Revision:

1. Laplace table revision:

Time domain	Freq dom
$u(t)$	$1/s$
$r(t)$	$1/s^2$
t^n	$n!/s^{n+1}$
$e^{\mp t\alpha} f(t)$	$F(s \pm \alpha)$
$\cos(\alpha t)$	$\frac{s}{s^2+\alpha^2}$
$\sin(\alpha t)$	$\frac{\alpha}{s^2+\alpha^2}$
$f(t \pm t_0)$	$e^{\pm s t_0} F(s)$
$f'(t)$	$sF(s) - f(0)$
$f''(t)$	$s^2 f(s) - f(0)s - \dot{f}(0)$
$\int f(t) dt$	$F(s)/s$
$t f(t)$	$\frac{dF(s)}{ds}$

simple cases:

1- 2^{nd} order:

check all coefficients are > 0

2- 3^{rd} order:

$a_3 s^3 + a_2 s^2 + a_1 s + a_0$

$a_i > 0 \ \forall_{i \in [1,4]}$

$a_2 a_1 > a_0 a_3$

2- Routh stability rev

ع السؤال إما بيجبلك رسمة لأى system ويقولك هى stable أو لا.

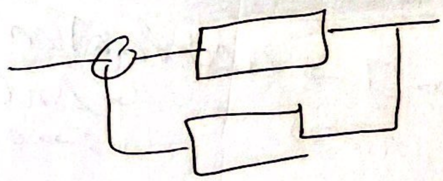
خطوات الحل:

١- بنجيب ال transfere function

٢- ناخد ال denominator = C/Cs
ده characteristic equation

٣- نساويه بصفر

٤- نعمل الجدول عشان نتأكد إن مفيش اى -ve موجود في أول column.



special cases:

1- case zero exist

ساعتها انت بتحط ε مكان ال (0) وتجيب $\lim_{\epsilon \to 0}$
وغالبا هتلاقي ال system بقى unstable، لو مش كدا يبقى critically stable

2. Row of zeros:

بناخد ال Row اللي فوقه و نعمله Differentiation

3- Steady state:

- $E(s) = \frac{R(s)}{1 + G(s)}$
- $e_{ss} = \lim_{s \to 0} (s\,E(s))$
- $G(s) = \frac{P(s)}{s^n Q(s)}$

Static error coefficients:

1. $K_p \to$ ☐ $\to$ Position $\to \lim_{s \to 0} G(s)$ (@ n = 1)
2. $K_v \to$ ☐ $\to$ velocity $\to \lim_{s \to 0} (s\,G(s))$ (@ n = 2)
3. $K_a \to$ ☐ $\to$ acceleration $\to \lim_{s \to 0} (s^2 G(s))$ (@ n = 3)

Evaluation table:

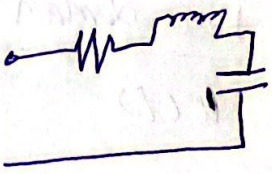
Type	Step	ramp	Parabola
zero	Const	∞	∞
1	0	Const	∞
2	0	0	Const

For $H(s) \neq 1$:

$$TF = \frac{G(s)}{1 + H(s)\,G(s) - G(s)}$$

4- Mathmatical Modeling:

1- Electric systems:



$R \to R$

$l \to sl$

$C \to \frac{1}{Cs}$

2- Mechanical systems:

1- $F = ma$ & 2- for every action there is a reaction which is equal in magnitude & opposite in direction $F \to \leftarrow F$

3- spring — K → spring constant

$F = X_t K = X(s) K$

X_t → Displacement

4- Piston

$\to F = B\dot{X}(t) = sBX(s)$

5- Fluids:

$Q_o = H/R$

$Q_{in} - Q_{out} = \frac{A\,dH}{dt}$