2b:

The controller is initially improper because the order of the polynomial in the numerator(order of y = m) is greater than the order of the polynomial in the denominator(order of x = n)

To make m = n such that D becomes a proper controller, we must add k = 5 number of poles to T.

G(s) = b(s)/a(s)

Find D(s) = y(s)/x(s)

f(s) = 0 at (-1, -1, -3, -3, -6, -6, -20, -20, -20, -20, -20)

We can find x and y using the diophantine equation(ax + by = fs) which leverages the bezout identity.

Diophantine takes input a, b, and fs and will solve for x and y.

By adding 5 poles to T we increase the order of fs to n = 11(previously n = 6). Adding only 4 poles to T brings the order of fs n=10.

Diophantine eq we retrieve the “best” y which is the smallest option – When the order of f(s) increases, y(s) will also increase because Euclidean is finding the greatest common factor of a and b and then Diophantine is finding the smallest y that solves its equation

Y will grow when gcf of a and b shrinks and f increases by c = f/g

Importance of proper functions: It is important to have a proper function because an improper function allows the noise in the system to blow up. With a high frequency input(noise) the magnitude will grow bigger. When analyzing the Bode plot, the system’s response needs to roll off with high frequencies i.e. it must be proper.