Name: **Lab# 09** **Your ID #:**

Ordinary Differential Equations (ODEs)

Please answer the below questions:

Q1 (5pts): Use any example that you know the answer to, to answer the questions below that was raised in our class.

(a) Check whether the midpoint method is equivalent to Euler method with h=0.5 or not?

(a) Does adding more iteration for Huen's predictor method improve the accuracy?

Q2 (5pts): Use the following methods.

- **Euler Method**
- **Midpoint Method**
- **Heun's Predictor Corrector**
- **Runge Kutta methods (RK2)**
- **Runge Kutta methods (RK4)**

to solve the following the differential equations (h=0.01):

$$\frac{dy}{dx} = 1 + y + x^2, \qquad y(0) = 0.5$$

(a) Find the exact solution.
(b) Use a table to compare the accuracy between these method for 10 steps.
(c) Graph the exact solution with the solution with the above methods.
(d) Graph the error of these methods.

Q3 (5pts): Compare the performance of Euler's method and fourth-order Runge-Kutta method in solving the differential equation for a simple harmonic oscillator, given by:

m d^2x/dt^2 = -kx, x(0) = 1 and v(0) = 0.

where m = 1 kg and k = 1 N/m. The displacement from equilibrium is denoted by x, and t is the time.

(1) Express the differential equation in the form of two first-order equations:
(2) Compare the exact solutions with the (**Displacement vs t**) & (**V vs t**) obtained by the two methods by graphing them for 10 seconds.