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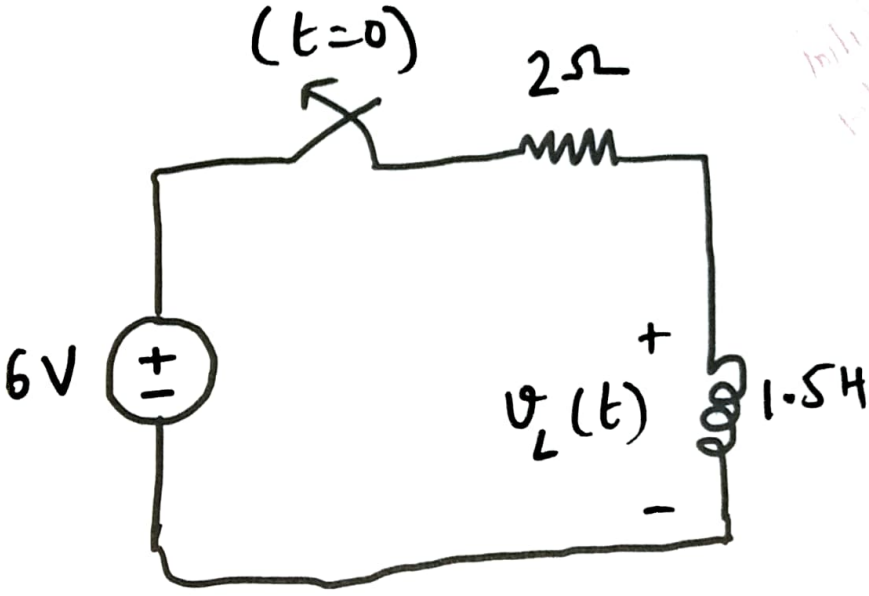
ECE 215 – Circuit Theory and Devices
Quiz 4 (20 marks)

1. (10 marks) Given the following function,

$$F(s) = \frac{4(s-2)}{(5s^2 + 30s + 45)(s+2)}$$

(d) Find $f(t)$
(e) Plot the poles and zeros on the complex s plane
(f) Comment on the stability

2. (10 marks) For the following circuit, find $v_L(t)$ at t>0



1)

(a)

$$F(s) = \frac{4(s-2)}{(5s^2+30s+45)(s+2)}$$

$$= \frac{4(s-2)}{5(s^2+6s+9)(s+2)}$$

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

2

$$= \frac{0.8\,(s-2)}{(s+3)^2(s+2)} = \frac{A}{s+3} + \frac{B}{(s+3)^2} + \frac{C}{(s+2)} \quad -(1)$$

$$\Rightarrow \left(\frac{A}{s+3} + \frac{B}{(s+3)^2} + \frac{C}{s+2}\right) \times (s+3)^2(s+2)$$

$$= A(s+3)(s+2) + B(s+2) + C(s+3)^2$$

$$= A(s^2+5s+6) + Bs + 2B + C(s^2+6s+9)$$

$$= As^2 + 5As + 6A + Bs + 2B + Cs^2 + 6Cs + 9C$$

$\Rightarrow$ Compare the coefficients.

$$A + C = 0 \rightarrow A = -C \quad -(2)$$

$$5A + B + 6C = 0.8 \quad -(3)$$

$$6A + 2B + 9C = -1.6 \quad -(4)$$

Substitute (2) in (3) and (4)

$$B + C = 0.8 \quad -(5)$$

$$2B + 3C = -1.6 \quad -(6)$$

Multiply (5) by 2.

$2B + 2C = 1.6$

$2B + 3C = 1.6$

$(-)\quad (-)\quad (-)$

$C = -3.2$

$A = -C \Rightarrow \boxed{A = 3.2}$

Put value of A and C in (3)

$\Rightarrow 5A + B + 6C = 0.8$

$= 5 \times 3.2 + B + 6(-3.2) = 0.8$

$\Rightarrow B = 0.8 + 3.2$

$= \boxed{4}$

Put value of A, B and C in (1)

$$\Rightarrow \frac{3.2}{s+3} + \frac{4}{(s+3)^2} + \frac{(-3.2)}{(s+2)}$$

$$\Rightarrow \frac{3.2}{s+3} + \frac{4}{(s+3)^2} - \frac{3.2}{(s+2)}$$

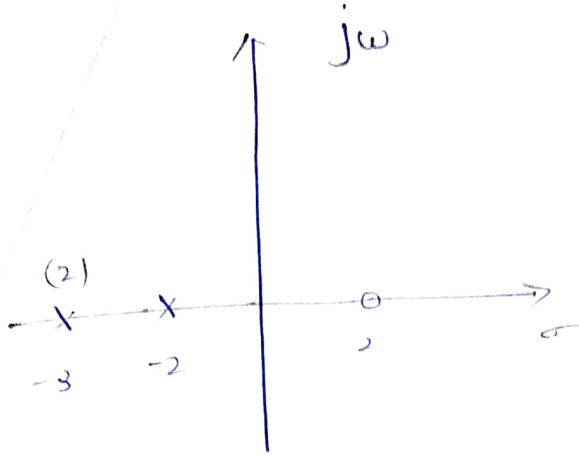
$\Rightarrow 3.2e^{-3t}u(t) + 4te^{-3t}u(t) - 3.2e^{-2t}u(t)$

(b) $0.8s - 1.6 = 0$

$s = 2, \infty$

Poles:- $(s+3)^2 = 0 \Rightarrow s = -3, -3$

$(s+2) = 0 \Rightarrow s = -2$

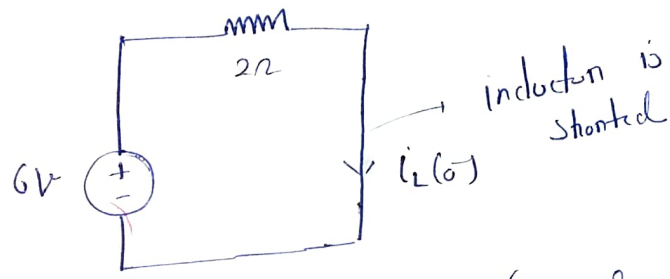


1.5

(1) The system is stable.

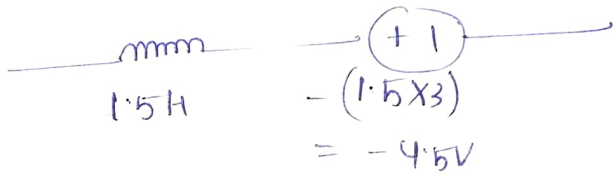
As all the pole are in left hand side of s plane.

Soln:2) Circuit of $t<0$

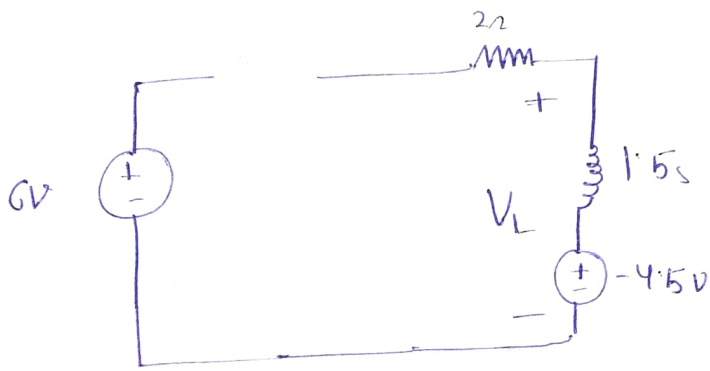


$\Rightarrow i_L(0^-) = \frac{6V}{2\Omega} = 3A$. (initial condition) 3

Now, inductor will be replaced by :-



Circuit of $t>0$:- 3



As the circuit is open circuit, so there will be no potential drop:

(4)

$$\boxed{V_L(t) = 4.5V}$$