# ECE 653 Assignment 1

Question 1

1. `a = [], b = []`. The fault is at row 8, and if the input is `a = [], b = []`, the program will crash at row 7, which does not execute the fault.

2. When a and b are square matrix and the dimension is same, for example `a = [[1, 2], [3, 4]], b = [[1, 2], [3, 4]]`.

3. Any list that the dimension is incompatible, for example, `a = [[1]], b = [[2], [1]]` an exception is thrown (which is expected and is not a failure).

4.
```
a = [[5, 7], [8, 21]]
b = [[8], [4]]
p = 2
p1 = 1
pc = at line 10
```

5.
```
digraph G {
    "7, 8" -> "9";
    "9" -> "10" [label = "T"];
    "9" -> "11" [label = "F"];
    "11" -> "12";
    "12" -> "15" [label = "F"];
    "12" -> "13" [label = "T"];
    "13" -> "12" [label = "F"];
    "13" -> "14" [label = "T"];
    "14" -> "13";
}
```
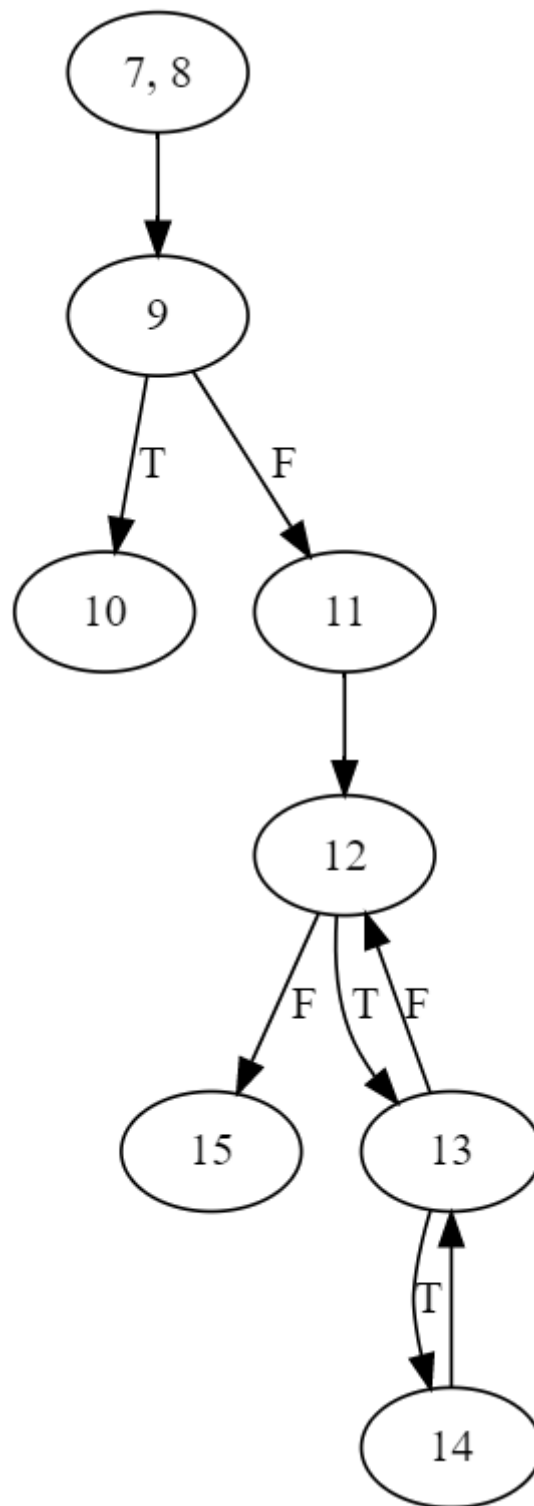
Question 2

```python
1.  class RepeatUntilStmt():
        def __init__(self, statement, condition):
            self.statement = statement
            self.condition = conditon

        def __eq__(self, other):
            return (
                type(self) == type(other)
                and self.statement == other.statement
                and self.condition == other.condition
            )
```

2.

$$\frac{< S,q >\Downarrow q' \quad < b,q' >\Downarrow false \quad < repeat\ S\ until\ b, q' >\Downarrow q''}{< repeat\ S\ until\ b, q' >\Downarrow q''}$$

$$\frac{< S,q >\Downarrow q' \quad < b,q' >\Downarrow true}{< repeat\ S\ until\ b, q' >\Downarrow q'}$$

3.

4. We need to prove:

$$< \mathbf{repeat}\ S\ \mathbf{until}\ b,\ q >\Downarrow\ q'' \quad \Leftrightarrow\quad < S;\ \mathbf{if}\ b\ \mathbf{then}\ skip\ \mathbf{else}\ (\mathbf{repeat}\ S\ \mathbf{until}\ b),\ q >\Downarrow q''$$

For the left side we have:

$$\frac{\dfrac{<S,q>\Downarrow q'\ <q',b>\Downarrow false}{<repeat\ S>}\quad \dfrac{<S,q>\Downarrow q''\ <q'',b>\Downarrow True}{skip}}{< S;\mathbf{if}\ b\ \mathbf{then}\ skip\ \mathbf{else}\ (\mathbf{repeat}\ S\ \mathbf{until}\ b) >}$$

For the right side we have:

$$\frac{< S,\ q >\ \Downarrow\ q'\ < q',\ b >\ \Downarrow\ \mathbf{repeat}\ < q',\ b >\ \Downarrow\ skip}{< \mathbf{repeat}\ S\ \mathbf{until}\ b >}$$

In this case, we can prove $left \Rightarrow right$.

For the reverse prove, for the left side we have:

$$< \mathbf{repeat}\ S\ \mathbf{until}\ b, q' >\Downarrow q''$$

For the right side we have:

$$< skip,\ q' >\ \Downarrow\ q''$$

We know q' is equivalent to q''. We can prove $left \Leftarrow right$.

Question 3

3. As for the first mutant, I change from `state = 0` to `state = 2`, this will cause the program jump out of the `for` loop immediately and cause the failure. And for the second one, I change from `elif c == separator:` to `elif c != separator:`, which can also cause the failure. The test cases are same, `"He^llo|world"`, which contains both `^` and `|`.

Question 4

Int.py: 75, for RelExp, it is impossible to assert False.

parse.py: 118, for _stmt_, it is impossible to return self.error.

parse.py: 268, for _bfactor_, it is impossible to return self.error.