GX552

OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS, 1999

SECOND MECHANICAL ENGINEERING
THIRD INDUSTRIAL ENGINEERING

ELECTRONIC ENGINEERING

Professor L.E. Davis
Professor D. J. Wilcox
Mr. F. C. O'Malley

Duration of examination: *Three* hours

Instructions: Answer *five* questions

1. **(a)** **(i)** State in what is meant by the *Principle of Superposition.* [2 marks]

(ii) Using the *Principle of Superposition* determine the voltage $\mathbf{V_{oc}}$ in the circuit of figure1. [7 marks]

(iii) Using the Principle of Superposition, or any other method, determine the current $\mathbf{I_{sc}}$ that would flow between terminals A and B should these terminals be short circuited. [7 marks]

(b) Using the values calculated in part (a) determine and draw the Thévenin equivalent of the circuit of figure 1. [4 marks]

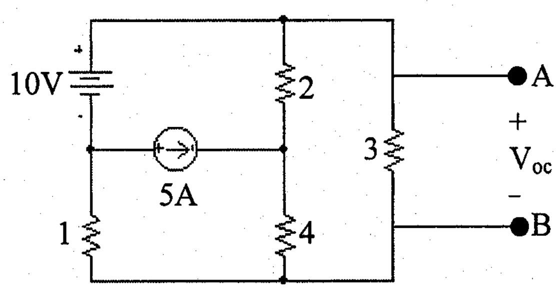

Figure 1.

2. (a) Sketch and label two cycles of the input voltage waveform, $v_i(t)$, of the circuit shown in figure 3 below. [3 marks]

Specify the following values for the waveform:

(i) Peak voltage. [1 mark]

(ii) RMS voltage. [1 mark]

(iii) Average value. [1 mark]

(iv) Peak to peak voltage. [1 mark]

(v) Angular frequency. [1 mark]

(b) Determine the magnitude (peak value) of the current, **I**, flowing in the circuit of figure 2. Proceed to determine the magnitude and phase angles (relative to the current) of the voltages $\mathbf{V_R}$, $\mathbf{V_C}$ and $\mathbf{V_L}$. Plot these voltages on a phasor diagram and determine the phase angle between the current **I** and the supply voltage. Plot two cycles of the current relative to the supply voltage.

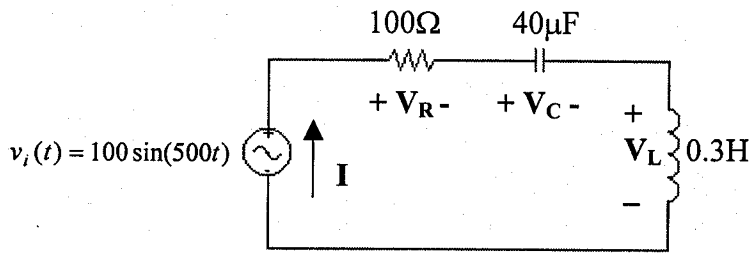

Figure 2.

[12 marks]

3. (a) If a voltage $v(t) = 10\sin(100\pi t)$ is applied across a 1kΩ resistor plot one cycle of the voltage and current and specify the rms values of each waveform. [2 marks]

(b) Derive the rms value of the half-wave rectified sinusoidal voltage waveform shown in figure 3.1. [8 marks]

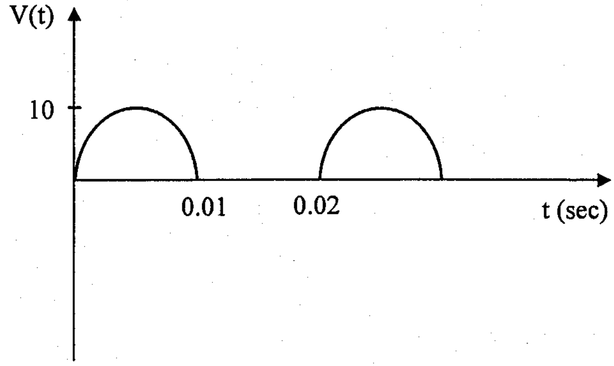

Figure 3.1

(c) The voltage waveform $v(t) = 100\sin(100\pi t)$ is applied to the input terminals of the circuit of figure 3.2. Assuming an ideal diode, plot one cycle of both the output voltage and the current flowing in the resistor. [5 marks]

(d) Specify the average power delivered to the resistor. [5 marks]

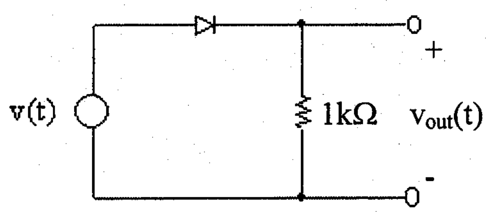

Figure 3.2

4. (a) Draw a block diagram for a basic transistor amplifier and explain the function of each component in the circuit. [5 marks]

(b) For the circuit of figure 4 determine the following :

(i) The value of I_c if V_{ce} equals zero volts. [2 marks]

(ii) The value of V_{ce} if I_c equals zero. [2 marks]

(iii) The value of the quiescent base current I_b. [3 marks]

(c) Given that the quiescent I_c = 3mA specify the current gain β and calculate the output voltage of the circuit. [4 marks]

(d) If β decreases by 25% calculate the new output voltage. [4 marks]

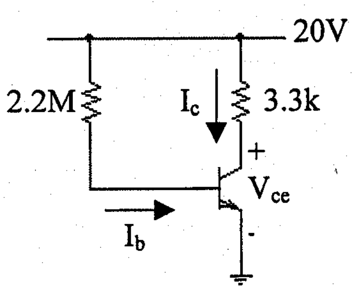

Figure 4.

5. **(a)** The circuit of figure 5 below shows a combinational logic circuit.

(i) Write down the truth table for this circuit. [3 marks]

(ii) Determine the Boolean expression describing this system. [3 marks]

(iii) Give a minimal expression for F. [3 marks]

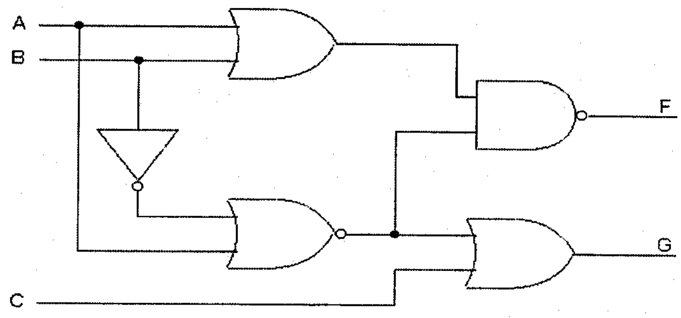

Figure 5.

(b) Using the laws of Boolean Algebra minmise the following expressions:

(i) $F = \overline{A}B\overline{C} + \overline{A}BC + ABC$ [3 marks]

(ii) $F = AB\overline{C} + ABC + A\overline{B}\overline{C} + A\overline{B}C$ [3 marks]

(c) Convert the following Gray coded numbers to their equivalent BASE-2 binary format and show how they would be subtracted using two's compliment arithmetic

$$1110_{GRAY} - 0110_{GRAY}$$

[5 marks]

6. You a required to design a combinational logic circuit for a process monitoring system. The circuit will be connected to a number of sensors (A, B, and C) and will have two outputs (X and Y).

Sensor A: Emits a HIGH if a CO_2 gas is detected.

Sensor B: Emits a HIGH while process is active.

Sensor C: Emits a 3 bit binary number which is directly proportional to the pressure in gas chamber.

In normal operation the pressure indicator should read between 4 and 7 (inclusive) while the process is active and between 2 and 6 (inclusive) when the process is inactive.

Output X: This is an Abnormal Pressure Alarm signal, which should go HIGH if the pressure is outside its normal ranges.

Output Y: This is a CO_2 Gas Alarm signal, which should go HIGH if CO_2 gas is detected when the process is inactive and at the same time the pressure is at an abnormal level.

Design the combinational logic circuit for the system.

Your design should include truth tables, Karnaugh Mapping minimisation and circuit implementation using **NAND** gates only.

[20 marks]

7. Answer any **TWO** parts.

(a) Design a synchronous sequential logic counter which will count in the following sequence: 1, 3, 5, 7, 9, 11, 13, 1, 3 ... [10 marks]

(b) Design a combinational logic circuit which will have two inputs A and B. Both A and B are two bit numbers. The circuit is to have a single output which will be HIGH if the product of the numbers A and B is even. Note that Zero is considered odd. Your design should include a truth table, minimisation and circuit implementation using **NOR** gates only.

[10 marks]

(c) Draw the truth table for a full adder which will add two single bit numbers X and Y a and a input carry bit C_{in} to give sum and carry outputs S and C_{out}. Write down Boolean expressions for the two outputs and proceed to express them in minimal form. Give a circuit implementation for the adder based on the minimal expressions.

[10 marks]