# Assignment 2

## Part 1:

Bradley Schmidt (T00711584)

$$\frac{d^3y}{dt^3} + 3\frac{d^2y}{dt^2} + 5\frac{dy}{dt} = \frac{d^3x}{dt^3} + 4\frac{d^2x}{dt^2} + 6\frac{dx}{dt} + 8x$$

$$s^3Y(s) + 3s^2Y(s) + 5sY(s) = s^3X(s) + 4s^2X(s) + 6sX(s) + 8X(s)$$

$$Y(s)\Big(s^3 + 3s^2 + 5s\Big) = X(s)\Big(s^3 + 4s^2 + 6s + 8\Big)$$

$$\boxed{H(s) = \frac{Y(s)}{X(s)} = \frac{s^3 + 4s^2 + 6s + 8}{s^3 + 3s^2 + 5s}}$$

## Part 2:

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### (a)

$$\frac{X(s)}{F(s)} = \frac{7}{s^2 + 5s + 10}$$

$$X(s)\Big(s^2 + 5s + 10\Big) = 7F(s)$$

$$s^2X(s) + 5sX(s) + 10X(s) = 7F(s)$$

$$\boxed{\frac{d^2x}{dt^2} + 5\frac{dx}{dt} + 10x = 7f}$$

### (b)

$$\frac{X(s)}{F(s)} = \frac{15}{(s + 10)(s + 11)}$$

$$X(s)(s + 10)(s + 11) = 15F(s)$$

$$X(s)(s^2 + 21s + 110) = 15F(s)$$

$$s^2X(s) + 21sX(s) + 110X(s) = 15F(s)$$

$$\boxed{\frac{d^2x}{dt^2} + 21\frac{dx}{dt} + 110x = 15f}$$

**(c)**

$$\frac{X(s)}{F(s)} = \frac{s+3}{s^3+11s^2+12s+18}$$

$$X(s)(s^3+11s^2+12s+18) = F(s)(s+3)$$

$$s^3X(s)+11s^2X(s)+12sX(s)+18X(s) = sF(s)+3F(s)$$

$$\boxed{\frac{d^3x}{dt^3}+11\frac{d^2x}{dt^2}+12\frac{dx}{dt}+18x = \frac{df}{dt}+3f}$$

## Part 3:

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$$\frac{C(s)}{R(s)} = \frac{s^4+3s^3+2s^2+s+1}{s^5+4s^4+3s^3+2s^2+3s+2}$$

$$R(s)(s^4+3s^3+2s^2+s+1) = C(s)(s^5+4s^4+3s^3+2s^2+3s+2)$$

$$s^4R(s)+3s^3R(s)+2s^2R(s)+sR(s)+R(s) = s^5C(s)+4s^4C(s)+3s^3C(s)+2s^2C(s)+3sC(s)+2C(s)$$

$$\frac{d^5c}{dt^5}+4\frac{d^4c}{dt^4}+3\frac{d^3c}{dt^3}+2\frac{d^2c}{dt^2}+3\frac{dc}{dt}+2c(t) = \frac{d^4r}{dt^4}+3\frac{d^3r}{dt^3}+2\frac{d^2r}{dt^2}+\frac{dr}{dt}+r(t)$$

$$r(t) = 3t^3,\ \frac{dr}{dt} = 9t^2,\ \frac{d^2r}{dt^2} = 18t,\ \frac{d^3r}{dt^3} = 18$$

$$\boxed{\frac{d^5c}{dt^5}+4\frac{d^4c}{dt^4}+3\frac{d^3c}{dt^3}+2\frac{d^2c}{dt^2}+3\frac{dc}{dt}+2c(t) = 54+36t+27t^2+6t^3}$$