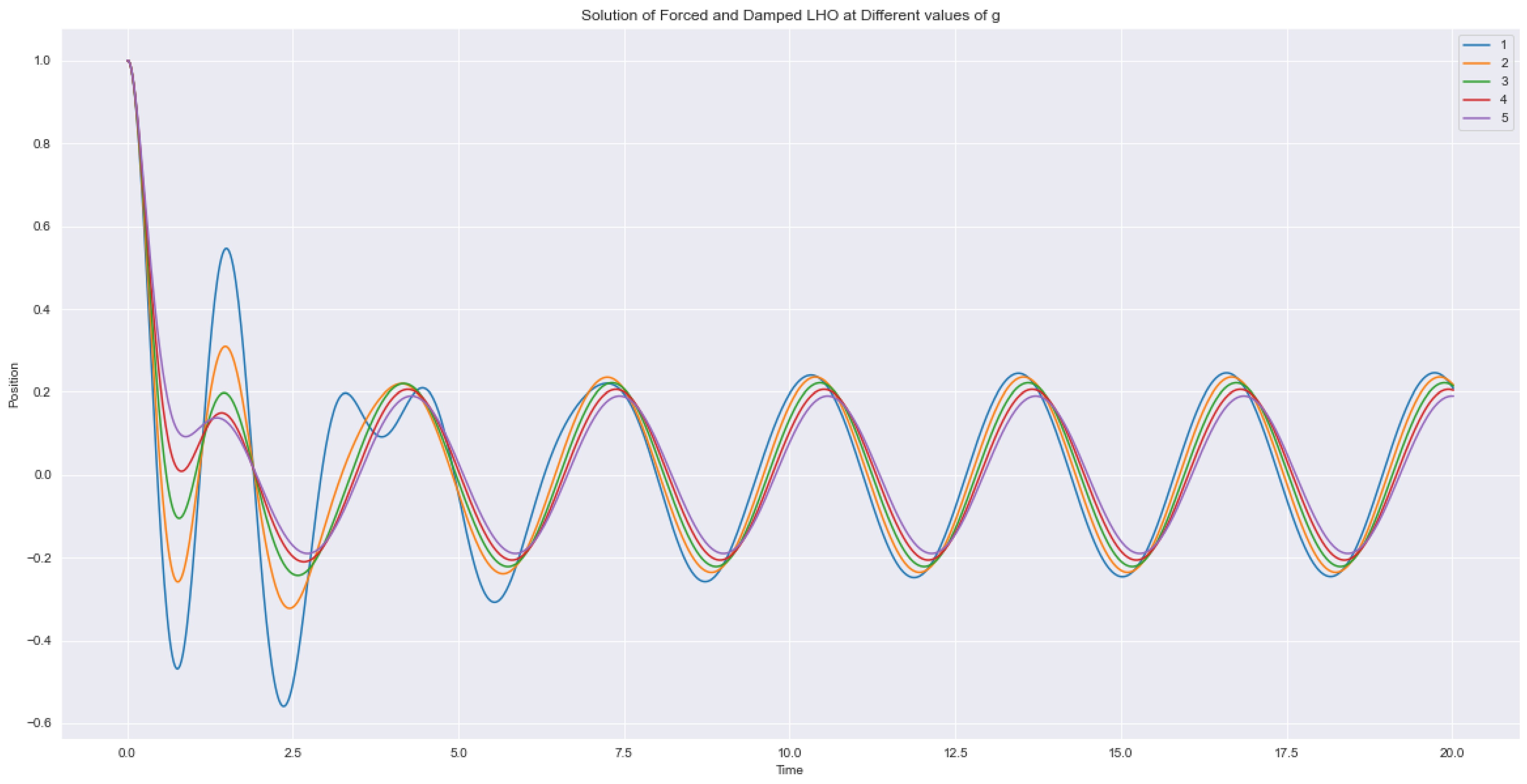
# 1. The Forced LHO at Different Damping Coefficients

Program:

In [57]:
```
import matplotlib.pyplot as plt
import seaborn as sns
import math as mth
import numpy as np
sns.set_style('darkgrid')
```

In [58]:
```
def f(t,x,v,g):
    return -w0**2*x - g*v + F0* mth.sin(w*t)

F0 = 3
w = 2
w0 = 4
x0 = 1.0
v0 = 0.0
ti = 0.0
tf = 20
n = 1000
h = (tf-ti)/n

for g in range(1,6):

    t = ti
    x = x0
    v = v0

    x_list = [x0]
    v_list = [v0]
    t_list = [ti]

    for _ in range(0,n+1):
        #print(t,x,v)
        x = x + h*v
        v = v + h* f(t,x,v,g)
        t = t+h

        x_list.append(x)
        v_list.append(v)
        t_list.append(t)

    plt.plot(t_list, x_list, label = g)
    plt.legend()
    plt.rcParams["figure.figsize"] = (20, 10)
    plt.title("Solution of Forced and Damped LHO at Different values of g")
    plt.xlabel("Time")
    plt.ylabel("Position")
```



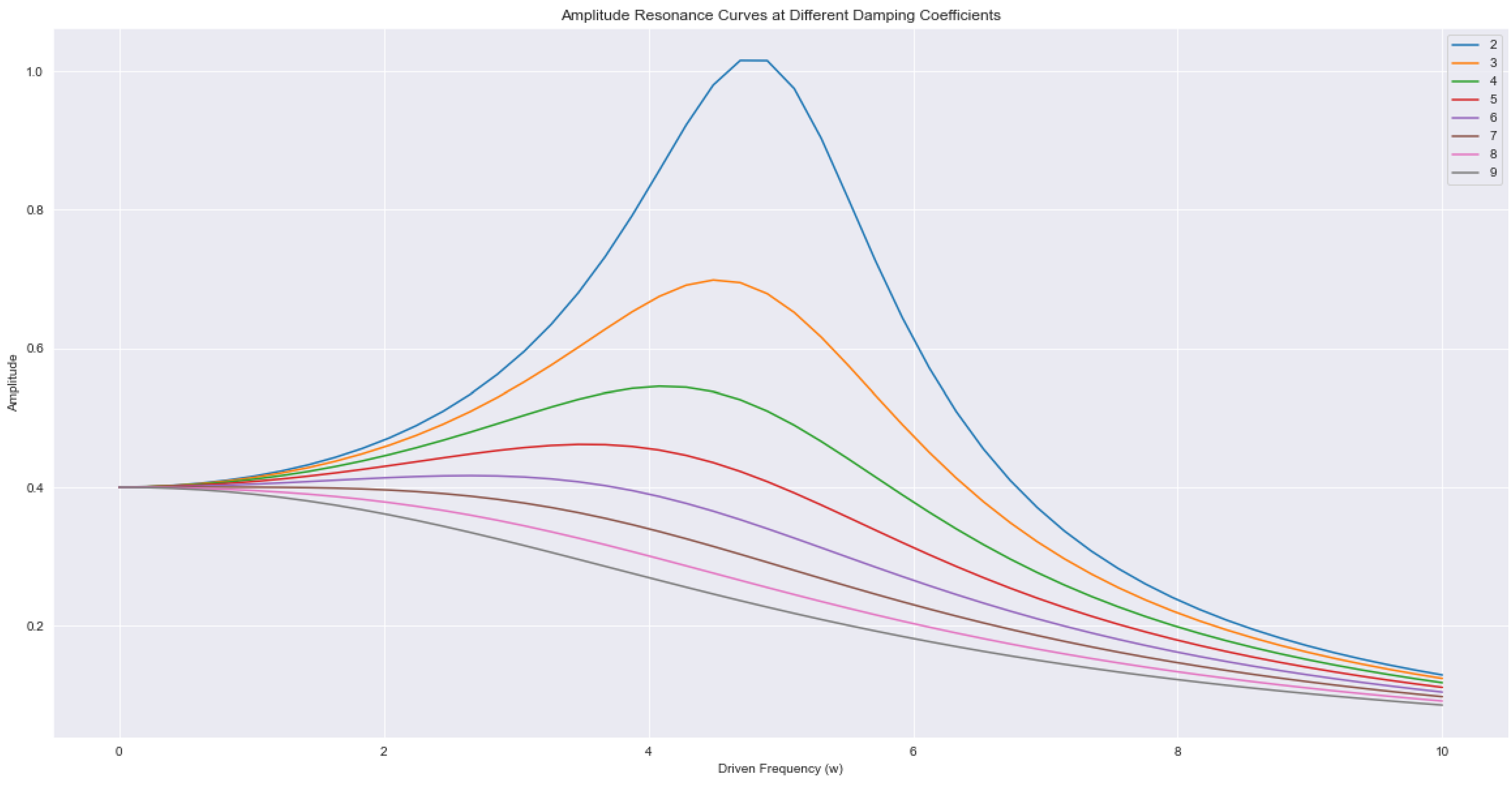

The above plot shows the different solutions of the system at different damping coefficients. Clearly we can observe a shift in the curves as g increases, which means that; as we increase the value of damping coefficient(g), the transient time decreases.

# 2. The Resonance Curves:

Program:

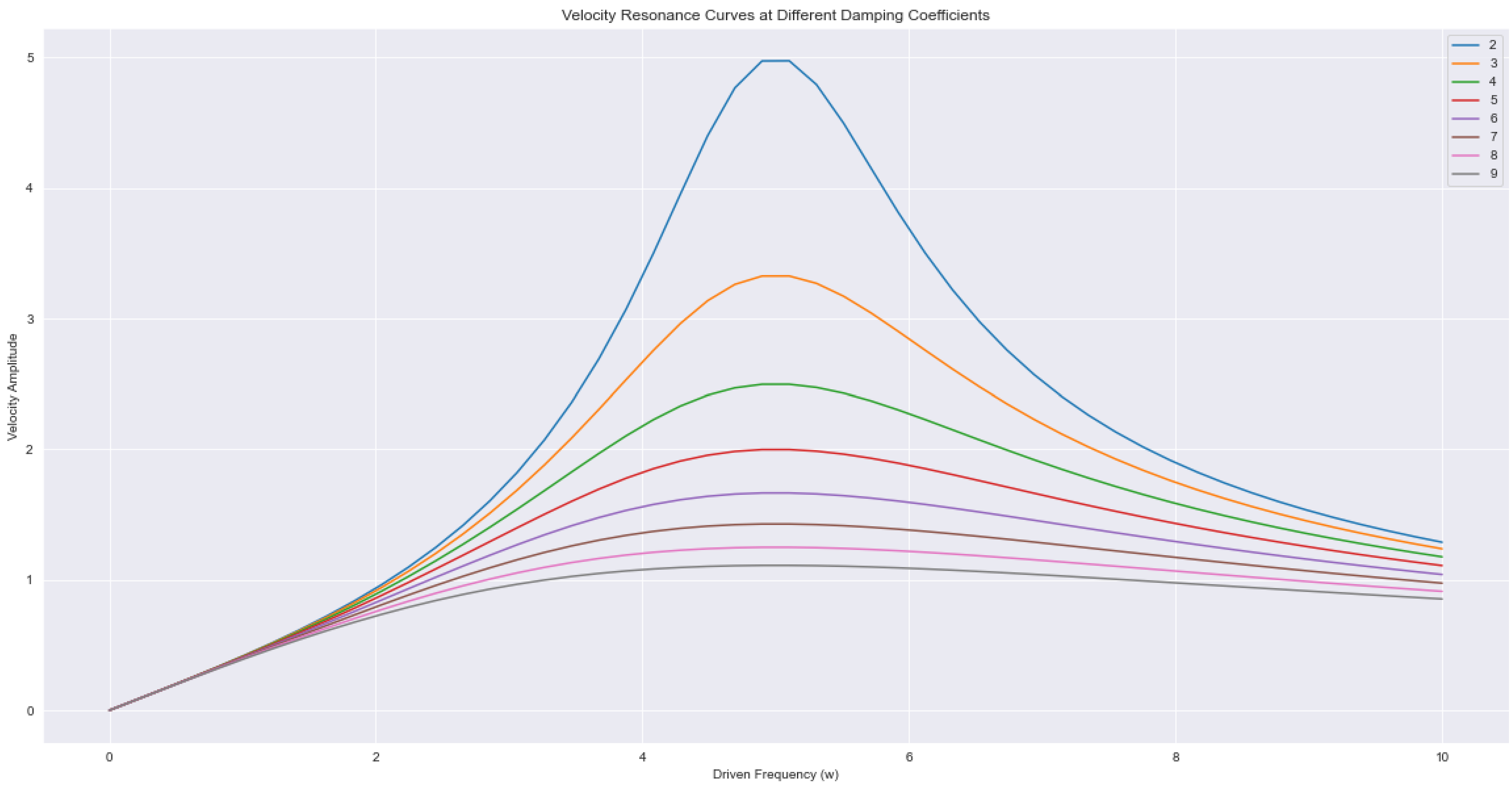
In [59]:
```
def ampl(F, w, W0, g):
    return F/np.sqrt((w**2 - W0**2)**2 + (g**2)*(w**2)) # position amplitude function

def vel(F, w, W0, g):
    return (w*F)/np.sqrt((w**2 - W0**2)**2 + (g**2)*(w**2)) # velocity amplitude function

F = 10
W0 = 5
w = np.linspace(0, 10)
```

In [60]:
```
for g in range(2,10):
    A = ampl(F, w, W0, g)
    plt.plot(w, A, label = g)
    plt.title("Amplitude Resonance Curves at Different Damping Coefficients")
    plt.legend()
    plt.xlabel("Driven Frequency (w)")
    plt.ylabel("Amplitude")
```




Velocity Resonance:

In [61]:
```
for g in range(2,10):
    V = vel(F, w, W0, g)
    plt.plot(w, V, label = g)
    plt.title("Velocity Resonance Curves at Different Damping Coefficients")
    plt.legend()
    plt.xlabel("Driven Frequency (w)")
    plt.ylabel("Velocity Amplitude")
```




From the above plots it is clear that the resonance phenomenon kind of disappears as we increase the damping coefficient (g).