

OLLSCOIL NA hÉIREANN
GAILLIMH

NATIONAL UNIVERSITY OF IRELAND,
GALWAY

SEMESTER 1 EXAMINATIONS 2002-2003

3rd year B.Sc. Unit CS308: Computer Modelling

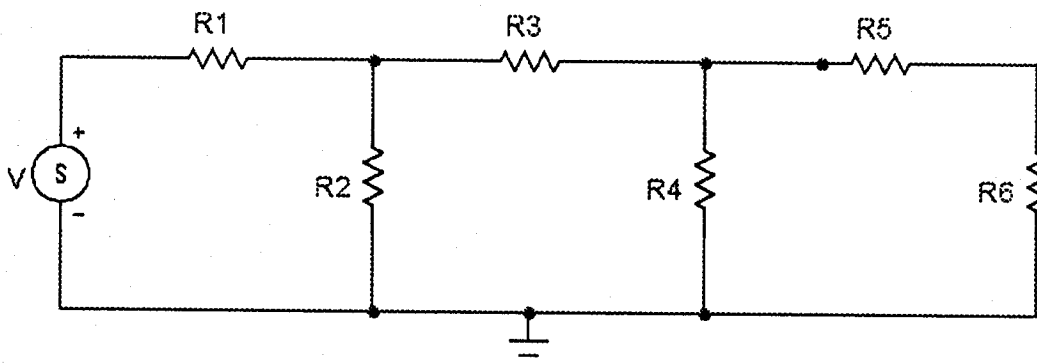
Prof. E. Kennedy
Dr. J. Martin
Dr. R. Butler

Time allowed: ONE and a HALF hours.

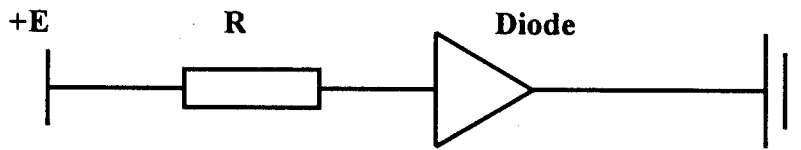
Answer TWO questions

- Q.1 Explain how the *Nodal Admittance Matrix*, $[Y]$, of a circuit whose only independent sources are current sources can be evaluated by inspection of the circuit, *without the construction of an Incidence Matrix*, $[A]$. Define the (*Equivalent*) *Current Vector*, $[J_n]$, for such a network. [4 marks]

The DC network shown in the figure below has $R_1 = R_3 = 2 \Omega$, $R_2 = 1 \Omega$, $R_4 = 2.5 \Omega$, $R_5 = 5 \Omega$, $R_6 = 1 \Omega$, with $V = 10 \text{ V}$. Convert the voltage source to its Norton equivalent and redraw the circuit, numbering the independent nodes. Draw up a carefully labelled (nodes and branches) directed graph for the converted network. Find the numerical values of the Nodal Admittance Matrix and the Current Vector. [6 marks]



- Q.2 The circuit shown below is the standard diode bias problem, where the circuit component values are $E = 10 \text{ V}$ and $R = 1 \text{ k}\Omega$. The (silicon) diode equation, at $T = 300 \text{ K}$, may be taken as $i = I_s [\exp(40 \cdot v) - 1]$, where $I_s = 10^{-13} \text{ A}$.



Derive the two simultaneous non linear equations for v and i , and explain fully (without numerical calculation) the method of solution by Newton Iteration. Sketch a graphical interpretation of the method. State briefly how practical circuit analysis programs like MicroCap or SPICE would actually solve this problem. **[6 marks]**

With the numerical values given above, and using a starting guess of 0.7 V for the diode voltage, apply the method of Newton Iteration to calculate the numerical values of the diode voltage and current after one iteration. **[4 marks]**

- Q.3 Answer *TWO* parts only.

[5 marks each]

- (a) Use Gaussian Elimination and Back Substitution to solve the following system of simultaneous equations:

$$x_1 + 2x_2 + x_3 = 3$$

$$x_1 + x_2 + 2x_3 = 2$$

$$2x_1 + 3x_2 + x_3 = 1$$

- (b) Discuss the use of the software packages MICROCAP and MATHCAD in the analysis of electronic circuits.
- (c) State the equations and explain the physical significance of the main parameters used in the SPICE model for the p-n semiconductor diode.
- (d) Give a labelled diagram of the Ebers-Moll injection model of the Bipolar Junction Transistor and describe its action.