STR Adaptive Controller-

Our plant transfer function from system identification, $G(s) = \dfrac{0.01964}{s^2 + 0.54s + 0.0045}$

So,
$$B = [0.01964]$$
$$A = [1 \quad 0.54 \quad 0.0045]$$

Model transfer function, $\dfrac{B_m(s)}{A_m(s)} = \dfrac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$

Now,
$$\frac{BT}{AR+BS} = \frac{BT}{AC} = \frac{B_m}{A_m}$$

$BT = B_m$ & $A_C = A_m$

$\deg(A_m) = \deg(A) = 2$

$\deg(B_m) = \deg(B) = 0$

$\deg(A_0) = \deg(A) - 1$
$= 2 - 1 = 1$

$\deg(S) = \deg(R) = 1$

Now, Let's choose $A_0 = s + a_0$

Control given by,

$$AR + BS = A_C$$

Now,

$$AR + BS = A_c$$

$$\Rightarrow AR + BS = A_m A_o$$

$$\Rightarrow (s^2 + 0.54s + 0.0045)(s + n_1) + (0.01964)(s_0 s + s_1)$$

$$= (s + a_0)(s^2 + 2\xi\omega_n s + \omega_n^2)$$

$$\Rightarrow s^3 + 0.54s^2 + 0.0045s + s^2 n_1 + 0.54 s n_1 + 0.0045 n_1$$

$$+ 0.01964 s_0 s + 0.01964 s_1 = s^3 + 2\xi\omega_n s^2 + \omega_n^2 s$$

$$+ a_0 s^2 + 2\xi\omega_n^2 a_0 s + a_0 \omega_n^2$$

equating co-efficient of equal power of s:

$$0.54 + n_1 = 2\xi\omega_n + a_0 \quad \text{— (i)}$$

$$0.0045 + 0.54 n_1 + 0.01964 s_0 = \omega_n^2 + 2\xi\omega_n a_0 \quad \text{— (ii)}$$

$$0.0045 n_1 + 0.01964 s_1 = a_0 \omega_n^2 \quad \text{— (iii)}$$

Since, no zero's are cancelled

$B^+ = 1$ and $B^- = B = [0.01964]$

$$B_m' = \frac{B_m}{B^-} = \frac{\omega_n^2}{b}$$

Now, $T = A_o B_m' = \dfrac{\omega_n^2}{b}(s + a_0)$

for our desired output,

Let's $a_0 = 1$, $\omega_n = 1$ & $\xi = 0.7$

$$\therefore T = \frac{1}{0.01964}(s+1)$$

Now, from eq^n (i), (ii) & (iii)

$$r_1 = 2.4 - 0.54$$

$$0.54 r_1 + 0.01964 s_0 = -0.0045 + 2.4$$

$$0.045 r_1 + 0.01964 s_1 = 1$$

Solving these three eq^n,

$r_1 = 1.86$

$s_1 = 46.65$

$s_0 = 70.82$

$$\therefore T = \frac{s+1}{0.01964}$$

$$R = (s + 1.86)$$

$$S = (70.82s + 46.65)$$