JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCE

UNIVERSITY EXAMINATION FOR BACHELORS DGREE

3RD YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR

MAIN

COURSE CODE: SPH 307

COURSE TITLE: INTRODUCTION TO ELECTRONICS

EXAM VENUE: LR 8 **STREAM: (BSc)**

DATE: 12/08/14 **EXAM SESSION: 9.00– 11.00 AM**

TIME: 2.00 HOURS

Instructions:

1. **Answer Section A (Compulsory) and ANY other 2 questions in section B**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

SECTION A.

1. a) i) Why is intrinsic conductivity different from extrinsic conductivity? **(**3 marks)

ii) Cite three important parameters of semiconductor diodes. (3 marks)

iii) What is the important characteristic that differentiate semiconductors from metals and insulators. (2 marks)

b) i) Electrons do not recombine with holes in the p-type base region as they diffuse to the collector. Why? (2 marks)

ii) Explain why NPN transistor is more popular than PNP transistor. (3 marks)

c) i) What conditions are required for an amplifier to oscillate? (3 marks)

ii) Name two areas in electronics where oscillators are used**.** (2 marks)

iii) An important parameter of an amplifier is *gain*. Define it and write a simple equation defining it in terms of signal voltage. **(**2 marks)

iv) Define *bandwidth* and give an example of an amplifier application where it is important.
. (3 marks)

d) i) In practice, why are transistors most often used in *common-emitter* configuration**.**
. (1 mark)

ii) A transistor shows a change of 0.995 mA in its collector current for a change of 1 mA in its emitter current. Compute:

(I) its common-base short circuit current gain

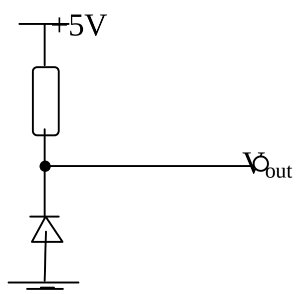
(II) its common-emitter short current gain**.** (3 marks)

iii) A transistor is connected in a common-emitter mode in a circuit and has collector load of 2 kΩ . The short-circuit current gain of the transistor is 100 and its input resistance is 1 k Ω. Calculate the voltage gain A_v and power gain A_p of the transistor. (3 marks)

SECTION B:

2. a) i) PN junctions often used as photo detectors. Assume you have a PN junction, that is reverse biased.

Fig. 1



The junction is specifically fabricated to expose the P-N interface. When light is shown is shown on the interface, the voltage V_{out} changes. Describe, briefly the mechanism that causes this voltage change. **(**8 marks)

ii) Assuming that this PN junction is made of silicon, will the voltage change occur for all frequencies of light. Explain. (3 marks)

iii) If you wanted the voltage swing at the output bigger for the same light intensity, are there any changes you could make to the doping concentration of the P and N regions of the PN junction. Explain. (3 marks)

b) i) When a PN junction is in equilibrium a depletion region forms at the interface. Explain the cause of this depletion region. (4 marks)

ii) Explain whether or not the width of the depletion region depends on doping concentrations of the P and N regions. (2 marks)

3. a) i) Define an oscillator. (2 marks)

ii) Draw a properly-labeled oscillator equivalent circuit and give its current equation.
. (5 marks)

iii) The solution to the circuit equation in (ii) above can be given as

$$i = (1/LC)\{ e^{-At} - (e^{Bt} - e^{-Bt})\}$$

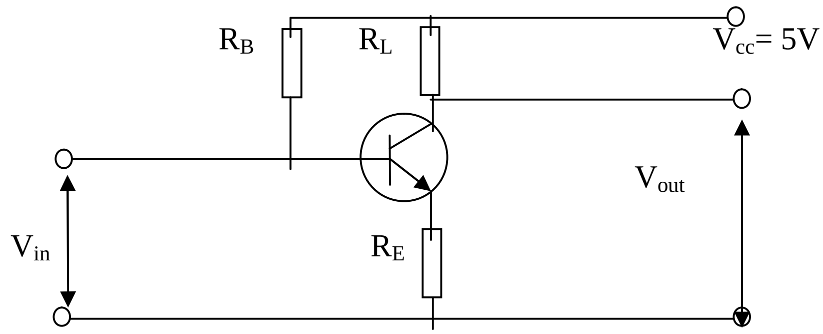
where A = R/2L and B = $(A^2 - 1/LC)^{1/2}$

With the help of graphical illustrations, describe the possible conditions that can be derived from the solution. (13 marks)

4. i) In a PNP bipolar transistor, what would happen if the base region was made extra wide (i.e much wider than the diffusion length of holes). (2 marks)

ii) Describe how such a device would operate and comment on the current flow. (4 marks)

b) A transistor biasing method is shown in figure 2.



Note: $R_E = 1.25\ k\Omega$, $R_L = 5\ k\Omega$, and $R_B = 530\ k\Omega$

i) Name the biasing method used. (1 mark)

ii) Write the bias-line equation. (2 marks)

iii) If $V_{CE} = 2.5$ V and $h_{FE} = 50$, find the collector current I_C and base current I_B.
. (8 marks)

5. a) i) Draw a schematic diagram of an operational amplifier. (1 mark)

ii) Cite four characteristics of an operational amplifier. (4 marks)

b) i) Draw the circuit of an op-amp wired as an *integrator*. Show the flow of currents in the circuit. (3 marks)

ii) Prove that the output voltage V_0 and the input voltage V_s of the integrator are related as

$$V_0 = -(1/RC) \int V_s\, dt$$ (8 marks)

iii) What does the equation in (ii) above reduce to when input voltage is constant and where can such a voltage be used. (4 marks)