
    for state, transitions in input_dict.items():
        for symbol, targets in transitions.items():
            for target in targets:
                if (state, symbol) in result:
                    result[(state, symbol)].add(target)
                else:
                    result[(state, symbol)] = {target}
    return result

# Input Section
epsilon_nfa = {}
n = int(input("Enter number of states in Epsilon-NFA: "))
states = ['q' + str(i) for i in range(n)]
alphabet = ['0', '1']

state_transitions = []
for i in range(n):
    state_transitions.append(('q' + str(i), 'E'))
    state_transitions.append(('q' + str(i), '0'))
    state_transitions.append(('q' + str(i), '1'))

for state in state_transitions:
    transitions = list(map(str, input(f"Enter transitions for state {state} :
").split()))
    epsilon_nfa[state] = transitions
```

```python
# Display Epsilon-NFA
print("\nEpsilon-NFA Transition Table:")
for key, value in epsilon_nfa.items():
    print(key, ":", value)

# Convert Epsilon-NFA to NFA
nfa = convert_epsilon_nfa_to_nfa(epsilon_nfa, states, alphabet)

# Display NFA Transition Table
print("\nTransition Table for NFA:")
for state, trans in nfa.items():
    print(f"State {state}: {trans}")

nfa = convert_to_tuple_dict(nfa)
dfa = nfa

# Deterministic Finite Automaton (DFA) Construction
dfa_states = set()
for i in dfa.keys():
    dfa_states.add(i[0])

new_dfa = {}
for i in dfa:
    new_state = "".join(dfa[i])
    if new_state not in dfa_states and new_state:
        dfa_states.add(new_state)
    new_dfa[(new_state, '0')] = fillStates(dfa, i, '0')
    new_dfa[(new_state, '1')] = fillStates(dfa, i, '1')

for i in new_dfa:
    dfa[i] = new_dfa[i]

# Display DFA Transition Table
print("\nTransition Table for DFA:")
for state, transitions in dfa.items():
    if isinstance(transitions, dict):
        for symbol, targets in transitions.items():
            target_string = ''.join(targets)
            print(f"({state[0]}, '{symbol}') : {target_string}")
    else:
        target_string = ''.join(transitions)
        print(f"({state[0]}, '{state[1]}') : {target_string}")
```

OUTPUT:

input

```
Enter number of states in Epsilon-NFA: 3
Enter transitions for state ('q0', 'E') : q1
Enter transitions for state ('q0', '0') :
Enter transitions for state ('q0', '1') : q0
Enter transitions for state ('q1', 'E') : q2
Enter transitions for state ('q1', '0') : q1
Enter transitions for state ('q1', '1') :
Enter transitions for state ('q2', 'E') :
Enter transitions for state ('q2', '0') : q1
Enter transitions for state ('q2', '1') : q0

Epsilon-NFA Transition Table:
('q0', 'E') : ['q1']
('q0', '0') : []
('q0', '1') : ['q0']
('q1', 'E') : ['q2']
('q1', '0') : ['q1']
('q1', '1') : []
('q2', 'E') : []
('q2', '0') : ['q1']
('q2', '1') : ['q0']

Transition Table for NFA:
State q0: {'0': {'q2', 'q1'}, '1': {'q2', 'q1', 'q0'}}
State q1: {'0': {'q2', 'q1'}, '1': {'q2', 'q1', 'q0'}}
State q2: {'0': {'q2', 'q1'}, '1': {'q2', 'q1', 'q0'}}

Transition Table for DFA:
(q0, '0') : q2q1
(q0, '1') : q2q1q0
(q1, '0') : q2q1
(q1, '1') : q2q1q0
(q2, '0') : q2q1
(q2, '1') : q2q1q0
(q2q1, '0') : q2q1
(q2q1, '1') : q2q1q0
(q2q1q0, '0') : q2q1
(q2q1q0, '1') : q2q1q0
```

7. Write a Python program to construct a Pushdown Automaton (PDA) for the following Language
L={a^n,b^n|n>=1}

CODE:

```python
class PDA:
    def __init__(self):
        self.stack = []

    def process(self, string):
        for char in string:
            if char == 'a':
                self.stack.append('a')  # Push 'a' onto the stack
            elif char == 'b':
                if not self.stack or self.stack[-1] != 'a':
                    return False  # Invalid sequence (more 'b's than 'a's)
                self.stack.pop()  # Pop 'a' for each 'b'

        return len(self.stack) == 0  # Accept if stack is empty

# Input and Execution
pda = PDA()
input_string = input("Enter a string of the form aⁿbⁿ: ")
if pda.process(input_string):
    print("Accepted")
else:
    print("Rejected")
```

OUTPUT:

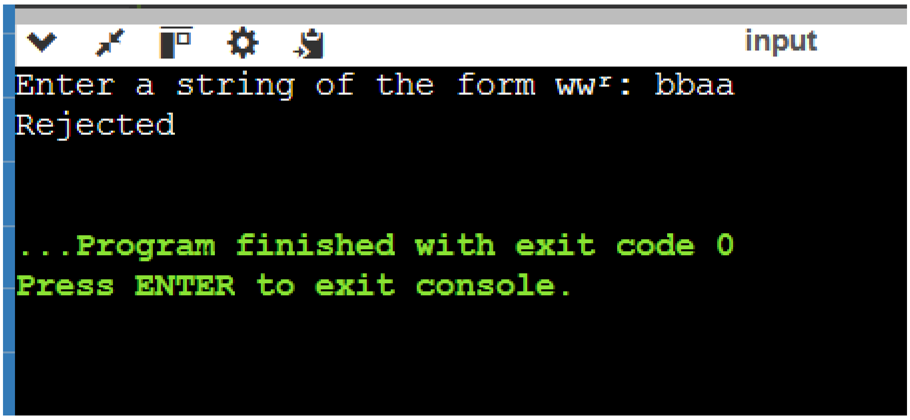
```
input
Enter a string of the form aⁿbⁿ: aabb
Accepted


...Program finished with exit code 0
Press ENTER to exit console.
```

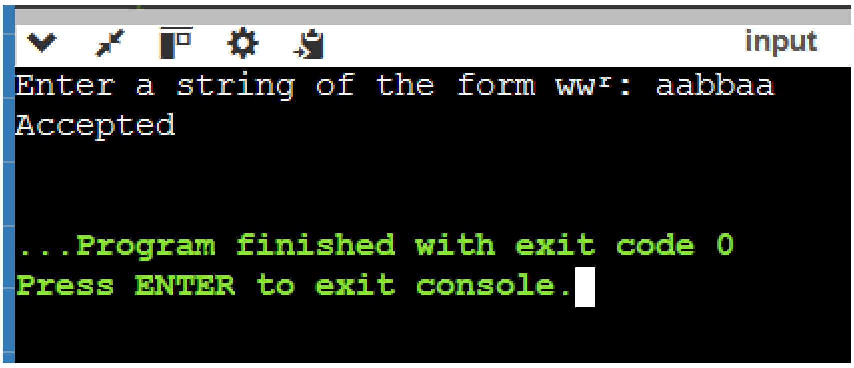
```
Enter a string of the form a^nb^n: abb
Rejected


...Program finished with exit code 0
Press ENTER to exit console.
```

8. Write a Python program to construct a Pushdown Automaton (PDA) for the following Language
L={ww^r|w=(a+b)^+}
CODE:

```python
class PDA:
    def __init__(self):
        self.stack = []

    def process(self, string):
        n = len(string)

        if n % 2 != 0:
            return False  # Length must be even for ww^r

        half = n // 2  # Find the midpoint

        # Push the first half of the string onto the stack
        for i in range(half):
            self.stack.append(string[i])

        # Check if the second half is the reverse of the first half
        for i in range(half, n):
            if not self.stack or self.stack[-1] != string[i]:
                return False  # Mismatch found
            self.stack.pop()  # Pop from stack

        return len(self.stack) == 0  # Accept if stack is empty

# Input and Execution
pda = PDA()
input_string = input("Enter a string of the form ww^r: ")
if pda.process(input_string):
    print("Accepted")
else:
    print("Rejected")
```

OUTPUT:





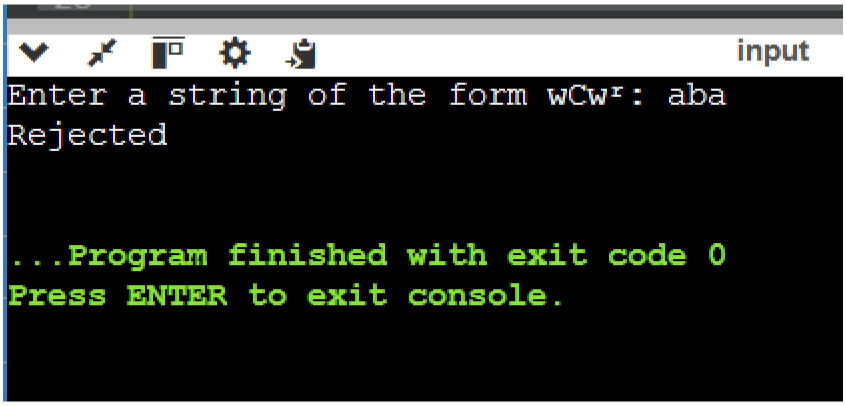
9. Write a Python program to construct a Pushdown Automaton (PDA) for the following Language
L={wCw^r|w belongs to (a+b)^*}

CODE:

```python
class PDA:
    def __init__(self):
        self.stack = []
        self.found_C = False  # Track if 'C' has been encountered

    def process(self, string):
        for char in string:
            if char != 'C' and not self.found_C:
                self.stack.append(char)  # Push w onto stack
            elif char == 'C':
                if self.found_C:  # Multiple 'C' are not allowed
                    return False
                self.found_C = True
            elif self.found_C:  # Matching wʳ with stack
                if not self.stack or self.stack[-1] != char:
                    return False  # Reverse check failed
                self.stack.pop()

        return self.found_C and len(self.stack) == 0  # Accept if stack is empty and 'C' was found

# Input and Execution
pda = PDA()
input_string = input("Enter a string of the form wCwʳ: ")
if pda.process(input_string):
    print("Accepted")
else:
    print("Rejected")
```

OUTPUT:

```
input
Enter a string of the form wCwʳ: aCa
Accepted


...Program finished with exit code 0
Press ENTER to exit console.
```



10. Write a Python program to construct a Pushdown Automaton (PDA) for the following Language

L={0^n1^m2^m3^n|n,m>=1}

CODE:

```python
class PDA:
    def __init__(self):
        self.stack = []

    def process(self, string):
        n = string.count('0')
        m = string.count('1')

        # Condition to check the count match
        if string.count('3') != n or string.count('2') != m:
            return False  # Count mismatch

        step = 0  # Track transitions
        for char in string:
            if char == '0':
                self.stack.append('0')
                step = 1
            elif char == '1':
                self.stack.append('1')
                step = 2
            elif char == '2':
                if not self.stack or self.stack[-1] != '1':
                    return False  # '1' must match with '2'
                self.stack.pop()
                step = 3
            elif char == '3':
                if not self.stack or self.stack[-1] != '0':
                    return False  # '0' must match with '3'
                self.stack.pop()
                step = 4
            else:
                return False  # Invalid character

        return len(self.stack) == 0  # Stack should be empty if valid

# Input and Execution
pda = PDA()
input_string = input("Enter a string of the form 0ⁿ1ᵐ2ᵐ3ⁿ: ")
if pda.process(input_string):
    print("Accepted")
else:
    print("Rejected")
```

OUTPUT:

```
input
Enter a string of the form 0^n1^m2^m3^n: 0112333
Rejected


...Program finished with exit code 0
Press ENTER to exit console.
```

```
input
Enter a string of the form 0^n1^m2^m3^n: 00112233
Accepted


...Program finished with exit code 0
Press ENTER to exit console.
```

11. Write a Python program to construct a Pushdown Automaton (PDA) for the following Language

L={a^nb^2n|n>+1}

CODE:

```
class PDA:
    def __init__(self):
        self.stack = []
        self.b_count = 0  # Count of 'b's encountered

    def process(self, string):
        n = 0  # Count of 'a's

        for char in string:
            if char == 'a':
                self.stack.append('a')  # Push 'a' onto the stack
                n += 1  # Track count of 'a's

            elif char == 'b':
                self.b_count += 1  # Count each 'b'

                if self.stack:
                    self.pop()  # Match the first batch of 'b's with
'a's
                else:
                    pass  # Second batch of 'b's (after stack is empty)
```

```
            else:
                return False  # Reject if an invalid character is found

        # Condition for acceptance:
        return self.b_count == 2 * n and not self.stack  # 2n 'b's and stack must be empty

# Input and Execution
pda = PDA()
input_string = input("Enter a string of the form aⁿb²ⁿ: ")
if pda.process(input_string):
    print("Accepted")
else:
    print("Rejected")
```

OUTPUT:

```
input
Enter a string of the form aⁿb²ⁿ: abb
Rejected


...Program finished with exit code 0
Press ENTER to exit console.
```

```
input
Enter a string of the form aⁿb²ⁿ: aabbbb
Accepted


...Program finished with exit code 0
Press ENTER to exit console.
```

12. Write a program to find the first and follow for the given CFG

CODE:

```
from collections import defaultdict

def compute_first(symbol):
    if symbol in first_sets:  # If already computed, return it
        return first_sets[symbol]
```

```python
    first = set()

    if not symbol.isupper():  # Terminal case
        first.add(symbol)
    else:
        for production in grammar[symbol]:
            for char in production:
                first_char = compute_first(char)
                first.update(first_char - {'ε'})  # Add FIRST(char) except ε

                if 'ε' not in first_char:
                    break  # Stop if epsilon is not in FIRST(char)
            else:
                first.add('ε')  # If all have ε, add it to FIRST(symbol)

    first_sets[symbol] = first
    return first

def compute_follow(symbol):
    if symbol in follow_sets:  # If already computed, return it
        return follow_sets[symbol]

    follow = set()

    if symbol == start_symbol:
        follow.add('$')  # Add '$' for the start symbol

    for lhs, productions in grammar.items():
        for production in productions:
            if symbol in production:
                index = production.index(symbol)

                while index < len(production) - 1:
                    next_symbol = production[index + 1]
                    first_next = compute_first(next_symbol)

                    follow.update(first_next - {'ε'})

                    if 'ε' not in first_next:
                        break
                    index += 1
                else:
                    if lhs != symbol:
                        follow.update(compute_follow(lhs))

    follow_sets[symbol] = follow
    return follow
```

```python
# Input Grammar
grammar = defaultdict(list)
first_sets = {}
follow_sets = {}

num_productions = int(input("Enter the number of productions: "))

for _ in range(num_productions):
    lhs, rhs = input("Enter production (A=abc format): ").split("=")
    grammar[lhs].extend(rhs.split("|"))  # Handle multiple productions

start_symbol = list(grammar.keys())[0]  # Assuming first entered symbol as
start

# Compute FIRST and FOLLOW sets
for non_terminal in grammar:
    compute_first(non_terminal)
for non_terminal in grammar:
    compute_follow(non_terminal)

# Querying FIRST and FOLLOW sets
while True:
    query = input("\nEnter the element whose FIRST & FOLLOW is to be found: ")
    if query not in grammar:
        print("Invalid non-terminal.")
    else:
        print(f"First({query}) = {first_sets[query]}")
        print(f"Follow({query}) = {follow_sets[query]}")

    cont = input("Continue? (1 for Yes, 0 for No): ")
    if cont == "0":
        break
```

Output:

input

```
Enter the number of productions: 3
Enter production (A=abc format): A=abc
Enter production (A=abc format): A=def
Enter production (A=abc format): A=g

Enter the element whose FIRST & FOLLOW is to be found: A
First(A) = {'a', 'g', 'd'}
Follow(A) = {'$'}
Continue? (1 for Yes, 0 for No): 1
```

13.Generating Three Address Code (TAC) for a Given Expression

Code:

```
def generate_tac(expression):
    tokens = expression.replace(" ", "").split("=")
    if len(tokens) != 2:
        print("Invalid expression format!")
        return []

    var = tokens[0]  # Left-hand side variable
    expr = tokens[1]  # Right-hand side expression
    operands = expr.split("+")  # Splitting the expression based on '+'

    if len(operands) < 2:
        print("Expression must contain at least one '+' operation!")
        return []

    temp_count = 1
    tac_code = []

    # First operation
    temp_var = f"t{temp_count}"
    tac_code.append(f"{temp_var} = {operands[0]} + {operands[1]}")

    # Processing remaining operands
    for i in range(2, len(operands)):
        temp_count += 1
        new_temp_var = f"t{temp_count}"
        tac_code.append(f"{new_temp_var} = {temp_var} + {operands[i]}")
        temp_var = new_temp_var

    # Final assignment
    tac_code.append(f"{var} = {temp_var}")

    return tac_code

# Taking input from the user
expression = input("Enter an arithmetic expression (e.g., x = a + b + c + d): 
")

# Generating and printing TAC
tac_output = generate_tac(expression)

if tac_output:
    print("\nGenerated Three-Address Code (TAC):")
    for line in tac_output:
        print(line)
```

Output:

```
input
Enter an arithmetic expression (e.g., x = a + b + c + d):  x = a + b + c + d

Generated Three-Address Code (TAC):
t1 = a + b
t2 = t1 + c
t3 = t2 + d
x = t3


...Program finished with exit code 0
Press ENTER to exit console.
```