Question-1

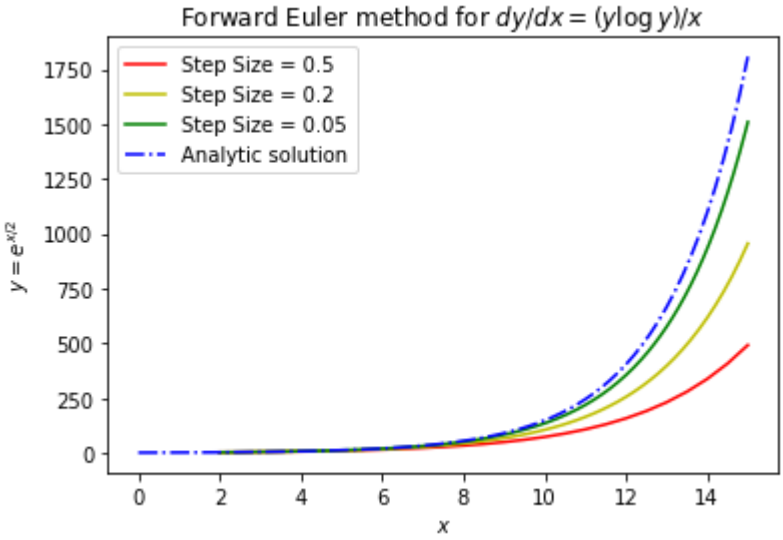
Use explicit Euler and Predictor-Corrector methods to solve the following ODE, taking step sizes 0.5, 0.2 and 0.05. Plot the solutions for each step sizes in two different plots for different methods. (Take $e = 2.71828$)

$$\frac{dy}{dx} = \frac{y \ln y}{x} \quad \text{Where} \quad y(2) = e$$

In [2]:

```
from My_Lib import*
import numpy as np
import matplotlib.pyplot as plt
import math

e = 2.71828 #BY DEFINITION IN THE QUESTION

def df(y, x):
    return (y*math.log(y))/x

#SOLVING BY EULER METHOD
x_1, y_1 = f_euler(df, e, 2, 15, 0.5) #defining boundary condition and step sizes
x_2, y_2 = f_euler(df, e, 2, 15, 0.2)
x_3, y_3 = f_euler(df, e, 2, 15, 0.05)


plt.title("Forward Euler method for $dy/dx = (y \log y)/x$")

x = np.arange(0, 15.2,0.2)
y = np.e**(x/2) #original function

print("The solution curves for different steps size in Euler method are")
#PLOT
plt.plot(x_1, y_1,'r-', label="Step Size = 0.5")
plt.plot(x_2, y_2,'y-', label="Step Size = 0.2")
plt.plot(x_3, y_3,'g-', label="Step Size = 0.05")
plt.plot(x, y, 'b-.', label='Analytic solution')
plt.xlabel("$x$")
plt.ylabel("$y=e^{x/2}$")
plt.legend()
plt.show()



#SOLVING BY PREDICTOR AND CORRECTOR METHOD

x_1, y_1 = predictor_corrector(df, e, 2, 15, 0.5) #defining boundary condition and step
sizes
x_2, y_2 = predictor_corrector(df, e, 2, 15, 0.2)
x_3, y_3 = predictor_corrector(df, e, 2, 15, 0.05)


plt.title("Predictor Corrector Method for $dy/dx = (y \log y)/x$")

x = np.arange(0, 15,0.2)
y = e**(x/2) #original function
print("The solution curves for different steps size in Predictor Corrector method are")
#PLOT
plt.plot(x_1, y_1,'r-', label="Step Size = 0.5")
plt.plot(x_2, y_2,'y-', label="Step Size = 0.2")
plt.plot(x_3, y_3,'g-', label="Step Size = 0.05")
plt.plot(x, y, 'b-.', label='Analytic solution')
plt.xlabel("$x$")
plt.ylabel("$y=e^{x/2}$")
plt.legend()
plt.show()
```

The solution curves for different steps size in Euler method are



The solution curves for different steps size in Predictor Corrector method are