① a) $m\ddot{x} + d\dot{x} + kx = F - F_f$

$v = F = -k_p x - k_d \dot{x}$

$\ddot{x} + \left(\frac{d+k_d}{m}\right)\dot{x} + \left(\frac{k+k_p}{m}\right)x = 0$

$\omega_0^2 = \frac{k+k_p}{m}$

$\omega_0 = \sqrt{\frac{k+k_p}{m}} = \sqrt{\frac{4+4}{2}} = 2$

$2\omega_0\zeta = \frac{d+k_d}{m}$

$\zeta = \frac{1}{2}\left(\frac{d+k_d}{m \cdot \omega_0}\right) = \frac{1}{2}\left(\frac{1+1}{2 \cdot 2}\right) = \frac{1}{4}$

$\omega_d = \omega_0\sqrt{1-\zeta^2} = 2\sqrt{1-\left(\frac{1}{4}\right)^2} = 1{,}93$

b) $\omega_0^2 = \frac{k+k_p}{m}$

$k_p = \omega_0^2 \cdot m - k = 10^2 \cdot 2 - 4 = 196$

$2\omega_0\zeta = \frac{d+k_d}{m}$

$k_d = 2\omega_0\zeta m - d = 2 \cdot 10 \cdot 1 \cdot 2 - 1 = 39$

c) —

d) $K_p K = 2{,}25 \quad T_k = 3{,}8$

$K_p = 0{,}6 \cdot 2{,}25 = 1{,}35$

$T_i = 0{,}5 \cdot T_k = 1{,}9$

$T_d = 0{,}125 \cdot T_k = 0{,}475$

e) $f_{max} = \frac{1}{3{,}8} = 0{,}26\,Hz$

$f_s \geq 2 f_{max}$

$f_s \geq 0{,}52\,Hz$

② a) For å fjerne høyfrekvensstøy, siden derivering av støy gir store signalverdier

③ a) $\dot{S} = -\beta I S + \alpha I$

$\dot{I} = \beta I S - \alpha I$

$N = S + I$

$S = N - I$

$\dot{I} = \beta I(N - I) - \alpha I$

$\dot{I} = \beta I N - \beta I^2 - \alpha I$

$\dot{I} = I(\beta N - \beta I - \alpha)$

$\dot{I} = I(r - \beta I)$

$\dot{I} = rI\left(1 - \frac{\beta I}{r}\right)$

$\dot{I} = rI\left(1 - \frac{I}{K}\right) \qquad K = \frac{r}{\beta}$

b)