Q3. $G(s) = \dfrac{35s^7 + 1086s^6 + 13285s^5 + 82402s^4 + 278376s^3 + 511812s^2 + 482964s + 194480}{s^8 + 33s^7 + 437s^6 + 3017s^5 + 11870s^4 + 27470s^3 + 37492s^2 + 28880s + 9600}$

$Num(s) = 194480s^7 + 482964s^6 + 511812s^5 + 278376s^4 + 82402s^3 + 13285s^2 + 1086s + 35$

$Num'(s) = 1361360s^6 + 2897784s^5 + 2559060s^4 + \cdots$

$Num''(s) = 8168160s^5 + 14488920s^4 + 10236240s^3 + \cdots$

$Num'''(s) = 40840800s^4 + 57955680s^3 + 30708720s^2 + \cdots$

$Num''''(s) = 163363200s^3 + 173867040s^2 + 61417440s + \cdots$

$Num'''''(s) = 490089600s^2 + 347734080s + 61417440 \Rightarrow$

$61417440s^2 + 347734080s + 490089600$

$Num''''''(s) = 98017920s + 347734080 \Rightarrow 347734080s + 98017920$

$Den(s) = 9600s^8 + 28880s^7 + 37492s^6 + 27470s^5 + 11870s^4 + 3017s^3 + 437s^2 + 33s + 1$

$Den' = 76800s^7 + 202160s^6 + 224952s^5 + 137350s^4 + \cdots$

$Den'' = 537600s^6 + 1212960s^5 + 1124760s^4 + 549400s^3 + \cdots$

$Den''' = 3225600s^5 + 6064800s^4 + 4499040s^3 + 1648200s^2 + \cdots$

$Den'''' = 16128000s^4 + 24259200s^3 + 13497120s^2 + 3296400s + \cdots$

$Den''''' = 64512000s^3 + 72777600s^2 + 26994240s + 3296400 \Rightarrow$

$Den'''''' = 193536000s^2 + 145555200s + 26994240 \Rightarrow$

$26994240s^2 + 145555200s + 193536000$

$3296400s^3 + 26994240s^2 + 72777600s + 64512000$

$$\cdot\ \overset{*}{G}_3(s) = \frac{61417440\,s^2 + 347734080\,s + 490089600}{32964005^3 + 26994240\,s^2 + 72777600\,s + 64512000}$$

$$G(s)\Big|_{s=0} = K\ \overset{*}{G}_3(s)\Big|_{s=0}$$

$$\frac{194480}{9600} = K\ \frac{490089600}{64512000}$$

$$\Rightarrow \boxed{K = \frac{20.2583}{7.5968} = 2.6666}$$

$$\boxed{G_3(s) = 2.6666 \cdot \frac{61417400\,s^2 + 347734080\,s + 490089600}{22964005^3 + 26994240\,s^2 + 72777600\,s + 64512000}}$$

3rd order

$$\overset{*}{G}_2(s) = \frac{347734080\,s + 980179200}{26994240\,s^2 + 145555200\,s + 193536000}$$

$$G(s)\Big|_{s=0} = K\ \overset{*}{G}_2(s)\Big|_{s=0}$$

$$20.2583 = K\ \frac{980179200}{193536000}$$

$$\Rightarrow \boxed{K = \frac{20.2983}{5.06458} = 3.9999 \approx 4}$$

$$\boxed{G_2(s) = 4 \cdot \frac{347734080\,s + 980179200}{26994240\,s^2 + 145555200\,s + 193536000}}$$

2nd order