Q.2 a. Determine the current in a circuit as shown in Fig.1, when the switch ‘s’ is closed at t=0 . Assume there is no initial charge on the capacitor or current in the inductor

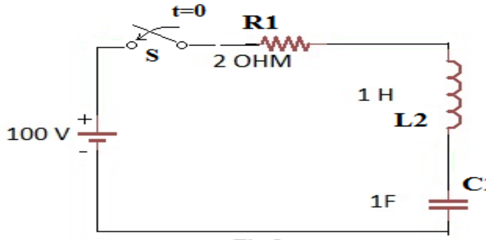


Fig.1

Answer:

(a) When the switch is closed, by applying Kirchhoff's law

$$2i(t) + \frac{di}{dt} + 1\int i\,dt = 100$$

Taking Laplace transform both side

$$2I(s) + [sI(s) - i(0)] + \frac{I(s)}{s} + \frac{q_0}{s} = \frac{100}{s}$$

Since the initial current in the inductor and initial charge on the capacitor is zero, the above equation reduce to

$$2I(s) + sI(s) + \frac{I(s)}{s} = \frac{100}{s}$$

$$I(s)\left[2 + s + \frac{1}{s}\right] = \frac{100}{s}, \quad I_s = \frac{100}{s^2+2s+1} = \frac{100}{(s+1)^2}$$

Taking Inverse transform on both side

$$i(t) = 100te^{-t}\ A$$

Q.3 a. Find the Laplace transform of any function that repeats itself.

Answer: Page Number 306 of Text Book

Q.4 a. State Reciprocity theorem and check whether the circuit shown in fig.3 obeys reciprocity theorem

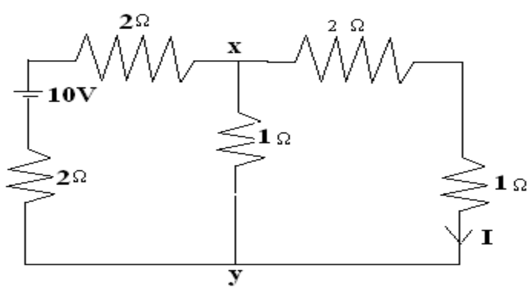
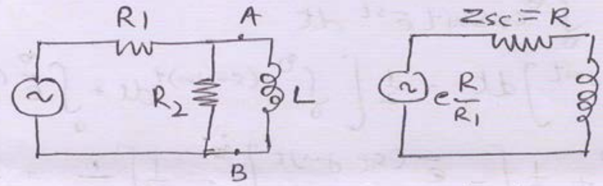


Fig.3

b. State and prove the substitution theorem.

Answer:

Q 4 (a)



Apply thevenin's theorem at terminal A and B

$$E_{oc} = \frac{e}{R_1+R_2} \times R_2 = \frac{e}{R_1} \times \frac{R_1 R_2}{R_1+R_2} = e \cdot \frac{R}{R_1}$$

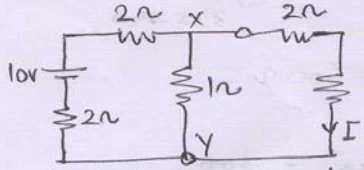
where $R = R_1 R_2 / (R_1+R_2)$ $\quad Z_{sc} = \frac{R_1 \cdot R_2}{R_1+R_2} = R$

In the thevenins Equivalent ckt
current I in the circuit is given as

$$I = \frac{E_{oc}}{R+j\omega L} = \frac{e \cdot R}{R_1} \times \frac{1}{R+j\omega L}$$ voltage across $L = I \cdot j\omega L$

$$= \frac{e \cdot R}{R_1(R+j\omega L)} \times j\omega L = \frac{e \cdot R \cdot j\omega L}{R_1(R+j\omega L)} = \frac{e \cdot R \cdot j\omega L}{R_1(R+j\omega L)} = V_L$$

(b)



Equivalent resistance between X & Y is $= \frac{3 \times 1}{3+1} = \frac{3}{4}$ ohm

Hence total circuit resistance $= 2+2+\frac{3}{4} = \frac{19}{4}$ ohm

$\therefore$ current drawn from the battery $= \frac{10}{\frac{19}{4}} = \frac{40}{19}$ A

15 > 1

$\therefore$ In fig(1) $I = \frac{40}{19} \times \frac{1}{1+2+1} = \frac{40}{19} \times \frac{1}{4} = \frac{10}{19}$ A

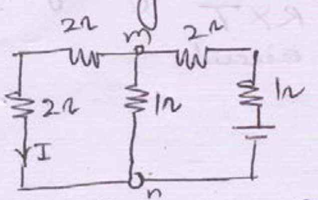


fig (2)

In fig (2) the net resistance between mn is $\frac{4 \times 1}{4+1} = \frac{4}{5}$ Ω

total circuit resistance $= \frac{4}{5}+2+1 = \frac{19}{5}$ ohm

Current drawn from the battery $= \frac{10}{\frac{19}{5}}$ A $= \frac{50}{19}$ A

In fig (2) $I = \frac{50}{19} \times \frac{1}{1+2+2} = \frac{10}{19}$ A

So current in fig 1 & fig 2 is same proved reciprocity theorem

Q.5 a. The z-parameter for a 2-port network are $Z_{11}=30\Omega$, $Z_{22} = 40\Omega$, $Z_{21} = 20\Omega$. Find the equivalent T network.

Answer: Page Number 512 of Text Book

b. For the given 2 port network calculate ABCD. Parameters and image impedances.

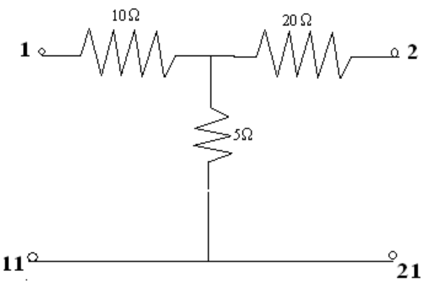


Fig.4

Answer: Page Number 523 of Text Book

Q.7 a. Explain the following
(i) Reflection coefficient (ii) Secondary line constants

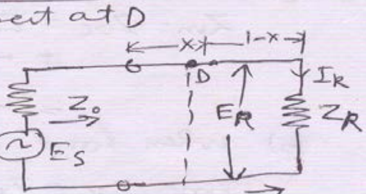
b. A transmission line connects a transmitter of 1.2 MHz to the aerial located 100m away from it. If Z_0 of the lines be equal to 500Ω. What is the input impedance of this line if antenna end is a) open circuited b) short circuited.

Answer:

Q: 7 (a) Reflection coefficient at any point along the line is defined as the ratio of the reflected component of voltage or current to the incident component of voltage or current. Since both incident and reflected signal components are vector quantity & ratio is vector quantity

$$K_D = \frac{\text{Reflected voltage or current at D}}{\text{Incident voltage or current at D}}$$

$$= \frac{E_R}{E_i} = \frac{(Z_R - Z_0)\,\varepsilon^{\gamma d}}{(Z_R + Z_0)\,\varepsilon^{-\gamma d}} = \frac{Z_R - Z_0}{Z_R + Z_0} \cdot \varepsilon^{2\gamma d}$$



At received end $d = 0$ and

$$K_R = \frac{Z_R - Z_0}{Z_R + Z_0}$$

(b) Secondary line const : Characteristic impedance and propagation constant are commonly termed as secondary line constants. The secondary line constants are

(i) Characteristic impedance Z_0
(ii) Propagation constant (γ)
(iii) Attenuation constant (α)
(iv) Phase shift constant (β)

values of these secondary constants are obtained in terms of primary line constant (R, L, G & C) because the latter are easily measurable. Apart from this, expression are also obtained for input impedance of the line; voltage and current present at any point along the line

7(b) Signal frequency $f = 1.2$ MHz

$\lambda = c/f = \dfrac{3\times10^8}{1.2\times10^6} = 250$ mt.

Phase shift for one wave length $= 2\pi$ radians

Phase shift for 100m length $= \dfrac{2\pi}{\lambda}\times l = \dfrac{2\pi\times100}{250}$

$= 0.8\pi$ rad.

(a) when the line is open circuited

$Z_{in} = Z_{oc} = Z_0 \coth \gamma l = -jZ_0 \cot\beta l$

$= -j\,500 \cot 144°$

$= -j\,500\times1.3764 = -j688\,\Omega$

(b) when load end is short circuited

$Z_{in} = Z_{sc} = Z_0 \tanh \gamma l = jZ_0 \tan\beta l$

$= -j500\times0.7265 = -j\,363.3\,\Omega$

Q.8 a. What is stub? Explain the different type of stub matching used in transmission lines.

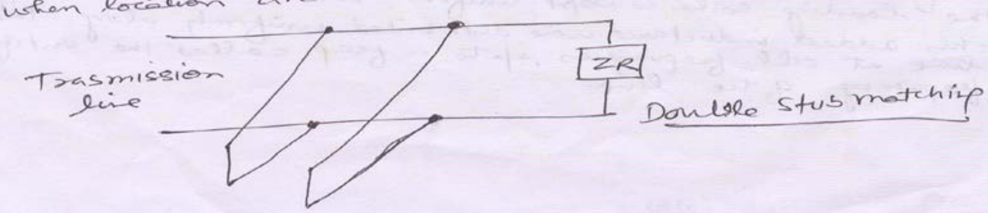
b. Derive the relation between VSWR ('S') and Reflection coefficient ('K').

Answer:

8(a) Stubs: A section of transmission line can be used as impedance matching element by inserting it between load and source. It is also possible to connect section of open or short-circuited line called stub in shunt with the main line at some points in order to achieve impedance matching. The proces is known as stub matching.

(i) Single Stub Matching: A short ckted transmission line of a specific length is connected in shunt with the main line at a certain distance from the receiving end. As the stubs impedance in inductive or capacitive, depending on its length, hence by suitable adjustment of stub length, it is possible to introduce into a line a desired value of inductive or capacitive reactance so that neutralises the reactive part of the line impedance. The single matching system is useful for a fixed frequency only.

(ii) Double Stub Matching: Two short ckted stubs, whose lengths are adjustable are installed and is known as double stub matching. The stub positions are fixed and are generally employed at HF transmission. Conventionally two stubs are placed at $\lambda/8$ distance apart, It provides good impedance matching though in some of the cases, double stub matching system may be inferior than single stub matching because of the fact that stub matching is most effective when location are variables.



$$|V_{max}| = |V_i| + |V_R| \qquad K = \frac{|V_R|}{|V_i|}$$

$$|V_{min}| = |V_i| - |V_R|$$

But $VSWR = \dfrac{|V_{max}|}{|V_{min}|} = \dfrac{|V_i| + |V_R|}{|V_i| - |V_R|} = \dfrac{1 + \left|\frac{V_R}{V_i}\right|}{1 - \left|\frac{V_R}{V_i}\right|}$

$$= \frac{1+|K|}{1-|K|} = S$$

$$S(1-|K|) = (1+|K|)$$

$$S - S|K| = 1 + |K| \quad = \quad S - 1 = |K| + S|K|$$

$$= |K|(1+S) \qquad \text{so} \quad |K| = \frac{S-1}{S+1}$$

Text Books

1. Network Analysis; G. K. Mittal; 14th Edition (2007) Khanna Publications; New Delhi

2. Transmission Lines and Networks; Umesh Sinha, 8th Edition (2003); Satya Prakashan,Incorporating Tech India Publications, New Delhi