MAL Und - II D Laplace Transform Definition Let f(t) be a function of I defined for all positive values of t, then the laplace transform of f(t), denoted by L(f(+)) is defined by Lff(t)3= Se-stf(t) dt provided the integral exist. Where; s -> parameter which may be real or complex number. tormulae List 1. (1) = 1/5 (9f n is integer) sn+1 (If n is not integer) L(+") = 1000 Camma function (eat) = 5-01 4. L (8in ad)  $\frac{5 \cdot 1 \left(\cos \alpha t\right)}{s^2 + \alpha^2}$ 

6. L(sinh at) = a  $s^2 - a^2$ 

7.  $L(coshat) = \frac{s}{s^2 - a^2}$ 

Existence of Laplace Tourstoom (Without Boost)

If f(t) is a function of which is preceived continuous on every frite-interval in the hange t > 0 & statisfies

1F(+)1 < Meat . (++>0)

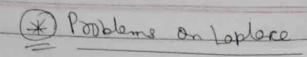
And for some constants a & M, then the Laplace transform of f(t) exists & p>a.

## · Proporties

## 2. Division Property

If 
$$L(f(t)) = \overline{f}(s)$$
  
then  $L(\frac{1}{t}f(t)) = \frac{1}{s}f(s)ds$ 

Later Later Could



Oves.

Find Laplace Transform of

f(t) = te-4+ sin3+

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L(sin 3+)= 3 52+9

(Use multiplication property)

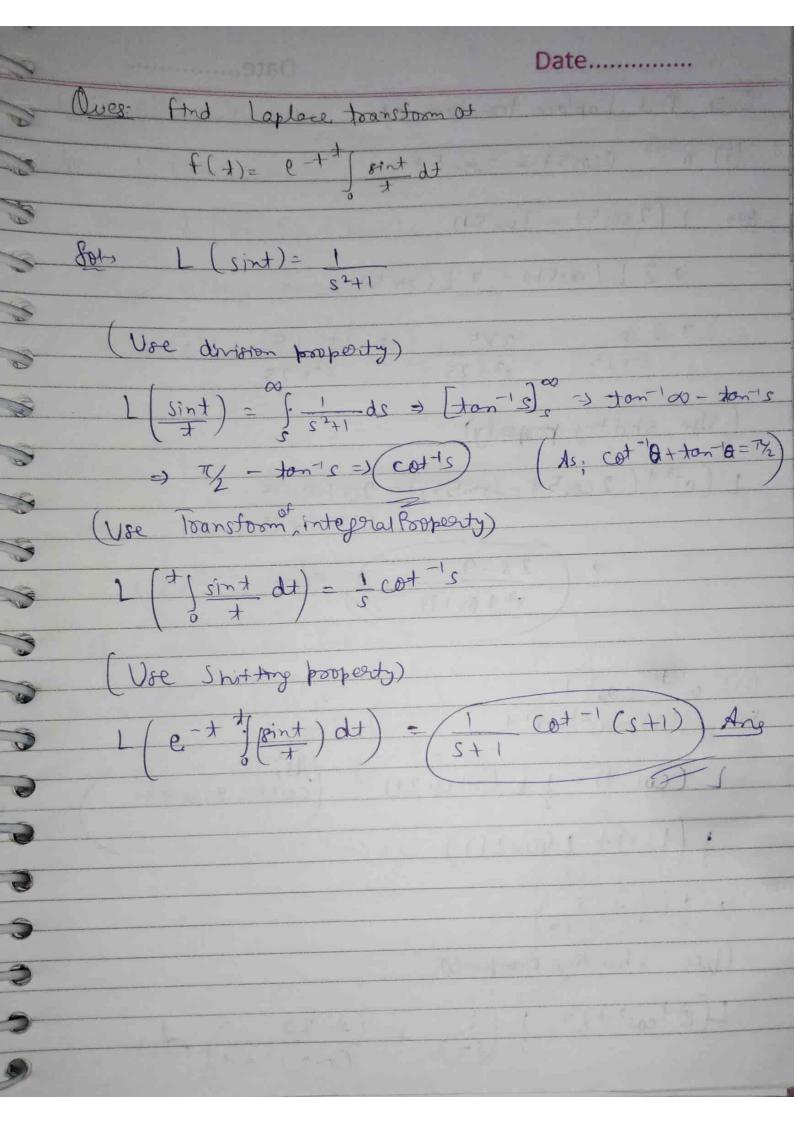
 $\frac{1}{ds}\left(\frac{1}{3}\right) = (-1)^{1} \frac{d}{ds}\left(\frac{3}{3}\right) = (-3) \frac{d}{ds}\left(\frac{3}{3}\right) + (-3) \frac{d}{ds}\left(\frac{3}{$ 

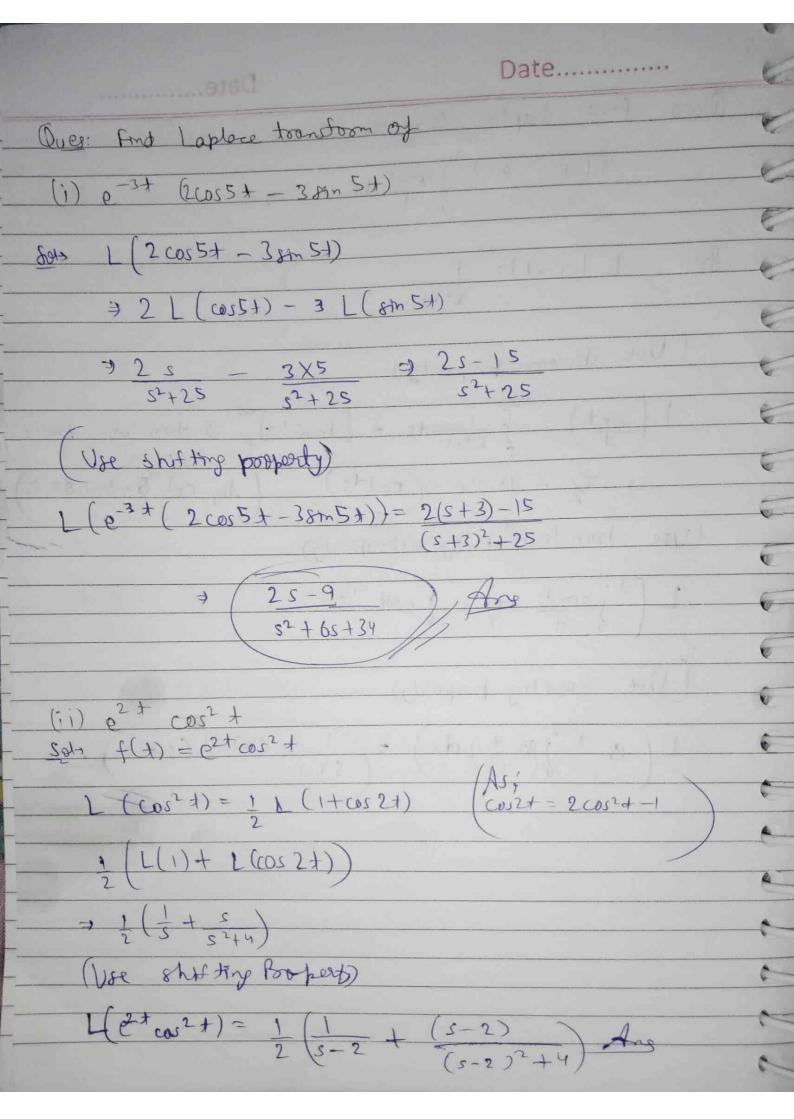
 $\Rightarrow (-3)(-1)(s^2+9)^2(2s) \Rightarrow 6s$   $(s^2+9)^2$ 

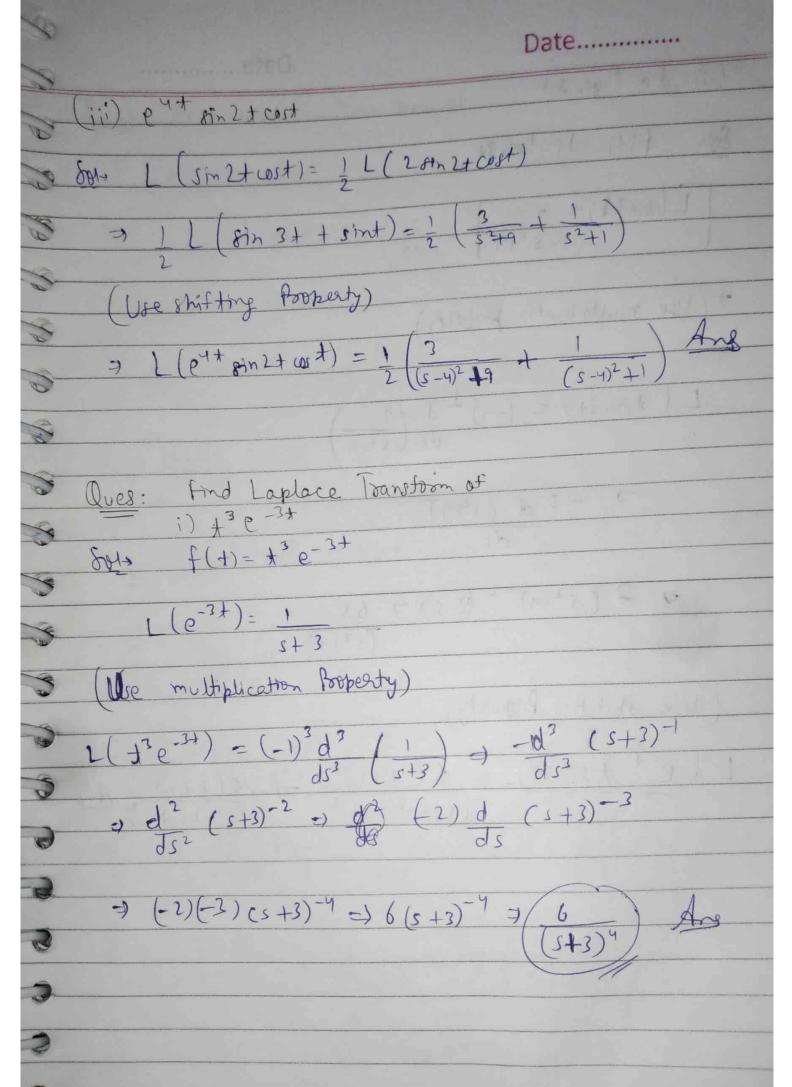
(Use I histing pooporty)

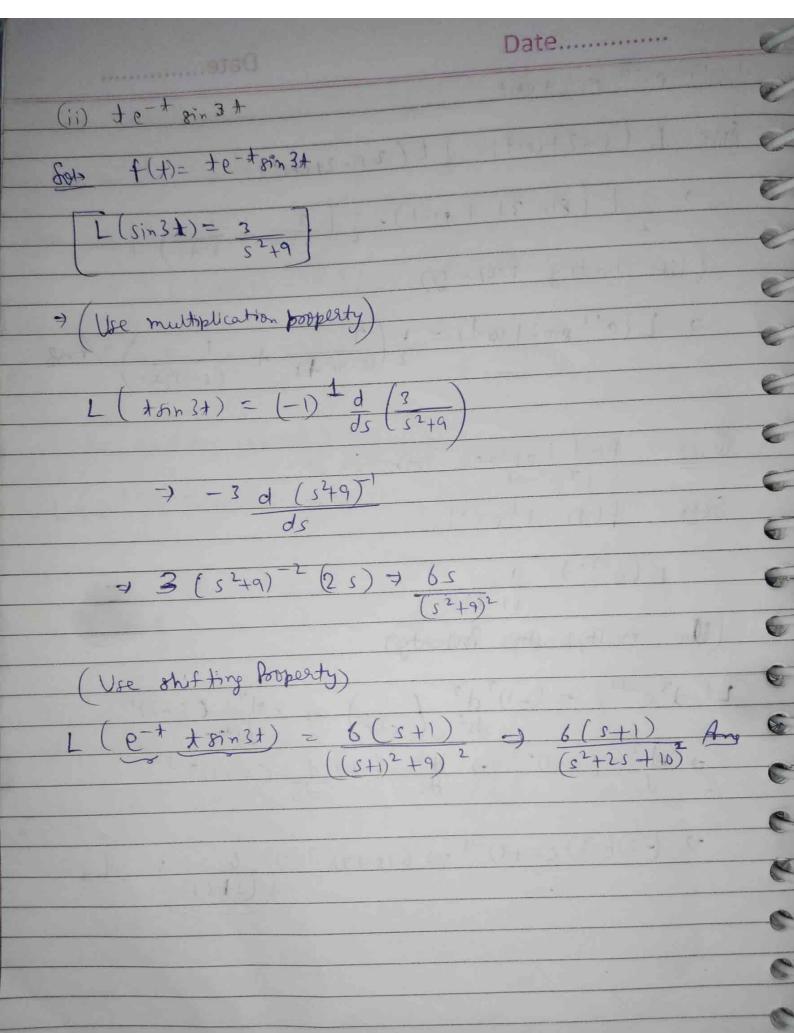
 $L(e^{-4t} t sin 3t) = 6(s+4)$   $(cs+4)^{2} + 9)^{2}$ 

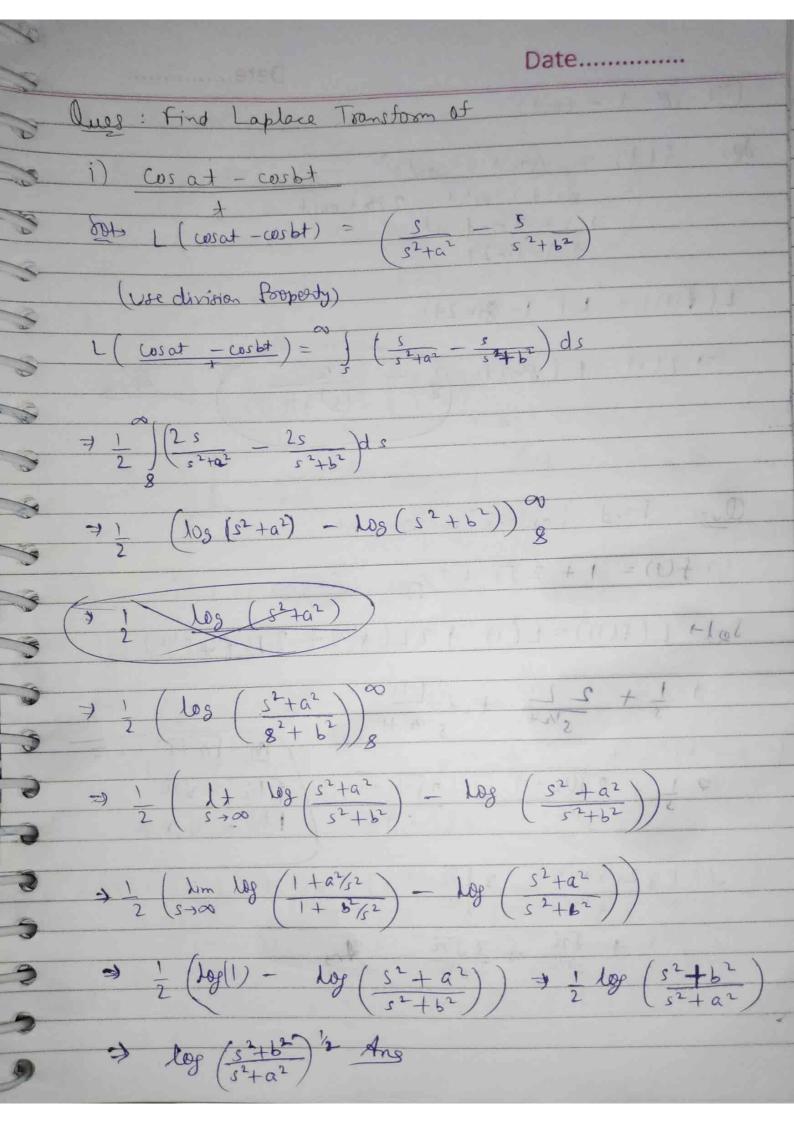
=) (6(s+4))  $(s^2 + 8s + 25)^2$ 











$$\frac{1}{2}$$
  $\frac{1}{2}$   $\frac{1}$ 

$$(i) f(t) = 1 + 2 \int_{a}^{b} + \frac{3}{\int_{a}^{b}}$$

$$\frac{1}{s} + \frac{1}{2} \frac{1}{2} + \frac{1}{2} \frac{1-1/2}{1-1/2}$$

$$\frac{7}{5}$$
 +  $\frac{2}{5}$   $\frac{(1/2+1)}{5^{2/2}}$  +  $\frac{2}{5}$   $\frac{-1/2+1}{5^{1/2}}$ 

-

$$\frac{\text{dol}_{3}}{\text{cos}^{3} + \frac{1}{2} \cos^{3} + \frac{1}{2} \cos^{2} + \frac$$

$$L\left(\cos^{3}2t\right) = \frac{1}{4}L\left(\cos 6t + 3\cos 2t\right)$$

$$L\left(\cos^{3}2t\right) = \frac{1}{4}L\left(\cos 6t\right) + \frac{3}{4}L\left(\cos 2t\right)$$

$$\Rightarrow \frac{1}{4} \left( \frac{s}{s^2 + 36} \right) + \frac{3}{4} \left( \frac{s}{s^2 + 44} \right)$$

$$\frac{1}{4} \left[ \frac{s}{s^2 + 36} + \frac{3s}{|s^2 + 4|} \right] \frac{4}{s^2}$$

$$bb = ((a-b)^3 - a^3 - b^3 - 3ab(a-b))$$

$$f(+)=(+^{1/2}-+^{-1/2})^3 \Rightarrow +^{3/2}-+^{-3/2}-3+^{1/2}+^{1/2}(+^{1/2}-+^{-1/2})$$

$$L(f(t)) = L(t^{3/2}) - L(t^{-3/2}) - 3L(t^{1/2}) + 3L(t^{-1/2})$$

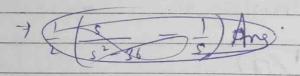
$$\frac{3}{5^{3/2+1}} = \frac{5^{3/2+1}}{5^{3/2+1}} = \frac{3}{5^{3/2+1}} = \frac{1}{5^{3/2+1}} = \frac{3}{5^{3/2+1}} = \frac{$$

$$\frac{3}{5} \frac{3}{2} \frac{1}{2} + 1 \qquad \frac{3}{5} \frac{1}{2} \frac{1}{2}$$

$$\frac{3}{2} \frac{1}{12} + 1 = \frac{(-2\sqrt{n})}{5^{-1/2}} - \frac{3\times\frac{1}{2}\times\sqrt{n}}{5^{3/2}} + \frac{3\sqrt{n}}{5^{3/2}}$$

$$\frac{3}{2} \frac{3}{2} \times 1/2 \times 1/2 + 2 \sqrt{\pi} - \frac{3}{5} \sqrt{\pi} + \frac{3}{5} \sqrt{\pi}$$

$$\frac{5}{5} \times 1/2 \times 1/2 + \frac{3}{5} \times 1/2 \times$$



$$\Rightarrow \left(\frac{1}{2}\left(\frac{s}{s^2-36}-\frac{1}{s}\right)\right)$$
 Any

Pind Laplace Toansform of (1-cost)

 $501> L(1-cost) = \frac{5}{5} - \frac{5}{5^2+1}$ 

(Use Division Property)

3

$$\frac{1}{1-(\omega s+1)} = \frac{1}{2}\left(\frac{1}{s} - \frac{s}{s^2+1}\right)ds \Rightarrow \int_{s}^{\infty} \left(\frac{1}{s} - \frac{2s}{2(s^2+1)}\right)ds$$

$$\Rightarrow \log 1 - \log s \Rightarrow \log (s^2+1)^{1/2} \Rightarrow \log (s^2+1)^{1/2}$$

$$\Rightarrow \frac{1}{2} \log \left( \frac{1+1}{s^2} \right) \Rightarrow \left( \frac{1}{2} (\log (1+s^{-2})) \right)$$

Again use division Property;

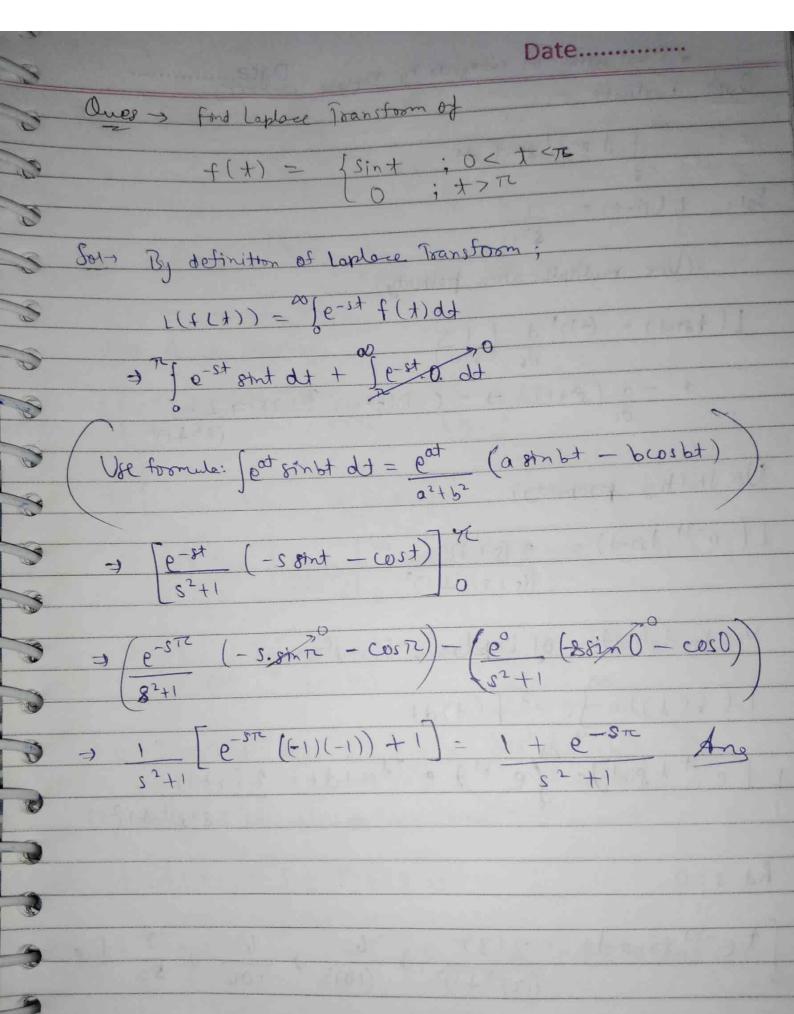
$$L\left(\frac{1-\cos t}{t^2}\right) = \frac{1}{2} \int_{S}^{\infty} \log(1+s^{-2}) ds$$

$$\frac{3}{2} \left[ s \log (1+s^{-2}) + 2 \int \frac{s^{-2}}{1+s^{-2}} ds \right]_{s}^{\infty}$$

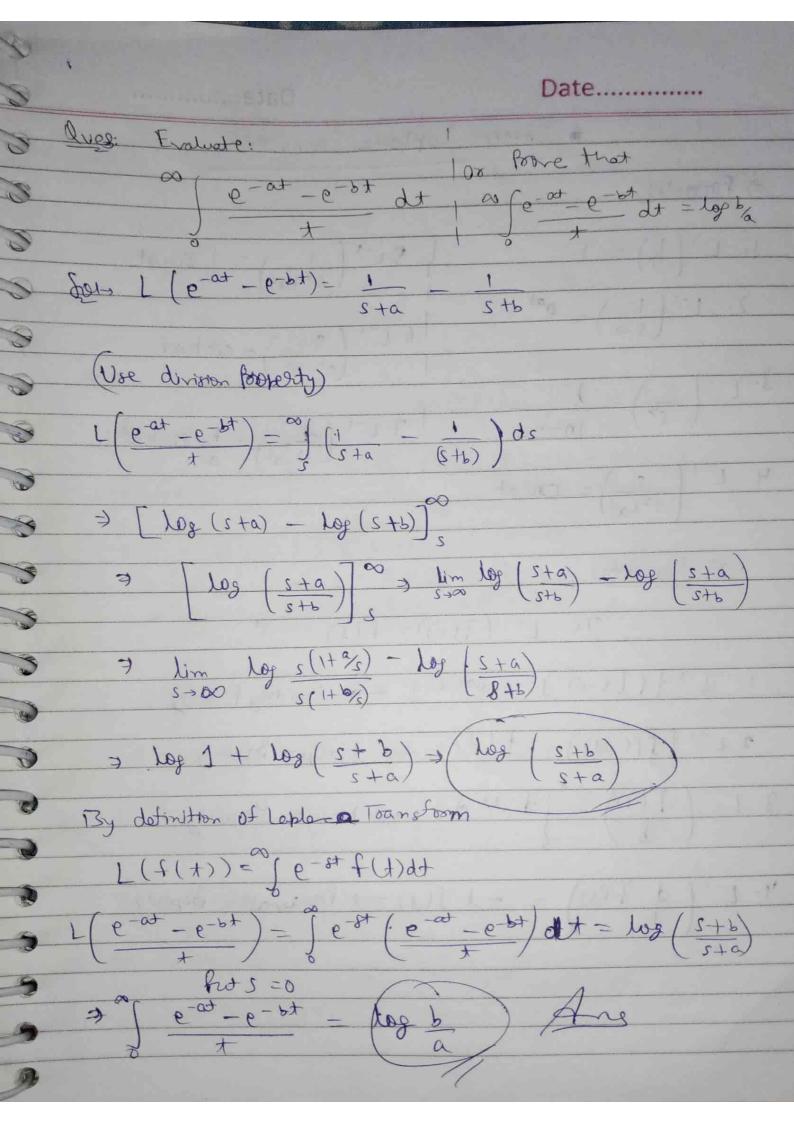
$$\frac{1}{2} \int_{S} \log(1+s^{-2}) + 2 \int_{S^{-2}} \frac{s^{-2}}{\left(\frac{1}{s^{-2}}+1\right)} ds$$

$$\frac{1}{2} \left( \frac{1+s^2}{1+s^2} + 2 \right) \frac{ds}{1+s^2}$$

$$\frac{1}{2} \left( \frac{1+s^2}{1+s^2} + 2 \right) \frac{ds}{1+s^2}$$



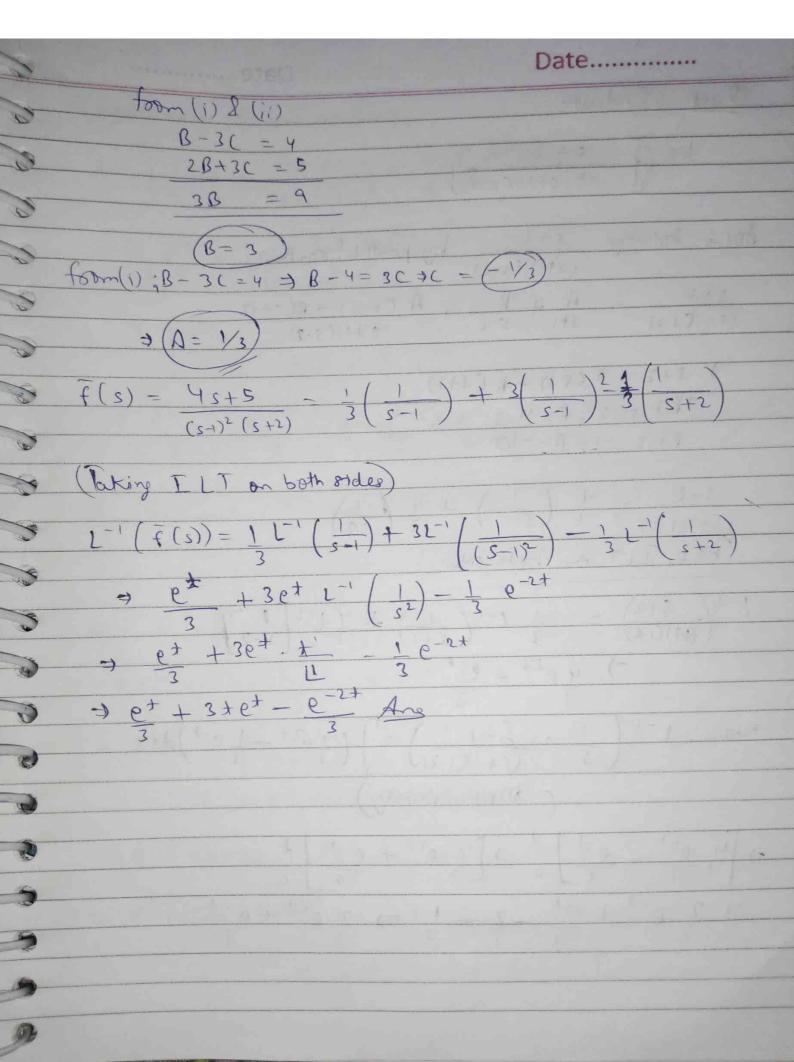
· Evaluation of integrals by Laplace Transform Ques: Evaluate # 6-3+ 8m+ dt  $L\left(\sin t\right) = \frac{1}{S^2 + 1}$ (Use multiplecation property) L(+8+nd) = (-1) d (1)  $\frac{1}{3} - \frac{1}{3} \left( \frac{1}{3^2 + 1} \right)^{-1} + \frac{1}{3} - \left( -\frac{1}{3} \left( \frac{1}{3^2 + 1} \right)^{-2} \left( \frac{2}{3} \right) + \frac{2}{3} \frac{1}{3} \frac{1}{3}$ (Use Shifting property) e-3+ trint) = 2 (s+3) Now by definition of Laplace Transform. L(f(t))= Je-st f(t)dt [e-3+ + gint] = (e-8+ + e-3+ sint d+ = 2(s+3)  $((8+3)^2+1)^2$ hat s = 0  $\int \frac{1}{5} \left( \frac{3}{3} \right)^2 + \left( \frac{3}{3} \right)^2 +$ 



4. L' (d F(s)) = -+ f(x) -> Designative Boperty.

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3	Poobleme on Inverse Laplace Transform
02	
3	Ques: Find ILT:
5	L-1 ( 1
	$\frac{2(z+1)(z+2)}{}$
S	
9	Sol-> 1 - 1 . 1
	S(s+1)(s+2) $S(s+1)(s+2)$
3	(Use Rastral Foodran)
300	
>	$\frac{1}{(s+1)(s+2)} - \frac{A}{s+1} + \frac{B}{s+2} - \frac{A(s+2) + B(s+1)}{(s+1)(s+2)}$
	(3+1)(3+2) 3+1
3	$\Rightarrow 1 = A(s+2) + B(s+1)$
3	⇒ Pect s=-1 ⇒ 1 = A+0 ≈ A=1
3	> Put s=-2 → 1= 0+B(-1) → B=-1
	The state of the s
3	THE RESIDENCE OF STREET STREET, STREET
	(s+1)(s+2) = (s+1) = (s+2)
9	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0	(Take ILT on both sides)
U	
0	1-1/1/1/-1-1/1/
3	$L^{-1}\left(\frac{1}{(s+1)(s+2)}\right) = L^{-1}\left(\frac{1}{s+1}\right) - L^{-1}\left(\frac{1}{s+2}\right)$
3	$ \frac{7e^{-t}-e^{-2t}}{f(t)} $ (Use division Rule) $ \frac{1^{-1}\left(\frac{1}{S+1}\left(\frac{1}{S+2}\right)\right)^{-1}}{S} = \frac{1}{S}\left(e^{-t}-e^{-2t}\right)dt $
T.	f(t)
7	(Use division Rule)
5	1-1/1/1 11 11/0-+-0-2+)d+
	S (5+1)(5+2)) = 1

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Oves: Evaluate

$$L^{-1} \left[ \begin{array}{c} S+2 \\ S^{2}(S+1)(S-2) \end{array} \right]$$

$$\frac{(s+1)(s-2)}{(s+1)(s-2)} = \frac{A + B}{s+1} + \frac{A(s-2) + B(s+1)}{(s+1)(s-2)}$$

$$\frac{S+2}{(S+1)(s-2)} = \frac{-1}{3} \left( \frac{1}{S+1} \right) + \frac{4}{3} \left( \frac{1}{S-2} \right)$$

$$\frac{1^{-1}\left(\begin{array}{c} S+2 \\ (+1)(s-2) \end{array}\right)}{3} - \frac{-1}{3} \frac{1^{-1}\left(\begin{array}{c} 1 \\ S+1 \end{array}\right)}{3} + \frac{4}{3} \frac{1^{-1}\left(\begin{array}{c} 1 \\ S-2 \end{array}\right)}{3}$$

$$\Rightarrow \left[\frac{4}{3} + \frac{e^{2t}}{2} + \frac{e^{-t}}{3}\right] \xrightarrow{\frac{1}{3}} \left[\frac{2}{3} + \frac{e^{2t}}{2} + \frac{e^{-t}}{3}\right] \xrightarrow{\frac{1}{3}} 0$$

$$\frac{1}{3} \frac{2^{2}}{3} + \frac{e^{-1}}{3} - \frac{2}{3} - \frac{1}{3} \rightarrow \frac{2}{3} \frac{e^{2}}{3} + \frac{e^{-1}}{3} - \frac{1}{3}$$

Again voting division postperty;

$$\frac{1}{s} = \frac{1}{s} = \frac{1}$$

$$\frac{1}{3} \left[ \frac{e^{2t}}{3} - \frac{e^{-t}}{3} - t \right]$$

$$\frac{1}{3} \frac{e^{2+}}{3} - \frac{e^{-+}}{3} - \frac{1}{3} - \frac{e^{0}}{3} + \frac{e^{0}}$$

Q Evaluate

$$\frac{\text{forth}}{\text{(s+3)}^2+9}$$

$$\frac{1}{3}$$
  $\frac{1}{(5+3)^2+4}$   $\frac{1}{(5+3)^2+4}$   $\frac{1}{(5+3)^2+4}$ 

$$\frac{1}{3} \frac{1}{1} \left( \frac{s+3}{s+3} + \frac{1}{4} \right) - \frac{1}{3} \frac{1}{1} \left( \frac{1}{(s+3)^2 + 4} \right)$$

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

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

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

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

Q. Fralvate

$$\frac{\text{Sol}}{2s^5} = \frac{3(s^2 + 2)^2}{2s^5} = \frac{3(s^4 - 4s^2 + 4)}{2s^5}$$

Taking ILT on both sides

Q. Evaluate:

Now; take IIT on both sides

Q Evaluate:  $\frac{s_5-42+13}{2+5}$ Sol-> Let  $L^{-1}(\bar{f}(s)) = L^{-1}(\underline{s+2})$  $\frac{L^{-1}\left(\frac{S+2}{(s-2)^2+3^2}\right)}{\left(\frac{S+2}{(s-2)^2+3^2}\right)}$  $\frac{1}{2} \left( \frac{s-2+2+2}{(s-2)^2+3^2} \right) = 2^{-1} \left( \frac{(s-2)+4}{(s-2)^2+3^2} \right)$ (Dre shifting Booperty) + 4 L ((S-2)2+32)  $\frac{L^{-1}(\bar{f}(s)) = e^{2t} L^{-1}(\frac{s}{s^2 + 3^2}) + 4e^{2t} L^{-1}(\frac{1}{s^2 + 3^2})}{2^2 + 2^2 + 3^2}$   $\Rightarrow e^{2t} \cos 3t + 4e^{2t} \sin 3t$ = et (cos 3+ + 43 sin 3+) Ang  $\frac{\sum \left(\frac{S+1}{S^2+S+1}\right)}{\left(\frac{S^2+S+1}{S^2+S+1}\right)}$ 

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$$\frac{3}{(5+1/2)^2 + (\sqrt{3}/2)^2} = \frac{(5+1/2)^2 + (\sqrt{3})^2}{(5+1/2)^2 + (\sqrt{3})^2}$$

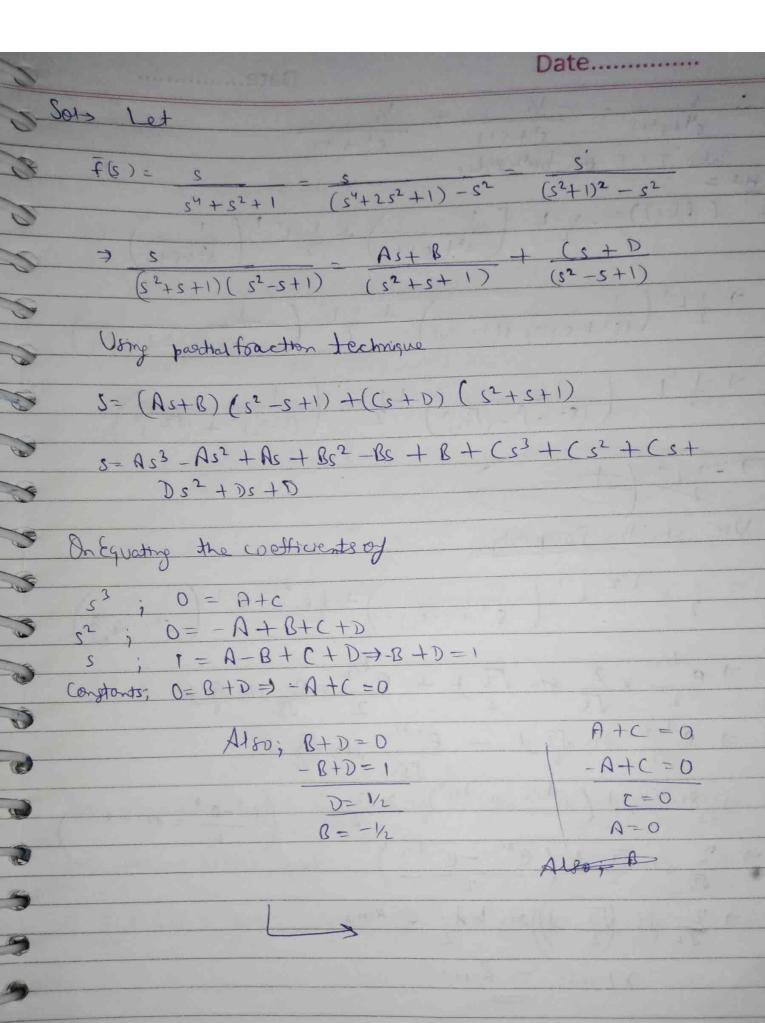
Take ILT On both sides

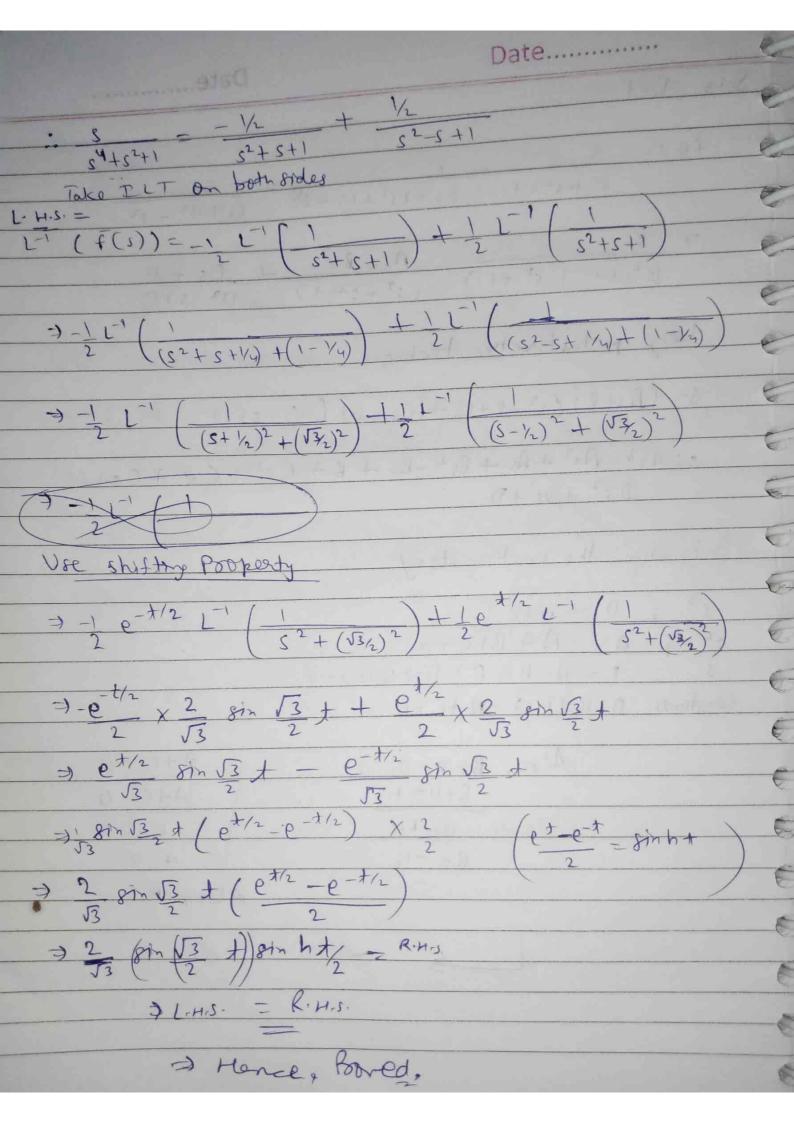
$$L^{-1}\left(f(s)\right) = L^{-1}\left(\frac{s+1/2}{s+1/2} + \frac{1}{(s+1/2)^2} + \frac{1}{2}L^{-1}\left(\frac{s+1/2}{s+1/2} + \frac{1}{(s+1/2)^2}\right)\right)$$
(3) (see Shifting Bobbashy)

(I Use I hifting Boberty)

$$\frac{1}{\sqrt{f(s)}} = e^{-\frac{1}{2}} \left( \frac{s}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + (\sqrt{3}z)^2}{s^2 + (\sqrt{3}z)^2} \right) + \frac{e^{-\frac{1}{2}}}{2} \left( \frac{s^2 + ($$

Dies: Prove that:





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The following with sides

$$\frac{d}{ds} = \frac{1}{(s)^2 + 1}$$
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$$\frac{d}{ds} = \frac{1}{(s)^2 + 1}$$
The following s

Take TIT on both order

$$\begin{bmatrix}
-1 & f(s) \\
ds
\end{bmatrix} = 21^{-1} \begin{pmatrix} s \\
s^2+1 \end{pmatrix} = 1^{-1} \begin{pmatrix} s \\
s^2+1 \end{pmatrix}$$

$$\Rightarrow -1 f(t) - 2 \cos t - 1 - e^{-t} \\
\Rightarrow + f(t) = 1 + e^{-t} - 2 \cos t$$

$$\Rightarrow 1 f(t) = 1 + e^{-t} - 2 \cos t$$

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$$\Rightarrow 1 f(t) = 1$$