

Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Computer Science and Technology
200 level 2nd Semester Examination – Dec. - 2017/Jan. - 2018
CST231-2 Microelectronics



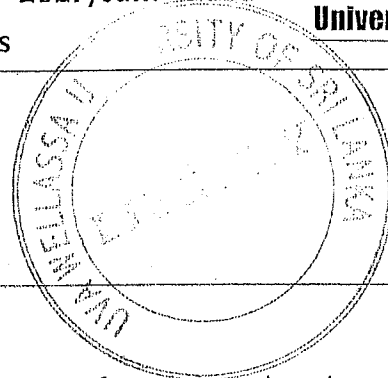
Instructions to candidates

Duration: Two (02) hours

Number of questions: Four (04)

Mark allocation: 100

Answer all questions



1.
 - a. Explain why Digital signals are preferred, in the perspective of storage, rather than Analog signals. (3 mark)
 - b. Explain the relationship between the following concepts with respect to signal processing using appropriate examples:
 - i. Sampling rate
 - ii. Bit depth (6 mark)
 - c.
 - i. List the key steps of the process of analog to digital conversion. (3 mark)
 - ii. Assume the bit-rate of a compressed audio file is specified as 144 Kbps while the compression ratio is approximately 10:1. Provided that the sampling rate is 44.1 KHz. Determine the bit-depth (resolution) of the particular audio. (5 mark)
 - d.
 - i. What is meant by a Band-Pass frequency filter? (4 mark)
 - ii. Explain the functionality of a Band-Pass frequency filter using circuit diagrams and/or frequency response curves. (4 mark)
2.
 - a. Distinguish between the P and N type semiconductors and explain why they need to be different from intrinsic semiconductor materials. (4 mark)
 - b. What is the important phenomenon happening at any P-N junction prior to formation of the depletion layer? (4 mark)
 - c.
 - i. List three (03) Two-terminal and two (02) Three-terminal semiconductor components. (5 mark)
 - ii. Explain the characteristics of two (02) components selected one from each category, from the list produced in above c.(i) using circuit diagrams and/or characteristic curves. (4 mark)

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

$$i = I_s (e^{V/V_T} - 1) \text{ while } V_T = kT/q$$

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 0.69 V. Given that the values of k , V_T and q are 8.62×10^{-5} eV/K , 25.3 mV (at room temperature) and 1.60×10^{-19} coulomb, respectively. Evaluate the junction scaling constant (saturation current).

(5 mark)

3.

a. State the conditions need to be satisfied in order to switch in between different functional regions of a typical NPN type Bipolar Junction Transistor (BJT).

Use the terms V_{BE} (Base-Emmitter Voltage), V_{FB} (Forward Bias Voltage), I_B (Base current) and derive a relationship among 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 100. Calculate the base current I_B required to switch a resistive load of 7 mA.

(2 mark)

ii. A NPN transistor has a DC base bias voltage, V_B of 12 V and an input base resistor, R_B of 200 K Ω . 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).

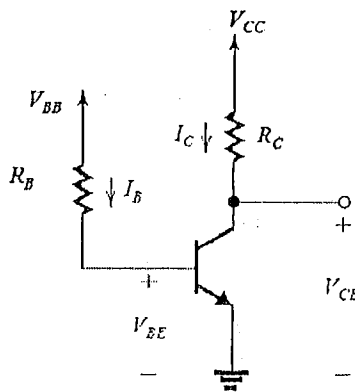


Figure 01: A transistor circuit

Assume that at the edge of saturation $V_{CE} = 0.67$ V, V_{BE} remains constant at 0.7 V. The transistor DC current gain β is specified to be 50. (At the active mode $V_{CE} = 5$ V.)

For the circuit shown in Figure 01, determine the value of the voltage V_{BB} that results in the transistor operating at the the active mode. Given that $V_{CC} = 11$ V, $R_B = 10$ K Ω , $R_C = 2$ K Ω .

(4 mark)

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

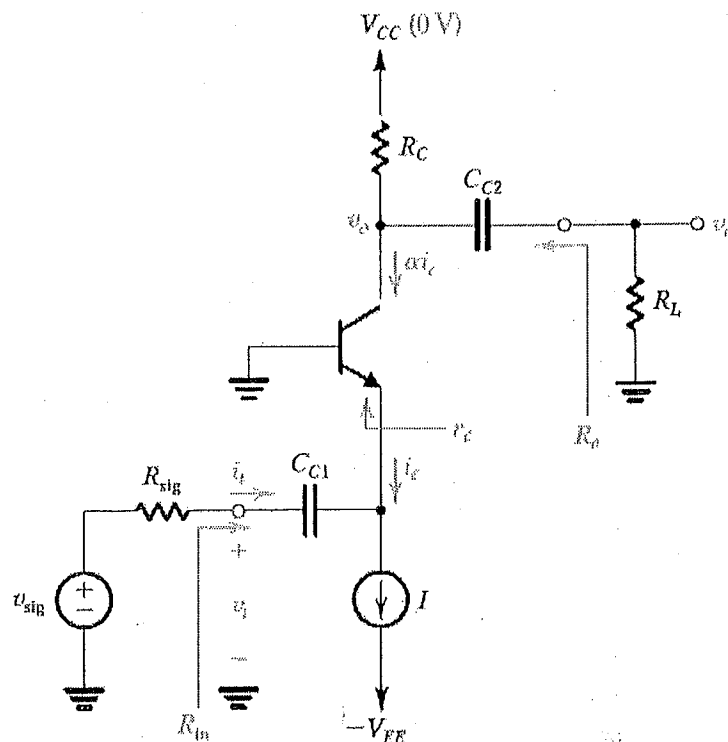


Figure 02: A transistor amplifier circuit

- i. Identify the configuration of the amplifier in Figure 02. (2 mark)
- ii. What is the functionality of the capacitor C_{C1} ? (3 mark)
- iii. What is the functionality of the capacitor C_{C2} ? (3 mark)

4.

- a. What are the disadvantages of Bipolar Junction Transistors (BJTs) compared to Field-Effect Transistors (FETs)? (3 mark)
- b. Differentiate the two (02) common types of FETs. (4 mark)
- c. The drain current I_D of a N-Type Junction gate Field-Effect Transistor (JFET) for any given bias point in the saturation or active region can be calculated using
$$I_D = I_{DSS} \left[1 - \left(\frac{V_{GS}}{V_{GS(\text{cut-off})}} \right) \right]^2$$
 - i. Define the terms of the formula. (3 mark)
 - ii. If a JFET has a drain current of 7 mA when $I_{DSS} = 2$ mA and $V_{GS(\text{cut-off})} = -5$ V, find the value of V_{GS} . (4 mark)

d.

i. Using appropriate circuit diagrams, explain how an operational amplifier can be configured differently.

(4 mark)

ii. Using standard notations, state the relationship among the parameters associated with an operational amplifier.

(5 mark)

iii. List any three (03) applications of operational amplifiers.

(2 mark)

