COMSATS University Islamabad, Attock Campus

Lab Terminal Examinations (Spring 2024)

Department of: **Computer Science**

Class/Program:	**BS(CS)-7th**	Date:	**31/05/ 2024 (1:30 - 4:30)**
Subject:	**Compiler construction Lab EXAM**	Instructor:	**Bilal Haider**
Total Time Allowed:	**3Hrs**	Maximum Marks:	**50**
Student Name:	**Talha Azeem**	Registration #:	**SP20-bcs-047**

Question 1

Write an introduction of your compiler construction project.

Answer:

The key components of the project are as follows:

1. **Lexical Analysis (Scanning)**: The first phase involves breaking down the source code into tokens using a lexer or scanner. Tokens are the basic building blocks of the language, such as keywords, operators, identifiers, and literals.
2. **Syntax Analysis (Parsing)**: The parser takes the tokens generated by the lexer and organizes them into a syntax tree (also known as a parse tree). This tree represents the grammatical structure of the source code according to the rules of the MiniLang grammar.
3. **Semantic Analysis**: This phase ensures that the syntax tree follows the semantic rules of the language. It involves type checking, scope resolution, and ensuring that operations are semantically correct.
4. **Intermediate Code Generation**: The validated syntax tree is translated into an intermediate representation, which is a lower-level code that is easier to optimize and translate into machine code.
5. **Optimization**: The intermediate code is optimized for performance improvements. This includes eliminating redundant code, optimizing loops, and other code enhancement techniques.

6. **Code Generation**: The final phase involves translating the optimized intermediate code into target machine code or bytecode that can be executed by a virtual machine or hardware processor.
7. **Error Handling**: Throughout the compilation process, the compiler will detect and report errors in the source code, providing meaningful feedback to help developers correct their programs.

Question 2

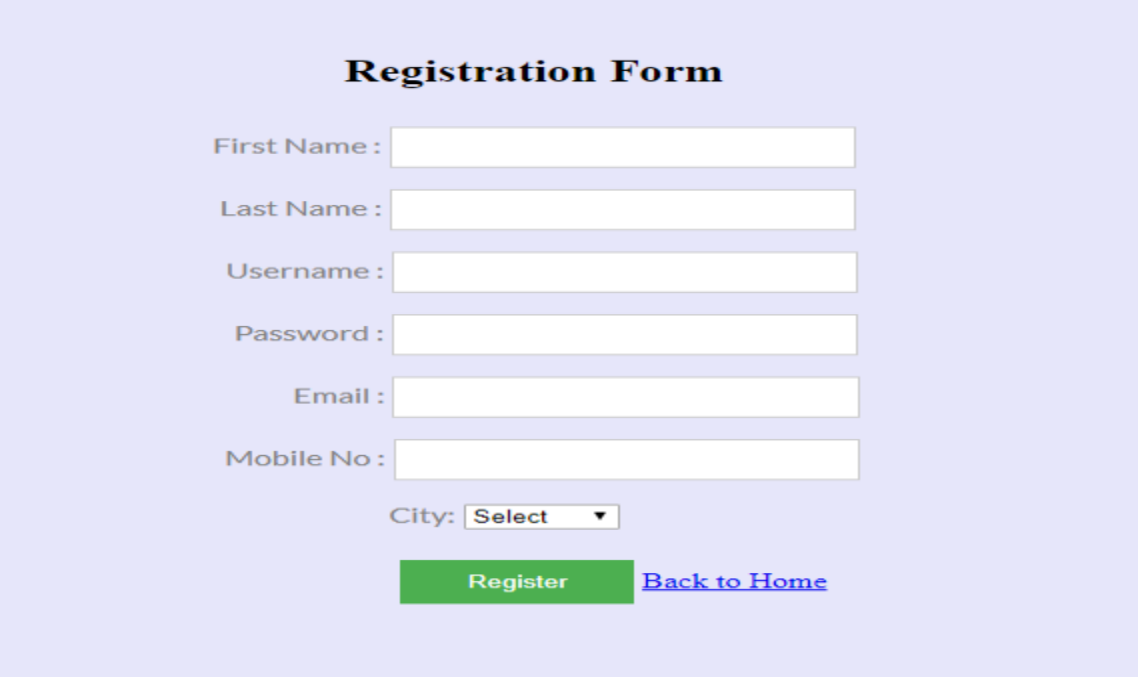
Give a sample input and output for your compiler construction project?

Answer:

```
PUSH BP             ; Save the base pointer
MOVE BP, SP         ; Set the base pointer to the current stack pointer
LOAD n, [BP+2]      ; Load the parameter n from the stack (assuming BP+2 is where the param
CMP n, 0            ; Compare n with 0
JEQ L1              ; If n == 0, jump to label L1

LOAD t1, n          ; Load n into temporary register t1
SUB t1, 1           ; Subtract 1 from t1
PUSH t1             ; Push t1 (n-1) onto the stack
CALL factorial      ; Recursively call factorial with (n-1)
POP t2              ; Pop the result of factorial(n-1) into temporary register t2
MUL t3, n, t2       ; Multiply n and the result of factorial(n-1), store in t3
JMP L2              ; Jump to label L2

L1:
LOAD t3, 1          ; If n == 0, load 1 into t3

L2:
STORE [BP-1], t3    ; Store the result t3 in the stack frame
POP BP              ; Restore the base pointer
RET                 ; Return from the function
```

Question 3

Create and implement RE and DFAs for the form below



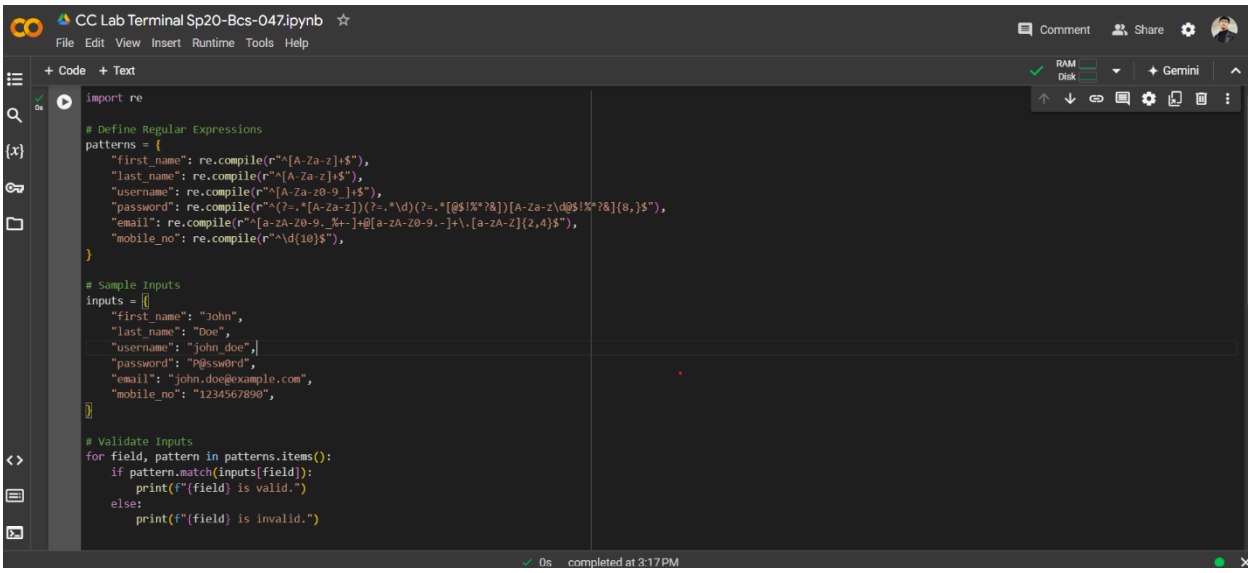
You must use Regex to validate data.

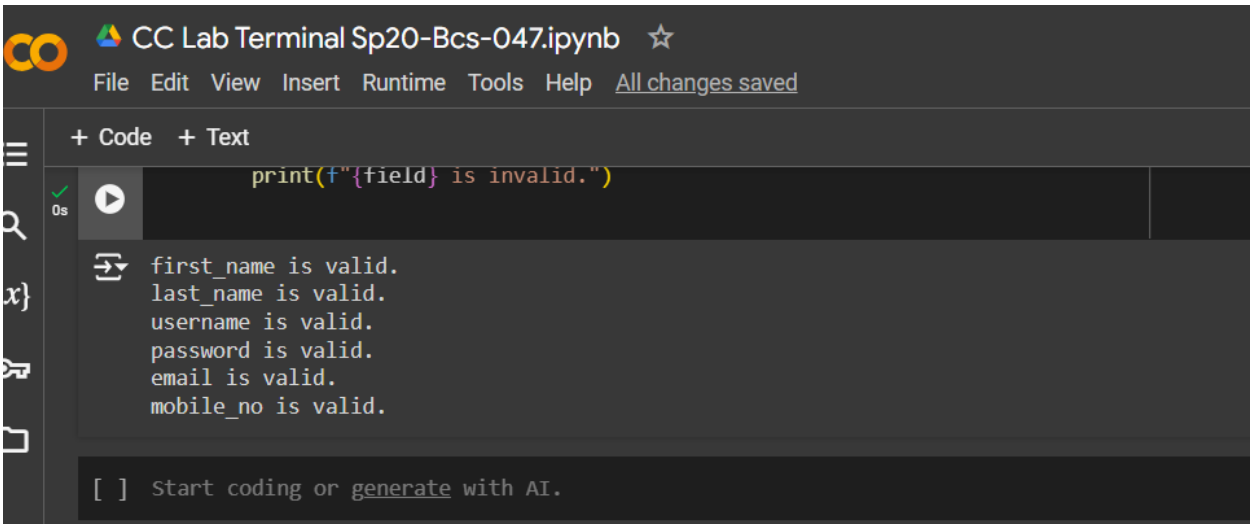
Answer:

Code:

```
import re


# Define Regular Expressions
patterns = {
    "first_name": re.compile(r"^[A-Za-z]+$"),
    "last_name": re.compile(r"^[A-Za-z]+$"),
    "username": re.compile(r"^[A-Za-z0-9_]+$"),
    "password": re.compile(r"^(?=.*[A-Za-z])(?=.*\d)(?=.*[@$!%*?&])[A-Za-z\d@$!%*?&]{8,}$"),
    "email": re.compile(r"^[a-zA-Z0-9._%+-]+@[a-zA-Z0-9.-]+\.[a-zA-Z]{2,4}$"),
    "mobile_no": re.compile(r"^\d{10}$"),
```

```
}


# Sample Inputs
inputs = {
    "first_name": "John",
    "last_name": "Doe",
    "username": "john_doe",
    "password": "P@ssw0rd",
    "email": "john.doe@example.com",
    "mobile_no": "1234567890",
}

# Validate Inputs
for field, pattern in patterns.items():
    if pattern.match(inputs[field]):
        print(f"{field} is valid.")
    else:
        print(f"{field} is invalid.")
```





Question 4:

Write a program which generates symbol table for the code you submitted in question 3.

Answer:

```
import re


class SymbolTableEntry:
    def __init__(self, identifier, type_, scope, attributes=None):
        self.identifier = identifier
        self.type_ = type_
        self.scope = scope
        self.attributes = attributes if attributes else {}

    def __repr__(self):
        return f"{self.identifier}: {{'type': '{self.type_}', 'scope': '{self.scope}', 'attributes': {self.attributes}}}"


class SymbolTable:
    def __init__(self):
        self.table = []

    def add_entry(self, entry):
```

```
        self.table.append(entry)

    def __repr__(self):
        return "\n".join(str(entry) for entry in self.table)

# Define MiniLang code
mini_lang_code = """
function factorial(n) {
    if (n == 0) {
        return 1;
    } else {
        return n * factorial(n - 1);
    }
}

let result = factorial(5);
print(result);
"""

# Regular expressions to capture function definitions, variable declarations, and function calls
function_def_re = re.compile(r"function\s+(\w+)\s*\((.*?)\)\s*{")
variable_decl_re = re.compile(r"let\s+(\w+)\s*=\s*(.+?);")
function_call_re = re.compile(r"(\w+)\s*\((.*?)\);")

# Symbol table
symbol_table = SymbolTable()

# Parsing the MiniLang code
lines = mini_lang_code.split('\n')
```

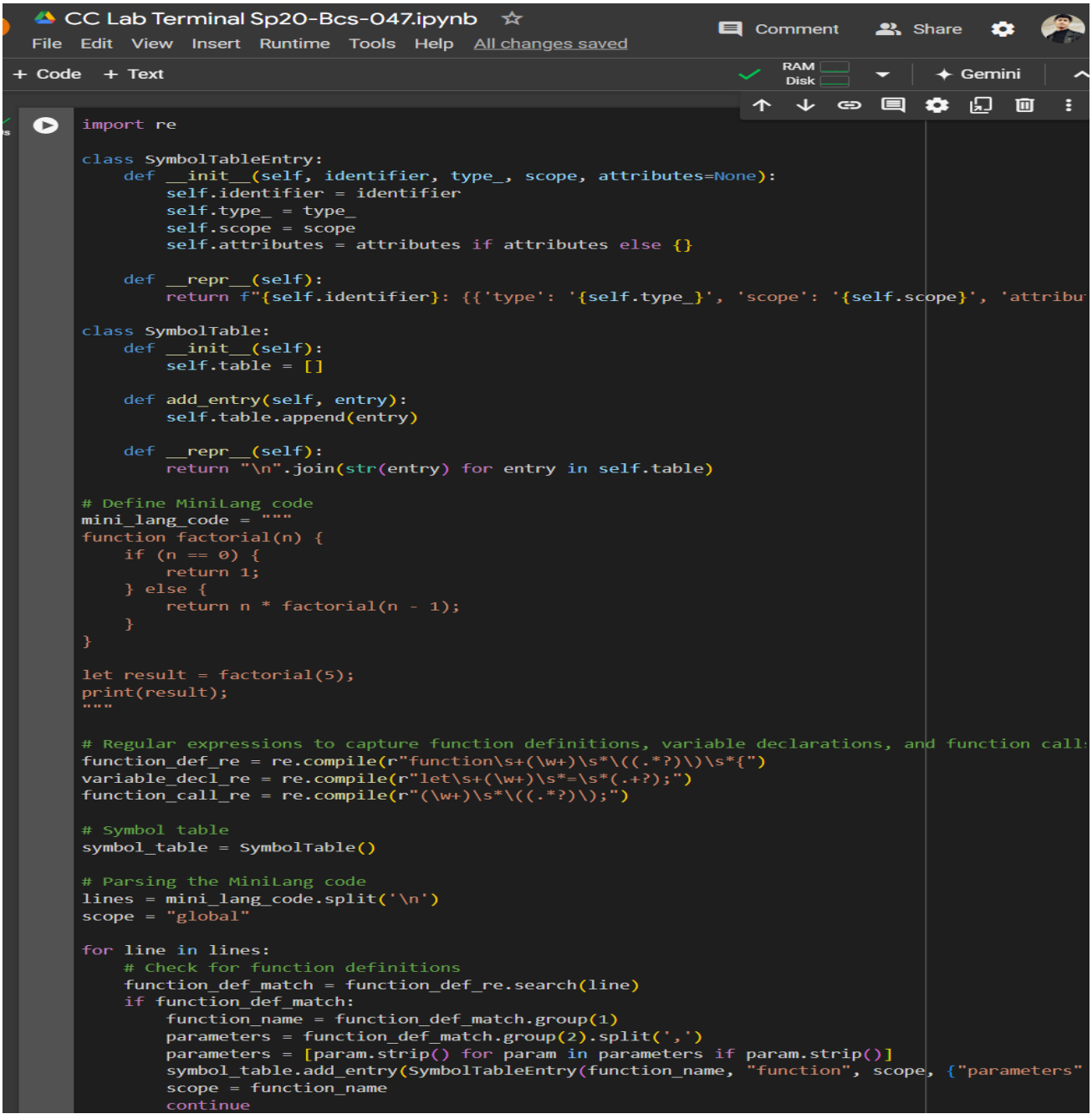
```
scope = "global"


for line in lines:
    # Check for function definitions
    function_def_match = function_def_re.search(line)
    if function_def_match:
        function_name = function_def_match.group(1)
        parameters = function_def_match.group(2).split(',')
        parameters = [param.strip() for param in parameters if param.strip()]
        symbol_table.add_entry(SymbolTableEntry(function_name, "function", scope, {"parameters":
parameters}))
        scope = function_name
        continue


    # Check for variable declarations
    variable_decl_match = variable_decl_re.search(line)
    if variable_decl_match:
        var_name = variable_decl_match.group(1)
        var_value = variable_decl_match.group(2)
        symbol_table.add_entry(SymbolTableEntry(var_name, "variable", scope, {"value": var_value}))
        continue


    # Check for function calls
    function_call_match = function_call_re.search(line)
    if function_call_match:
        func_name = function_call_match.group(1)
        arguments = function_call_match.group(2).split(',')
        arguments = [arg.strip() for arg in arguments if arg.strip()]
```

symbol_table.add_entry(SymbolTableEntry(func_name, "function_call", scope, {"arguments": arguments}))

continue

print("Symbol Table:")

print(symbol_table)



```
        continue

    # Check for variable declarations
    variable_decl_match = variable_decl_re.search(line)
    if variable_decl_match:
        var_name = variable_decl_match.group(1)
        var_value = variable_decl_match.group(2)
        symbol_table.add_entry(SymbolTableEntry(var_name, "variable", scope, {"value
        continue

    # Check for function calls
    function_call_match = function_call_re.search(line)
    if function_call_match:
        func_name = function_call_match.group(1)
        arguments = function_call_match.group(2).split(',')
        arguments = [arg.strip() for arg in arguments if arg.strip()]
        symbol_table.add_entry(SymbolTableEntry(func_name, "function_call", scope, {
        continue

print("Symbol Table:")
print(symbol_table)
```

```
Symbol Table:
factorial: {'type': 'function', 'scope': 'global', 'attributes': {'parameters': ['n'
factorial: {'type': 'function_call', 'scope': 'factorial', 'attributes': {'arguments
result: {'type': 'variable', 'scope': 'factorial', 'attributes': {'value': 'factoria
print: {'type': 'function_call', 'scope': 'factorial', 'attributes': {'arguments': [
```