Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Computer Science and Technology
200 level 2nd Semester Examination – Dec./Jan. 2016/17
CST231-2 Microelectronics

Uva Wellassa University

Instructions to candidates
Duration: Two (02) hours
Number of questions: Four (04)
Mark allocation: 100
Answer all questions

1.
   a. Discuss the advantages of Digital signals compared to Analog signals.

   (3 mark)

   b. Explain the following terms with respect to signal processing using appropriate examples.
      i. Maximum frequency
      ii. Quantization error

   (6 mark)

   c.
      i. Briefly explain the process of analog to digital conversion using appropriate hypothetical values.

      (3 mark)

      ii. Assume the bit-rate of a compressed audio file is specified as 92 Kbps while the compression ratio is approximately 9:1. Provided that the sampling rate is 44.1 Khz. Determine the bit-depth (resolution) of the particular audio.

      (5 mark)

   d.
      i. Differentiate between Low-Pass frequency filters and High-Pass frequency filters.

      (4 mark)

      ii. Explain the functionality of above d.(i) listed frequency filters using circuit diagrams and frequency response curves.

      (4 mark)

2.
   a. Briefly explain how to produce different types of (P and N type) semiconductors using intrinsic semiconductor materials.

   (4 mark)

   b. Explain the phenomenon of 'diffusion' which occurs in formation of a potential barrier at any P-N junction.

   (4 mark)

   c.
      i. List five (05) Three-terminal semiconductor components.

      (5 mark)

      ii. Explain the improved characteristics of any two (02) components selected from the list produced in above c.(i) using circuit diagrams or characteristic curves.

      (4 mark)

   d. The forward-bias i–v relationship of a typical P-N junction is given below:

$i = I_S(e^{v/V_T} - 1)$ while $V_T = kT/q$

⑦ 0

i. Define the terms of the formulae.

(3 mark)

ii. A silicon diode is said to be a 1 mA components exhibits a forward voltage of 0.67 V. Given that the values of k, V_T and q are 8.62 $\times 10^{-5}$ eV/K , 25.3 mV (at room temperature) and 1.60 x10^{-19} coulomb, respectively. Evaluate the junction scaling constant (saturation current).

(5 mark)

3.

a. State the conditions to be satisfied in order to switch in between the Cut-off Region (where the transistor acts as an off switch) and the Active Linear Region (where the transistor acts as a current amplifier) of a typical NPN type Bipolar Junction Transistor.

Use the terms V_{BE} (Base-Emmitor Voltage), V_{FB} (Forward Bias Voltage), I_B (Base current) and the derived relationship between I_B, $I_{C,max}$ (The maximum current that will flow across collector) and β (Common Emitter current gain) for each status.

(8 mark)

b.

i. A bipolar NPN transistor has a DC current gain (β) value of 50. Calculate the base current I_B required to switch a resistive load of 9 mA.

(2 mark)

ii. A NPN transistor has a DC base bias voltage, V_B of 10 V and an input base resistor, R_B of 150 KΩ. What would be the value of the base current (I_B) into the transistor? Clearly state any assumptions you made.

(3 mark)

c. Consider the following circuit diagram (Figure 01).

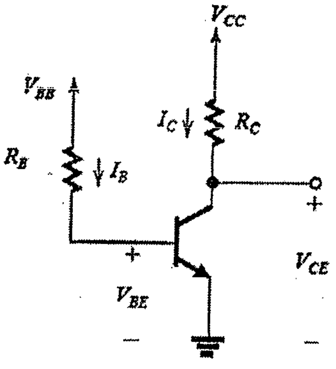

Figure 01: A transistor circuit

Assume that at the edge of saturation VCE = 0.6 V, VBE remains constant at 0.7 V. The transistor DC current gain β is specified to be 100.

For the circuit shown in Figure 01, determine the value of the voltage V_{BB} that results in the transistor operating at the edge of saturation. Given that V_{cc} = 10 V, R_B = 12 KΩ, R_c = 2.5 KΩ.

(4 mark)

d. Consider the following schematic diagram of the amplifier circuit (Figure 02).

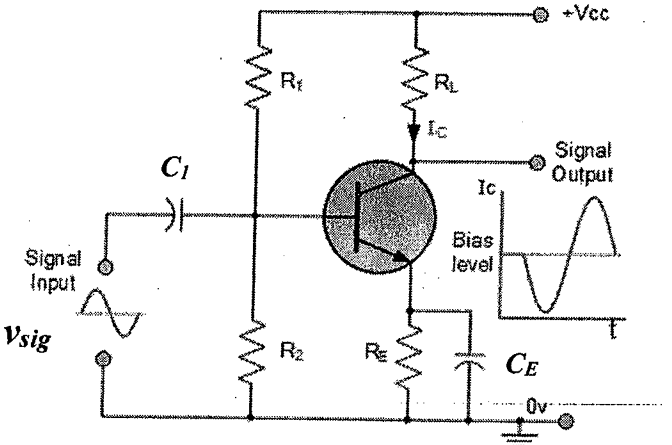

Figure 02: A transistor amplifier circuit

i. Identify the class and the configuration of the amplifier in Figure 02.

(2 mark)

ii. What is the functionality of capacitor C_1 ?

(3 mark)

iii. What is the functionality of capacitor C_E ?

(3 mark)

4.

a. Compare and contrast Field-Effect Transistors (FETs) against Bipolar Junction Transistors (BJTs).

(3 mark)

b. List two (02) applications from each: Junction Field-Effect Transistors (JFETs) and Metal-Oxide-Semiconductor FETs (MOSFETs).

(4 mark)

c. The Drain current I_D of a N-Type JFET for any given bias point in the saturation or active region can be calculated using

$$I_D = I_{DSS} \left[1 - (V_{GS} / V_{GS(cut\text{-}off)}) \right]^2$$

i. Define the terms of the formula.

(3 mark)

ii. If a JFET has a Drain current of 6 mA when $I_{DSS} = 4$ mA and $V_{GS(cut\text{-}off)} = -5.5$ V, find the value of V_{GS}.

(4 mark)

d.

i. What are the two (02) basic configurations of operational amplifiers?

(4 mark)

ii. Using appropriate circuit diagrams, explain how to construct a comparator using an operational amplifier.

(5 mark)

iii. List three (02) applications of operational amplifiers except voltage comparators.

(2 mark)