EECS 104, Spring 1992
Midterm #2
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(NOTE: Greek letters are sometimes written in Roman alphabet in all caps. Subscripts are written A_1, etc. Micro is sometimes represented by a 'u'.)

Problem #1 (25 pts.)

For the digraph shown in Figure 1:

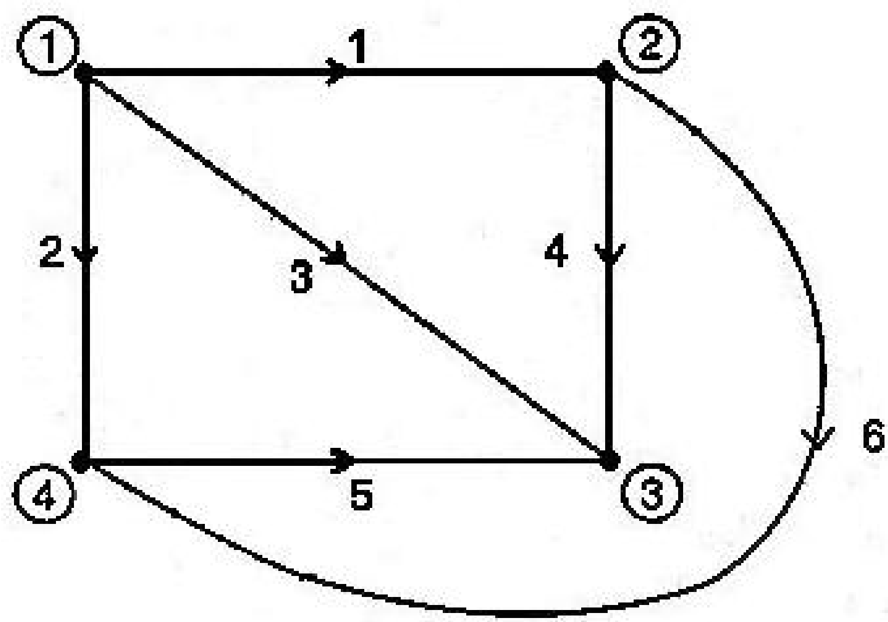


Figure 1

(a) Write down the reduced incidence matrix A with node 3 as the datum.

(b) Let the branch voltage and branch current vectra be **v** and **i** respectively. Specify a minimum set of branch currents and a minimum set of voltages so that **i** and **v** can be unambiguously determined.

(c) Write all KCL cutset equations for the digraph, which are not already included in

$$\mathbf{A}\,\mathbf{i} = \mathbf{O}$$

Problem #2 (25 pts.)

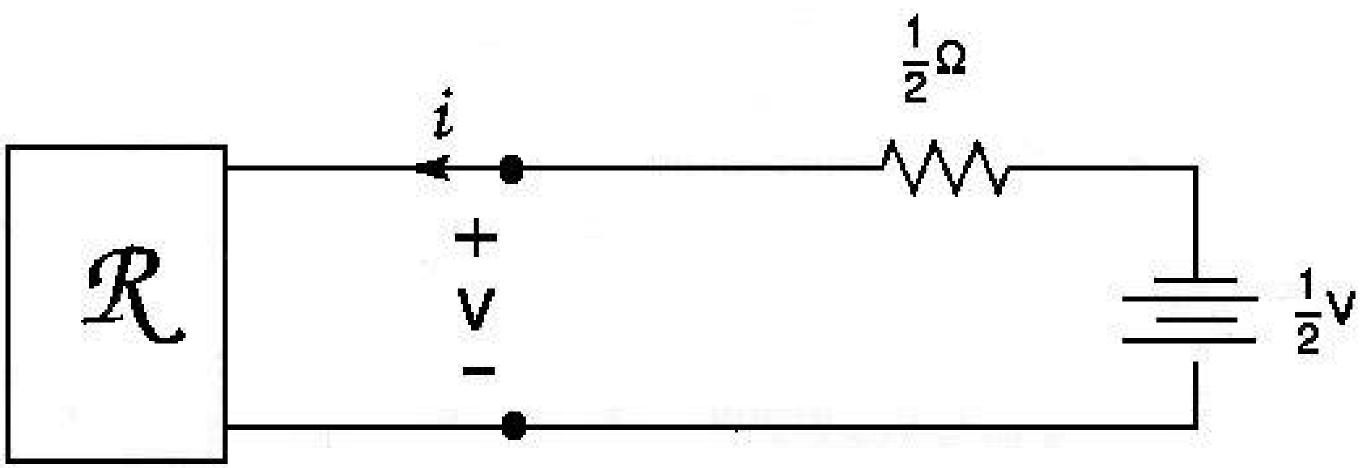
(a) (10 pts.) Find all operating points of the circuit shown in Figure 2a, where the 1-port resistor is described by the driving-point (**v-i**) characteristic shown in Figure 2b.

(b) (10 pts.) Using only <u>one</u> ideal diode, <u>one</u> positive linear resistor, and <u>one</u> negative linear resistor, synthesize the 1-port resistor.

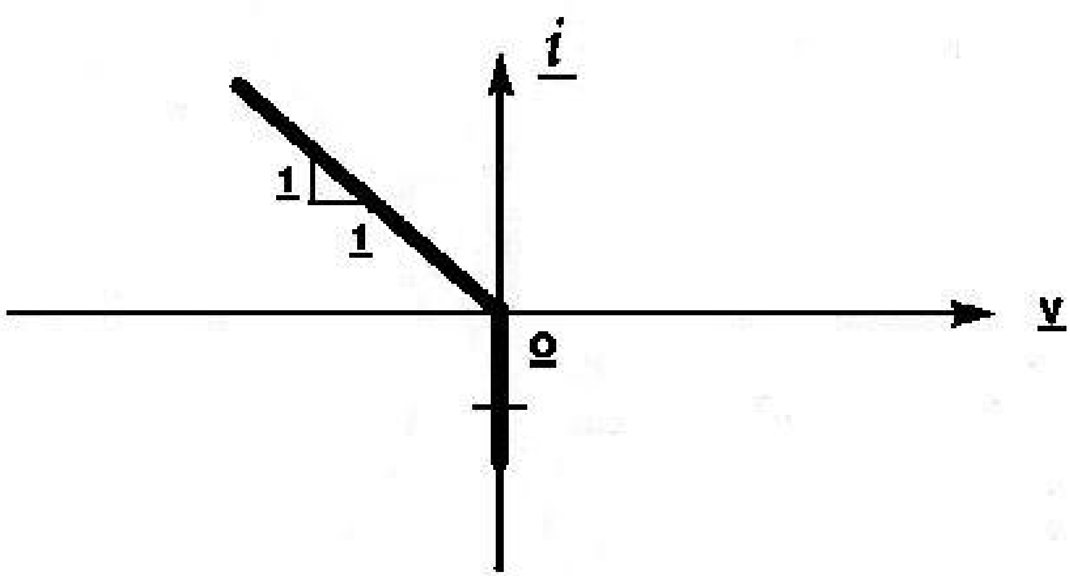
(c) (5 pts.) The piecewise-linear characteristic in Figure 2b can be described exactly by the equation

v = a_0 + a_1 * i + a_2 * |i - b|

Find the parameters a_0, a_1, a_2, and b.



(a)



(b)

(b)

Figure 2

Problem #3 (25 pts.)

A nonlinear resistive 2-port is connected to its source and load connections as shown in Figure 3.

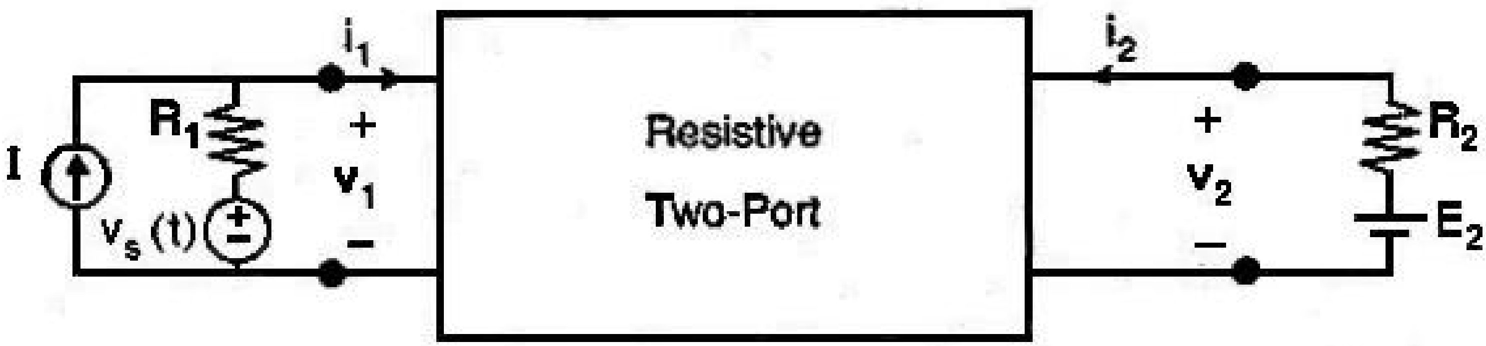


Figure 3

The 2-port is characterized by the following equations:

v_1 = 1 + i_1

i_2 = i_1 ^ 2 + 2 * v_2

The following information is also given:

I = 2A, E_2 = 4V, R_1 = 2Ohm, R_2 = 1Ohm and v_s(t) = 0.01cos(w_0 * t)V

(a) Determine the dc solution of the circuit i.e., the operating point: (V_1Q, I_1Q) and (V_2Q, I_2Q) of the 2-port.

(b) Draw the small-signal equivalent circuit and indicate all element values.

(c) Determine the output voltage v_2(t) under simultaneous dc and ac excitation.

Problem #4 (25 pts.)

(a) (10 pts.) Over its linear range of operation, the op amp circuit shown in Figure 4 is a physical realization of a VCCS: i_2 = g_m*v_1. Specify the controlling coefficient g_m in terms of R.

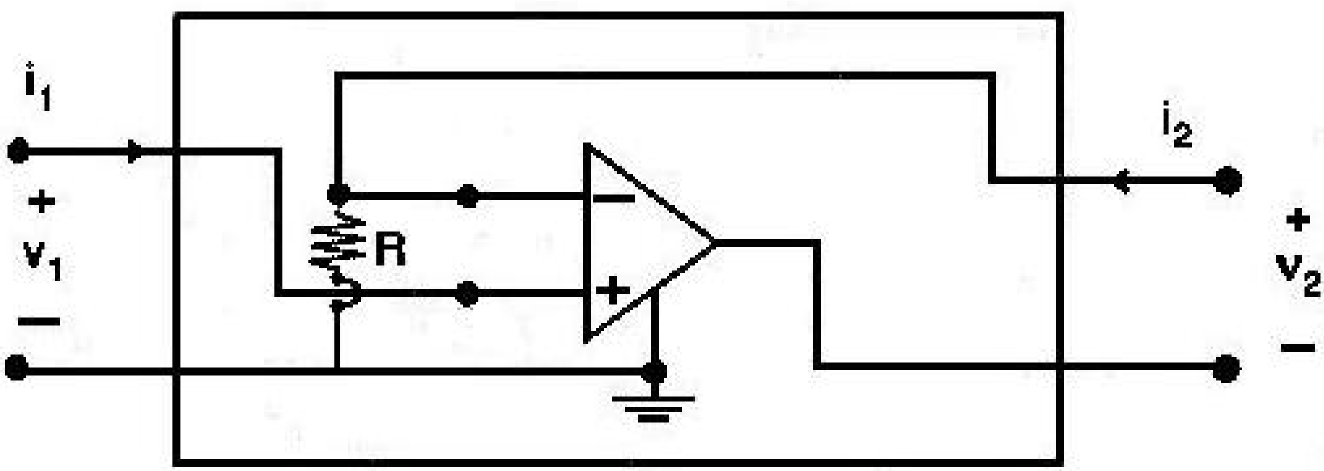


Figure 4a

(b) (15 pts.) To measure the transmission 1 representation

$$\begin{bmatrix} v_1 \\ i_1 \end{bmatrix} = \begin{bmatrix} t_{11} & t_{12} \\ t_{21} & t_{22} \end{bmatrix} \begin{bmatrix} v_2 \\ -i_2 \end{bmatrix}$$

of a linear 3-terminal device *D*, you must simultaneously apply a voltage source V_2 and a current source i_2 into *D*, and then measure the corresponding voltage v_1 (with a voltmeter) and current i_1 (with an ammeter). Show how the terminals are connected in order to achieve this measurement.
Specify the range of the measured voltage v_1 for which this measurement is valid, assuming the op amp has a saturation voltage of +/- 15V.
Hint: There is only one way to connect the terminals. No terminal is left unconnected, although some may be connected to the ground node. Exploit the virtual short circuit property.

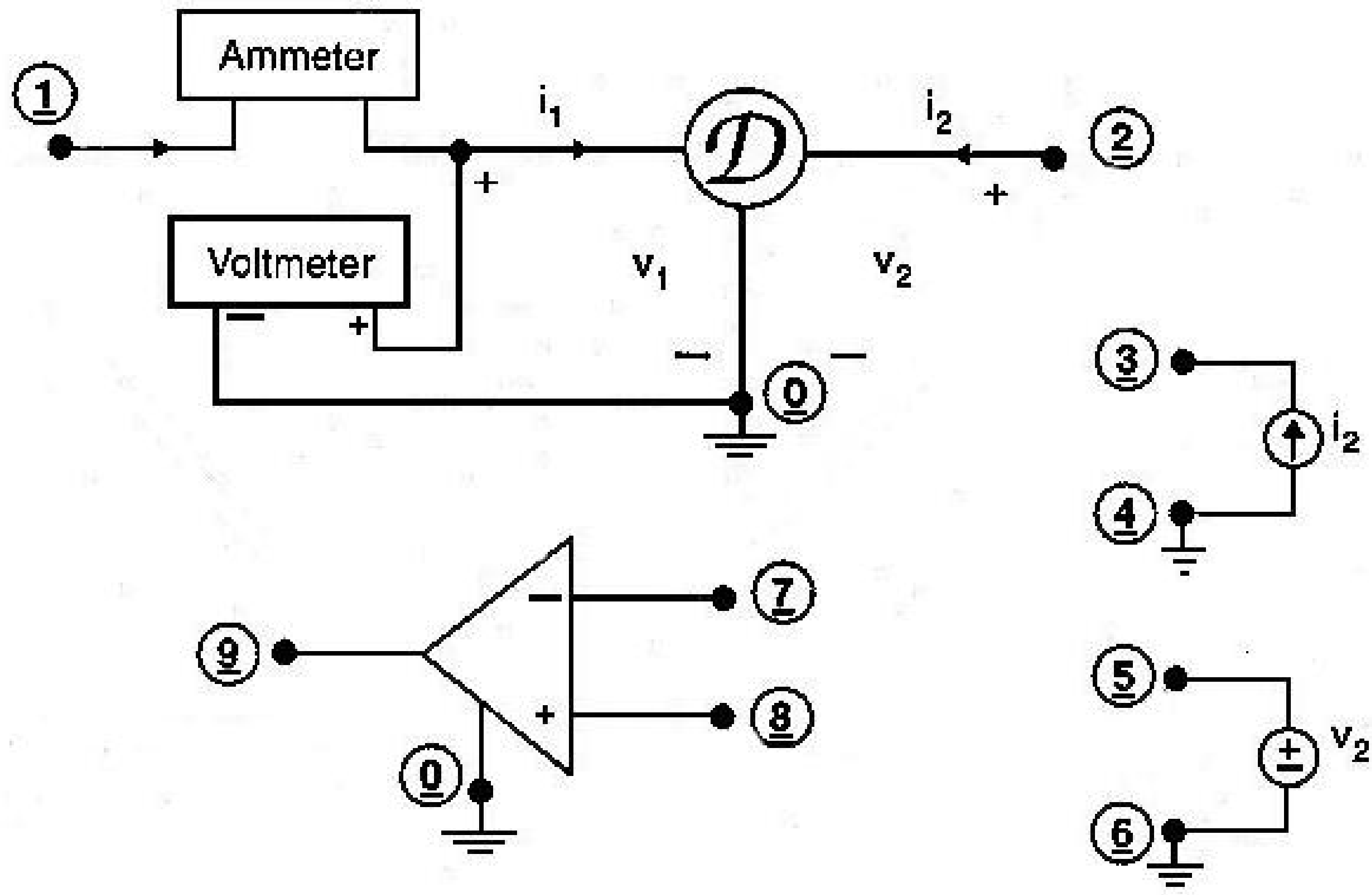


Figure 4b
