**Q1 (a)**

D1 = k1

D2 = k2 v2

Pmotor = Pmax (1 – ) \* (1 - )

**Q1 (b)**

**Q1 (c)**

**Q2**

For an object travelling at constant speed v, force F, and power P are related by the following equation

P = Fv

which allows you to determine the constant power P required to sustain a constant force F.

Newton’s second law states that F = ma, if the e-bike is moving at a constant velocity, then the net force acting on the e-bike is zero as there is zero acceleration, this means that the driving force and drag force sum to give zero in this scenario. Using equations 1, 2 and 4 we can derive the total amount of power needed for the e-bike. The drag force consists of two main components D = D1 + D2­ where D1 = k1 and D2 = k2 v2. So, we have the total power, P, of the e-bike equal to Pmotor + P­rider and the force, F, in the equation P = Fv equal to D.

Therefore P = Prider + Pmotor = Fv = (D)v = (D1 + D2)v = (k1 + k2v2)v = k1v + k2v3

**Q3 (a)**

The equation we have is Prider + Pmotor = k1v + k2v3, with P­rider = 50 W this equation becomes the following

50 + Pmotor = k1v + k2v3

re-arranging for Pmotor we obtain the equation

Pmotor = k1v + k2v3 - 50

Newton’s method is defined as xk + 1= xk -

The numerical approximation to the derivate is defined as

The test for convergence of Newton’s method will be < tol

Using Newton’s Method using the above formulas with a tolerance (tol) of 0.0001, a perturbation (h) of 0.0001 and an initial estimate x0 of 0 in MATLAB we obtain the following

**Q3 (b)**

**Q3 (c)**

**Q4 (a)**