University of Ghana

Bachelor of Science in Engineering
Second Semester Examinations 2016/2017
Department of Computer Engineering
FAEN 108: Basic Electronics (3 Credits)
Time Allowed: 3 hours

INSTRUCTION: Attempt all questions in the answer booklet provided

1. (a) Write short notes on the history of the development of electronics, identifying the three (3) key developments that spearhead the modern information revolution and the unique contributions from scientists and engineers. [6 marks]

   (b) Differentiate between analog and digital signals. [2 marks]

   (c) Assume you are tasked to record the sound coming from stethoscope onto a media player for remote medical diagnosis by doctors. Describe the process by which you will convert the sound coming from the stethoscope into a music file (say .mp3) that can be transmitted over a network and played on a media player. [4 marks]

2. (a) State the Nyquist criterion for signal sampling and reconstruction. Why is it important in sampling and reconstruction? [2 marks]

   (b) Explain the process of signal level quantization for digitizing analog signals. [2 marks]

   (c) Assume you are provided with a $0 - 10V$ analog signals which you intended to convert into digital signal. How would you quantize the signal levels using a 4-bit binary system for the voltage level? [5 marks]

   (d) How would you improve the accuracy of the measured digital signal based on the level of quantization? Draw a block diagram of the ADC conversion process. [2 marks]

3. (a) Sketch a circuit diagram showing how four(4) diodes may be connected to the secondary winding of a transformer in order to obtain unsmoothed full-wave rectification. [6 marks]

   (b) For the circuit drawn in *3(a)* above, sketch the waveform of the output voltage assuming a sinusoidal input voltage was presented. [2 marks]

   (c) Explain the importance of smoothing the output voltage in *3 (b)* above before applying it to a transistor amplifier. [2 marks]

(d) For the circuit shown below in figure 1, assume that the diode is ideal with linear forward resistance $R_F = 50k\Omega$ and the built-in potential $V_\phi = 0.7V$ and also given the following circuit parameters: $R_1 = 10k\Omega$, $R_2 = 20k\Omega$, $R_3 = 20k\Omega$, $R_4 = 20k\Omega$, $R_5 = 15k\Omega$ and Voltage $V_1 = 20V$.

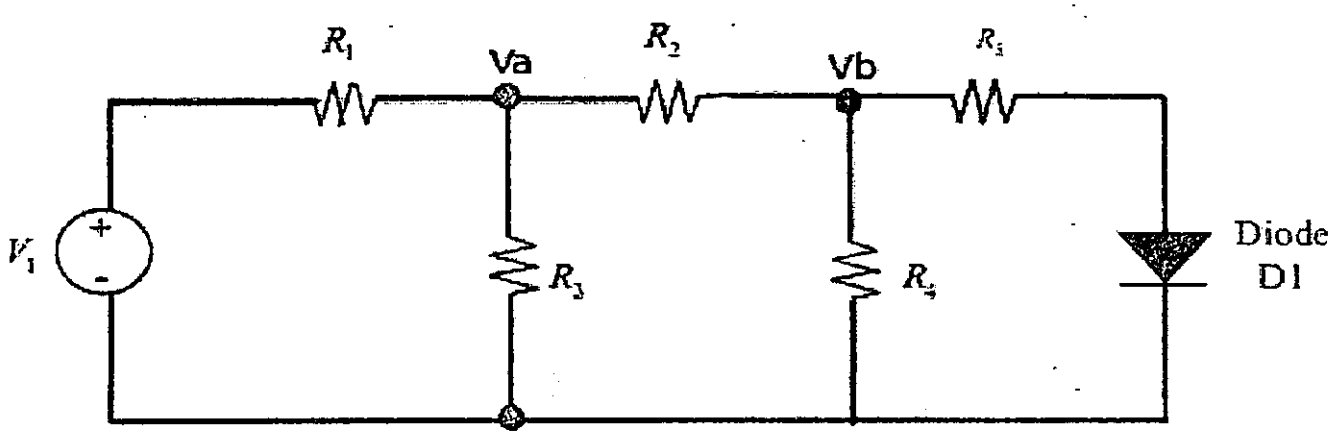

Figure 1: A simple diode circuit with resistors

i. Calculate the voltages at the nodes V_a and V_b and the corresponding currents in all branches of the circuit

[6 marks]

ii. Calculate the power dissipated in the resistor R_3

[2 marks]

iii. If the power rating of resistor R_3 is $\mathbf{2.55W}$, would it be able to allow the current calculated to flow through it or not? Justify your answer.

[2 marks]

4. The common-emitter (CE) amplifier circuit shown below in figure 2 has $V_{CC} = 12V$, $R_1 = 90k\Omega, R_2 = 60k\Omega, R_E = 50k\Omega$ and $R_C = 40k\Omega$. The transistor has amplification gain $\beta = 120$ and early voltage $V_A = 100V$.

(a) Calculate the dc bias current I_E.

[5 marks]

(b) If the amplifier operates between a source for which $R_{sig} = 10k\Omega$ and a load, R_L of $2k\Omega$, determine the following:

i. Small signal equivalent diagram of the transistor circuit.

[2 marks]

ii. Calculate the values of r_π, r_o and indicate this on the small signal equivalent diagram.

[5 marks]

iii. Calculate the voltage gain v_o/v_{sig}

[8 marks]

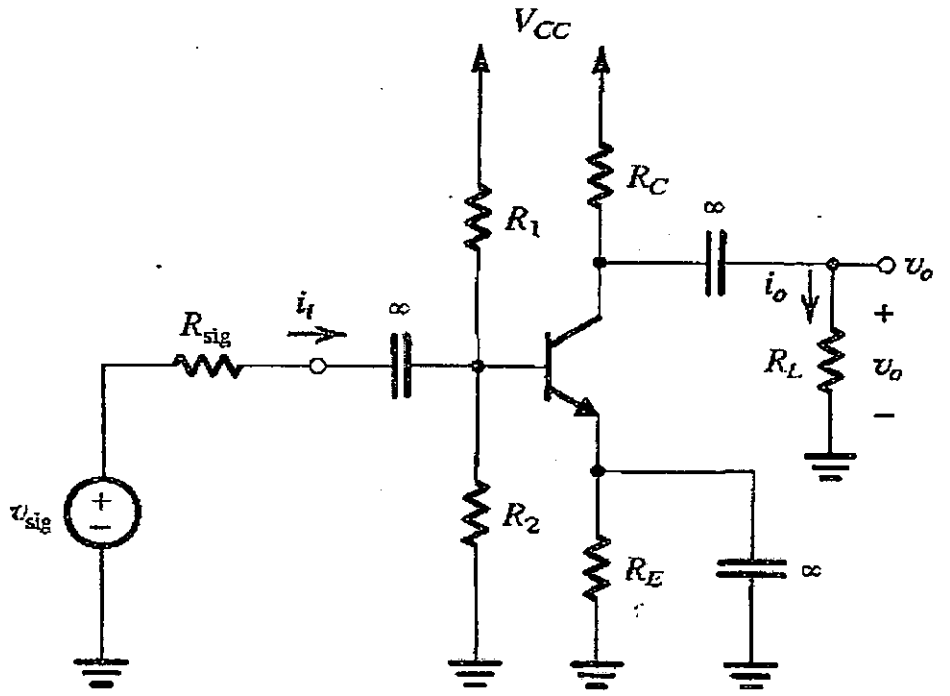

Figure 2: Common-emitter transistor circuit

5. (a) With the aid of a well-labelled diagram, describe in detail the operation of a **p-channel** MOSFET.

[6 marks]

(b) Mention the modes of operation of a **n-channel** MOSFET with their corresponding equations for the drain current.

[6 marks]

(c) Give three (3) reasons why CMOS technology is preferred to NMOS technology in modern electronic devices?

[3 marks]

6. (a) Why are some logic gates referred to as universal gates? Mention two universal gates and provide the truth table with three (3) inputs (A, B, C) for one of them.

[6 marks]

(b) Show by a well-labelled diagram how any of the universal gate is used to accomplish the operation of an **OR** gate.

[5 marks]

(c) The output of a combinational logic circuit for a home security system gives an output of $1(HIGH)$ only when any one of the following patterns is present at its three inputs (A, B, C)

$$\mathbf{f(A, B, C) : \sum(001, 010, 011, 100, 111)}$$

i. Draw the truth table of the output function $F(A, B, C)$.

[4 marks]

ii. Obtain the minimal Boolean expression. (i.e. simplify the resulting output function using Boolean algebra).

[5 marks]

iii. Draw a logic circuit to generate the output signal $F(A, B, C)$ after minimizing using Boolean algebra.

[5 marks]

(d) Convert the following figures in the tables into their corresponding bases and fill the table in your answer booklet. Show all work in answer booklet for full credit.

Binary	Octal	Hexadecimal	Decimal
10011.11			
	723.4		
		AC7	
			4801.5

[12 marks]

(e) Perform the following operations indicated below

i. Add the decimal numbers **105** and **62** by binary means. [3 marks]

ii. Subtract the decimal number **15** from **25** by binary means. [3 marks]

iii. Multiply the binary numbers **10101** and **01001**. [4 marks]

(f) Write down the Boolean expression for $\mathbf{F_1}$ and $\mathbf{F_2}$ in the logic gate diagram shown below in figure 3.

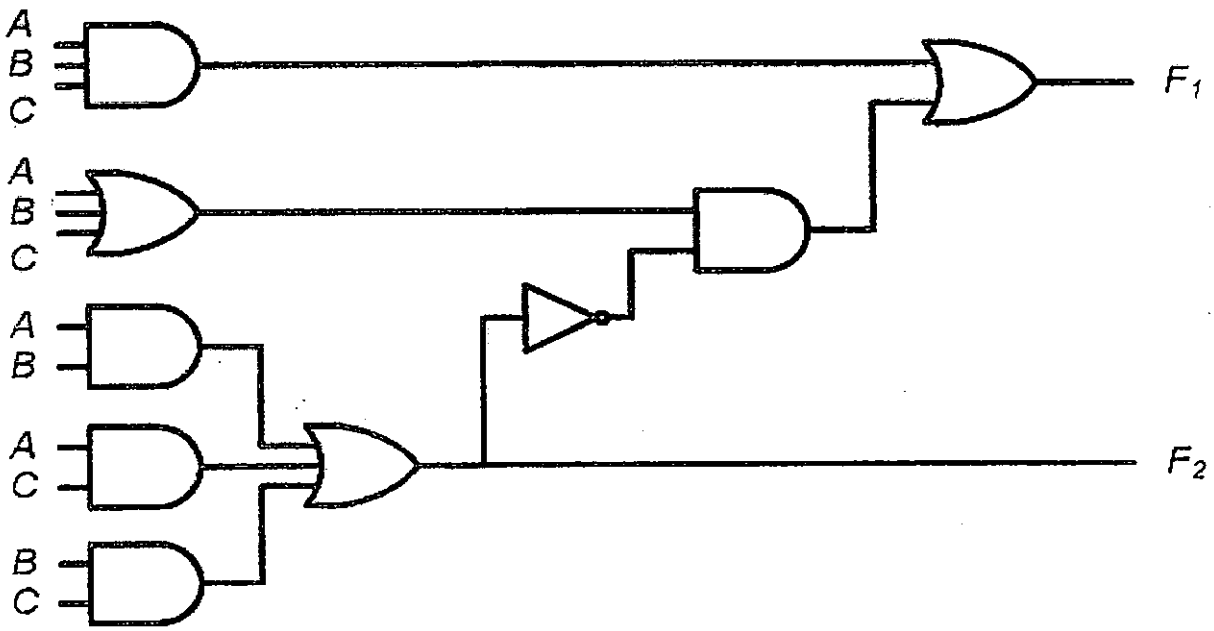

Figure 3: Combinational Logic gate circuit

and use Boolean algebra and De-Morgan's laws to simplify the expressions where necessary.

[10 marks]