Electronic Circuits (EEEN 20040)

Homework 2

Due by: 12:00 Friday 6th March 2015 (to School Office, Room 226)

Name:______________________________________

Student number: | | | | | | | | |

Corresponding symbols, to be used throughout this homework set in the places indicated:

		α	β	χ	δ	ε	ϕ

For examiner's use only

Q1 (/10)	Q2 (/10)	Q3 (/5)	Total (/25)

Read the following carefully before proceeding:

This cover sheet is to be attached to the front of your submission.

Late submissions will be accepted up to 12:00 on Friday 20th March, but penalty will apply. No submissions will be accepted after 12:00 pm on Friday 20th March.

The last six digits of your student number are used to define certain circuit elements in this homework set. They are indicated by α, β, χ, δ, ε and ϕ, and the correspondence is as given above. Be sure that you enter these correctly in the appropriate places.

Note that in all questions you must document your method: writing down the right answer with no method documented will gain you no marks.

Plagiarism and copying are offences under the terms of the Student Code, and you should be aware of the possible consequences (www.ucd.ie/studentguide).

Declaration of Authorship
I declare that all material in this assessment is my own work.

Signed______________________________ Date____________________

1. The diode in the circuit of Figure 1 is modelled by the equation

$$i_D = I_S\,(\exp(v_D/V_T) - 1)$$

where $I_S = 10^{-16}$ A and V_T can be taken to be 25 mV. $E = (5 + \alpha)$ V and $R = (1 + \beta)$ kΩ.

(i) Either by hand (on graph paper) or using a computer, plot the v_D-i_D characteristic for the pn junction diode.

(ii) Taking $e_s(t)$ to be zero for now, include in your plot the load line produced by the series combination of the voltage source and resistor. From this, estimate the values of v_D and i_D.

(iii) Now taking $e_s(t)$ to equal $(E/10)\sin 100t$ V, use small-signal analysis to estimate the total diode voltage, including dc (from (ii)) and ac components.

(iv) Reading the intersection of two graphs is not a practical method for finding the diode voltage and current. Taking $e_s(t) = 0$ again, suggest a piecewise-linear model for the diode characteristic and use it to solve analytically for v_D and i_D.

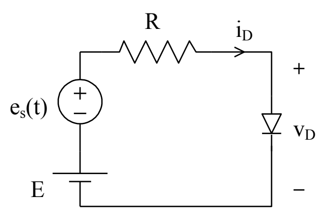

Figure 1

2. The zener diode in the shunt regulator of Figure 2 is specified to have $v_Z = 6.1$ V at $i_Z = 5$ mA. The small-signal resistance of the device in the breakdown region is 20 Ω. Outside the breakdown region, the zener diode can be modelled by an ideal diode in series with a 0.8 V source. $V_s = (10+\chi)$ V and $R = (1+\delta)$ kΩ.

(i) Draw an equivalent circuit for the zener diode in the breakdown region.

(ii) Plot the output driving-point characteristic of the regulator (i.e. the v_L-i_L characteristic delivered by the part of the circuit in the dashed box).

(iii) Find the output voltage v_L with an open circuit load ($R_L = \infty$).

(iv) Find v_L when $R_L = 20$ kΩ.

(v) Find v_L when $R_L = 100$ Ω.

(vi) What is the minimum value of R_L for which the zener diode operates in the breakdown region?

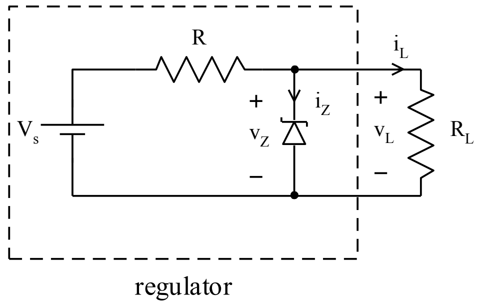

Figure 2

3. Design a circuit whose input-output characteristic is as shown in Figure 3, showing the analysis that proves your design will operate as desired. You can assume that all diodes you use are ideal. Take E = (1 + ε) V and m = 1/(2+φ).

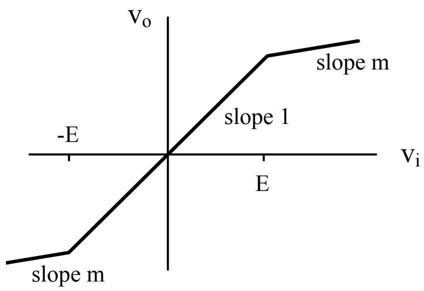

Figure 3