Task 4

Defines file path

```
addpath('classes');
```

Task description

Implementer varianten av RK4-metoden beskrevet i avsnitt 4.4. Dere kan om dere vil implementere varianten av Runge Kutta Fehlberg-metoden (RKF45) som er beskrevet i avsnitt 4.5. Vær nøye på å implementere metoden nøyaktig slik den st˚ar. En liten feil i koefisientene vil gjøre metoden omtrent like unøyaktig som Eulers metode.

Parameter initialization

```
X0 = eye(3);  % X-matrix
I = eye(3);   % Moment of intertia matrix
L = [1 0 0]'; % Torque vector

h = 0.1;      % Step size
n = 10000;    % Number of iterations
TOL = 1e-50; % Tolerance
```

RKF45

```
rkf45 = RKF45(h, n, TOL);
[t, W] = rkf45.solve(X0, I, L);
W45 = W{end}
```

```
W45 = 3×3
    1.0000         0         0
         0    0.5624   -0.8269
         0    0.8269    0.5624
```

RK4

```
rk4 = RK4(h, n);
[~, W] = rk4.solve(X0, I, L);
W4 = W{end}
```

```
W4 = 3×3
    1.0000         0         0
         0    0.5624   -0.8269
         0    0.8269    0.5624
```

The exact solution

```
X = @(x) [ 1    0           0
           0 cos(x) -sin(x)
```

```
            0 sin(x)   cos(x) ];

X = X(t(end))
```

```
X = 3×3
    1.0000         0         0
         0    0.5624   -0.8269
         0    0.8269    0.5624
```

Calculates the error

RK4

```
RK4Error = abs(X - W4)
```

```
RK4Error = 3×3
10^-12 ×
         0         0         0
         0    0.3871    0.4192
         0    0.4192    0.3871
```

RKF45

```
RKF45Error = abs(X - W45)
```

```
RKF45Error = 3×3
10^-13 ×
         0         0         0
         0    0.1887    0.1288
         0    0.1288    0.1887
```

We can see from this that RK4 and RKF45 are more accurate than newtons method, even on this trivial example.

Checks if energy is conserved

```
 w0 = (X0 * I)^(-1) * L;
 E0 = Energy.calculate(L, X0 * w0);
```

RK4

```
 w1 = (W4 * I)^(-1) * L;
 E1 = Energy.calculate(L, W4 * w1);

 fprintf('Initial energy: %i \nFinal energy:   %i \nDifference:     %i', E0, E1, abs(E1
```

```
Initial energy: 5.000000e-01
Final energy:   5.000000e-01
```

```
Difference:     0
```

RKF45

```
w1 = (W45 * I)^(-1) * L;
E1 = Energy.calculate(L, W45 * w1);

fprintf('Initial energy: %i \nFinal energy:   %i \nDifference:     %i', E0, E1, abs(E1
```

```
Initial energy: 5.000000e-01
Final energy:   5.000000e-01
Difference:     0
```