EE225 Network Theory
Tutorial Problems- Set Four

August 26, 2017

Q1. The network shown in Fig. 1.1 and 1.2 are simple representations of a transistor. For each of these networks, determine the Thevenin equivalent seen by the load R_L.

Q2. Determine the Thevenin equivalents and Norton equivalents of the networks shown in Fig. 2.1 and Fig. 2.2 at the terminals T shown.

Q3. (a) The voltage source $v(t)$ in Fig. 3 is sinusoidal with angular frequency ω. Obtain the Thevenin impedance as seen at the terminal T, in terms of ω. Find the value of the load resistor R_L that ought to be connected at T (again as a function of ω) to draw the maximum power from the rest of the circuit.

(b) Now let $v(t)$ be an arbitrary voltage source with Laplace Transform $V(s)$. Use the Thevenin equivalent to obtain the Laplace transform of the current in the load resistor for a unit step input voltage.

Q4. In the circuit of Fig. 4, obtain the value of R_3 which would draw the maximum power from the circuit when switch K is

(a) Open

(b) Closed

Now repeat parts (a) and (b) when the $100V$ DC source is replaced by a source of voltage $v(t) = 100\sin(10\pi t)$

Q5. Use Thevenin's Theorem to find the condition under which the Wheatstone bridge of Fig. 5 is balanced (i.e has no current flowing through the ammeter A).

Q6. Find the Thevenin and Norton equivalents of the circuits shown in Figs. 6.1, 6.2, 6.3, 6.4 and 6.5 between the points a and b. Hence or otherwise obtain the current that would flow through a 10Ω resistor connected between points a and b.

Q7. The network in Fig. 7 consists of a resistor and capacitor in addition to various controlled sources.

(a) With respect to the load consisting of a series resistor R_L and inductor L, determine the Thevenin equivalent network.

(b) Obtain the total energy, or average power, as appropriate, transferred to the load, as a function of the load parameters.

(c) Investigate whether it is possible to maximize the power transferred to the load, under three different conditions: R_L variable, L variable, both variable. (This could be tedious. There is a more **general challenging problem:** are there specific cases in which one can come up with a maximum power transfer criterion for excitations other than DC and sinusoidal ? In some specific cases, for simple circuits, one could possibly come up with solutions. You are encouraged to try and come out with some. **Rewards await good attempts**).

Q8. Find the conditions that should exist among the constants K_1, K_2 and the resistors R_1, R_2 so that the network shown in Fig. 8 is reciprocal as seen from the terminal pairs ab and cd.

Q9. In Fig. 9, when a current source of 5A is connected at terminal pair B_1B_2 with current flowing from B_2 to B_1, the voltage established at the other ports are $V_{A1A2} = -10V$, $V_{C1C2} = +15V$, $V_{D1D2} = -20V$. Current sources are now to be connected at the three pairs of terminals A, C and D while that at B is to be removed. If the currents in the three sources are 10A, 15A and 20A; how and where should they be connected in order that the power consumed in the 2Ω resistance be

(a) Maximum

(b) Minimum

Q10. The network shown in Fig. 10 consists of constant resistances only. When $I_1 = 5$A and $I_2 = 10$A, $V_{ab} = 120$V. When $I_1 = 10$A and $I_2 = 5$A, $V_{ab} = 15$V.

(a) Find V_{ab} when $I_1 = I_2 = 10$A.

(b) Find I_1 when $V_{ab} = 45$V, $I_2 = 5$A.

(c) Show that a value of k exists such that if $I_1 = kI_2$, $V_{ab} = 0$ and find this value

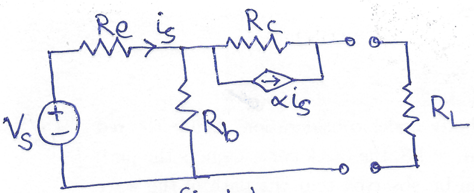


fig 1-1

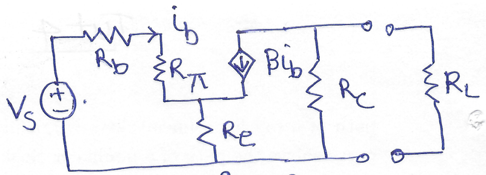


fig 1-2

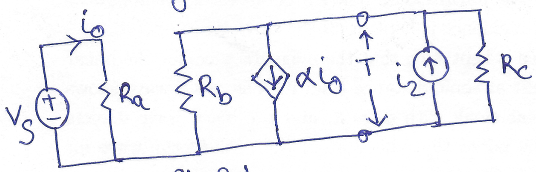


fig 2-1

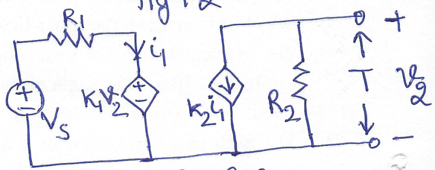


fig 2-2

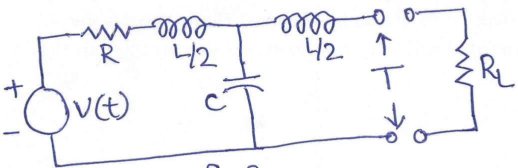


fig 3

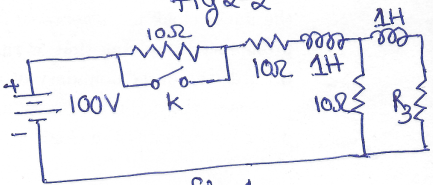


fig 4

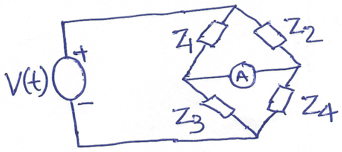


fig 5

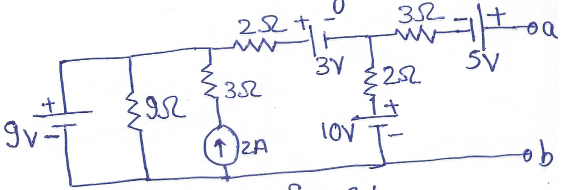


fig 6.1

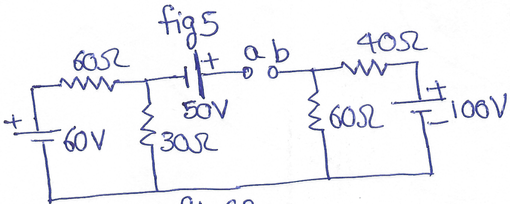


fig 6.2

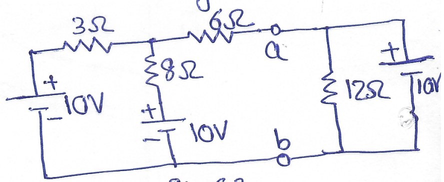


fig 6.3

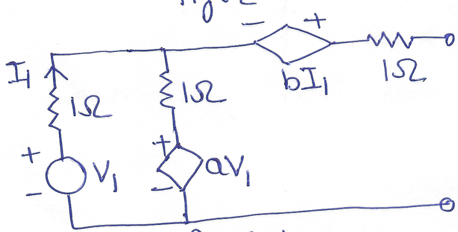
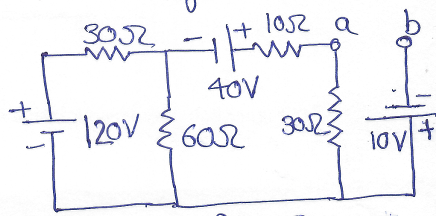


fig 6.4



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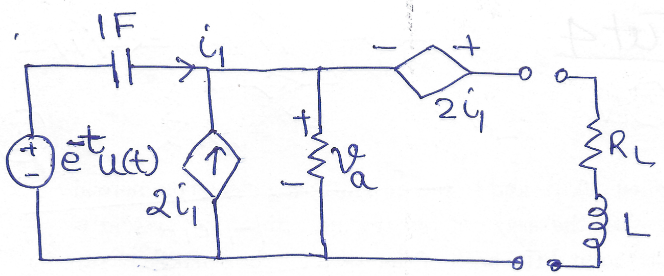

fig 7

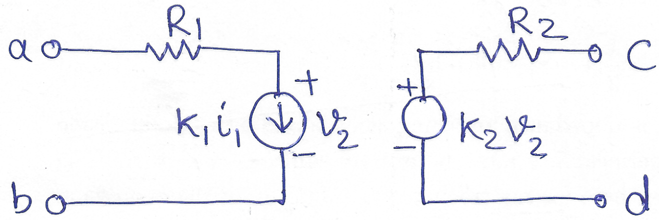

fig.8

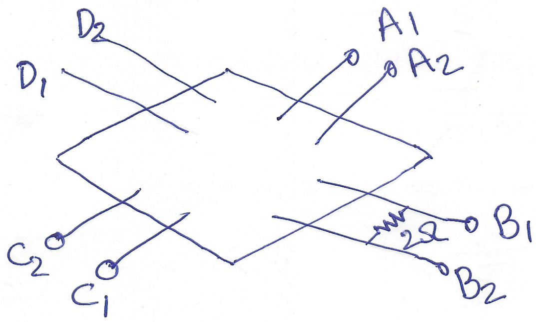

fig.9

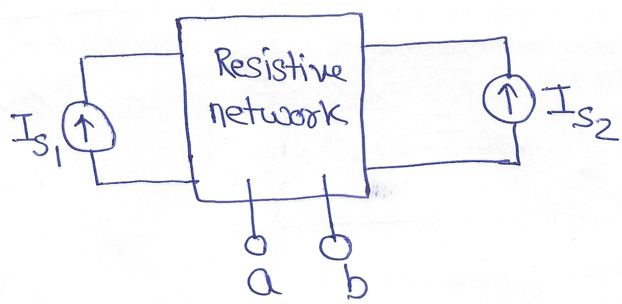

fig.10