Answer to Question 2 – Enzyme Kinetics (Ordinary Differential Equations)

a)

$$\frac{d[E]}{dt} = -k_1[E][S] + k_2[ES] + k_3[ES] = -k_1[E][S] + (k_2 + k_3)[ES]$$
$$\frac{d[S]}{dt} = -k_1[E][S] + k_2[ES]$$
$$\frac{d[P]}{dt} = k_3[ES]$$
$$\frac{d[ES]}{dt} = k_1[E][S] - (k_2 + k_3)[ES]$$

b) & c)

$$rate = \frac{d[P]}{dt} = k_3[ES]$$

Assuming steady-state approximation,

$$rate = \frac{d[P]}{dt} = \frac{V_{max}[S]}{K_M + [S]},\ K_M = \frac{k_2 + k_3}{k_1}$$
$$\frac{d[S]}{dt} = K_M[ES]$$

given that the rate constants are: k_1=100/µM/min, k_2=600/min, k_3=150/min.

$$\frac{d[P]}{dt} = \frac{V_{max}[S]}{K_M + [S]}$$