EECS 42 Spring 1995 Final Exam

Professor Paul Hagouel

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100 Points Total

Problem 1

: (DC analysis, resistor combinations, Thevenin and Norton equivalent circuits): For each circuit, find the specified current, voltage and/or equivalent circuit. Hint: you may use source transformations where and if appropriate. (5 poin ts each).

a. Find the current *i* and the voltage *v* (no mesh or nodal analysis).

b. Find R_{eq}. All resistances are in Ohms. (NO mesh or nodal analysis).

c. Find the voltage v_1.

d. Find the Thevenin equivalent circuit at terminals a-b.

Problem 2

: (Operational amplifiers, ideal op-amp techniques): Find v_0/v_s for the circuit shown below (13 points). Assume that the operational amplifiers are ideal and that an ideal amplifier has an

A = oo (infinite). State the properties of an ideal operational amplifier (2 points).

Problem 3

: (Capacitor voltage initial condition, forced and transient response): For the circuit shown below, find i(t) for t>0. Assume the circuit is in steady state at t=0. Hint: Voltages across capacitors ca n not change instantaneously. 0+ denotes time and t=0+. The current source 10u(t) mA signifies that its value (i.e. the value of the source current) is equal to 0 A (or alternatively the source is "dead") for time t<=0, and equal to a 10 mA source for t>0. (15 points)

Problem 4

: (Sinusoidal steady-state analysis including phasors and impedances. Frequency response and Bode aymptotic plots):

a. A circuit is shown below with a voltage source equal to v_s=100cos1000t V. (8 points no partial credit)

For the circuit shown find:

(a_1) the impedance **Z**

(a_2) using **Z**, find the phasor current **I**

(a_3) find i(t)

b. An operational amplifier circuit is shown below. Find the ratio $\mathbf{V}_o/\mathbf{V}_s$ as a function of

ω(4 points) and sket ch the asymptotic Bode plot when R2=10R1 and R2C=0.1 .(it should show the corner frequency ωc and the frequency ωm where it crosses the ωaxis). (4 points)

Problem 5

: (Combinatorial logic, truth table, Karnaugh map, logic circuit realization): Minority checker. A minority function is generated in a combinational circuit when the output is equal to 0 if the inp ut variables have more 1s than 0s. The output is 1 otherwise. Design a 3-input minority function. (5 points each: if the implementation is not done with two-input NAND gates then 2 points)

a. Fill the following truth table (5 points)

b. Use the Karnaugh map to find the minimum function F.

c. Implement using only two-imput NAND gates (i.e. the gate has only two inputs). You can assume that the input complements are available. (5 points)

Problem 6

: (Sequential logic with **D** flip-flops, state table, state diagram, timing diagram): A sequential circuit with two **D** - type flip flops A and B (i.e. with inputs $\mathbf{D}_A$, $\mathbf{D}_B$ and respective ou tputs **A** and **B**), two input variables **X** and **Y**, and one output variable **Z** is specified by the following input equations:

D

$_A$ = (bar over **X**)**Y + XA** , $\mathbf{D}_B$ = (bar over **X**)**B** + **XA** , and **Z = B**.

a. Draw the logic diagram of the circuit (6 points)

b. Fill up the state table (7 points). Hint: Take all possible combinations of inputs and initial states.

c. (you can either do c_1 or c_2) [c_1] draw the state diagram or [c_2] fill in the timing diagram. (7 points)

c_1

c_2

Solutions:

1a) $i = 3.33$ A, $v = -13.33$ V

b) $R_{eq} = 14$ Ohms

c) $v_1 = 10$ V

d) $V_T = 16$ V, $R_T = 16/3$ Ohms

2) $(V_o/V_s) = 22$

3) $i(t) = -2 + (10/3)e^{-2000t}$ mA

4a$_1$) $Z = 2 + j = 5^{1/2} \angle 26.7°$ Ohms

a$_2$) $447 \angle -26.7°$ A

a$_3$) $i(t) = 44.7\omega s(1000t - 26.7°)$ A

b) $(Vo/Vs) = 1/(1 + j\omega R_2 C)$

5a)

Truth table:

A B C F

0 0 0 1

0 0 1 1

0 1 0 1

0 1 1 0

1 0 0 1

1 0 1 0

1 1 0 0

1 1 1 0

b) K map for F:

c\AB 00 01 11 10

0

1 1 0 1

1

1 0 0 0

c) A----**D**---\

| **D** ---------= **D** \

B--**D**---/ /

| | **D** - F

C---| /

| /

D --------------/