UNAM
UNIVERSITY OF NAMIBIA

FACULTY	AGRICULTURE, ENGINEERING, AND NATURAL SCIENCES		
SCHOOL	SCIENCE		
DEPARTMENT	PHYSICS, CHEMISTRY, AND MATERIAL SCIENCE (PCMS)		
SUBJECT	ELECTRONICS		
SUBJECT CODE	S3611PE		
DATE	JUNE 2026		
DURATION	3 HOURS	**MARKS**	100

FIRST OPPORTUNITY EXAMINATION

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This question paper consists of 7 pages (including this cover page)
Total marks: 100
Maximum obtainable marks: 100

Instructions

- Answer all questions.
- Show all your working.

The following constants may be useful:

Avogadro's number	:	N_A	=	$6.02 \times 10^{23}\ \text{mol}^{-1}$
Electron charge	:	e	=	$1.6 \times 10^{-19}\ \text{C}$
Speed of light in vacuum	:	c	=	$3.0 \times 10^{8}\ \text{ms}^{-1}$
Electronic mass	:	m	=	$9.11 \times 10^{-31}\ \text{kg}$
Planck's constant	:	h	=	$6.63 \times 10^{-34}\ \text{Js}$
		$\hbar$	=	$1.05 \times 10^{-34}\ \text{Js}$
Boltzmann constant	:	k_B	=	$1.38 \times 10^{-23}\ \text{JK}^{-1}$

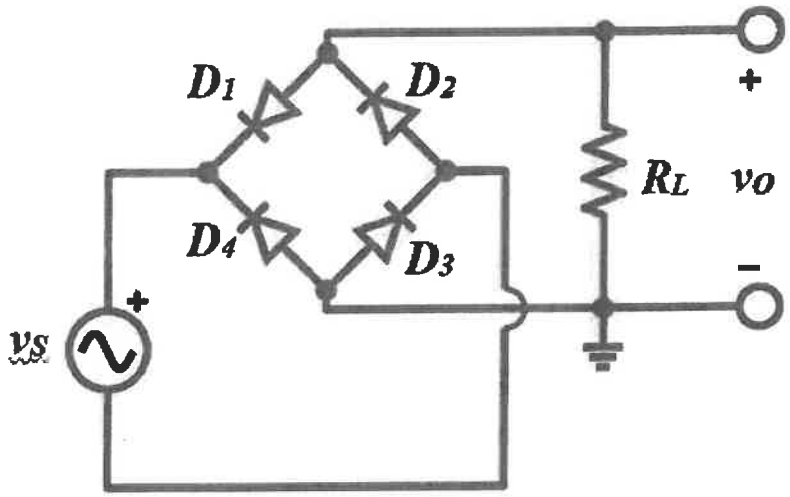
Question 1 **[20 marks]**

(a) Describe the difference between P-type and N-type semiconductor materials, and indicate the position of the Fermi level, for each, in an energy band diagram. [6]

(b) Explain how a depletion region with a built-in electric field is established when p- and n- type materials are joined to form a p-n junction. [4]

(c) With the aid of sketches, explain the meaning of (i) reverse biasing, (ii) forward biasing, of a pn junction diode, indicating in both cases, how increase in applied bias affects the width of the depletion region, and conductivity of the diode. [6]

(d) Identify the circuit below, describe its function as an example of diode application, and sketch the output signal in comparison to the input sinusoidal voltage. [4]



Question 2 **[20 marks]**

(a) How should the Base – Emitter, and Collector - Base, junctions of an n-p-n transistor be biased for it to operate in the active region? [2]

(b) Given the load line of Fig.2.1 and the defined *Q*-point, for a fixed-bias configuration, determine the required values of

(i) V_{CC}, [2]

(ii) I_C [2]

(iii) R_C, and [2]

(iv) R_B. [2]

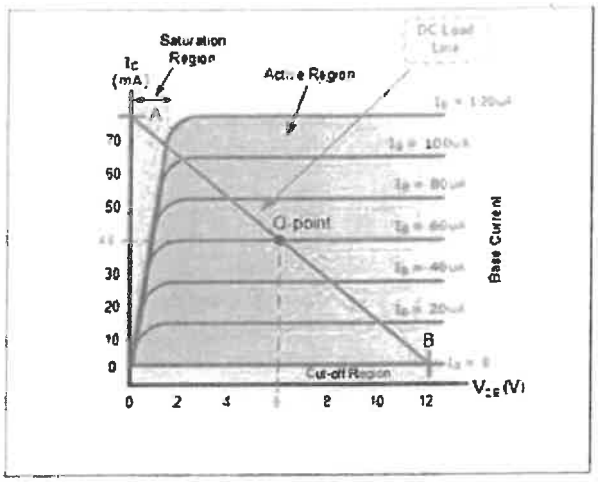


Fig. 2.1

(c) A voltage-divider biased Common Emitter amplifier shown in Figure 2.3 below uses V_{CC}=15 V, R_1 = 33kΩ, R_2 = 10 kΩ, R_C = 2.2 kΩ, and R_E = 1 kΩ. Assuming $\beta - 0.7\,V$, calculate the quiescent operating point (I_{CQ}, V_{CEQ}) [10].

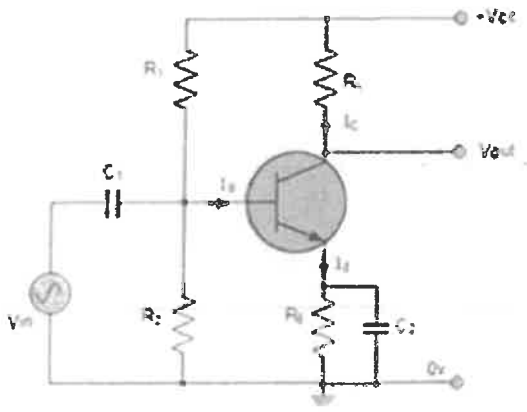


Fig.2.3

Question 3 **[20 marks]**

a) Given the transistor amplifier circuit as in Figure 3.1 below, draw its well labelled h-parameter equivalent circuit. [12]

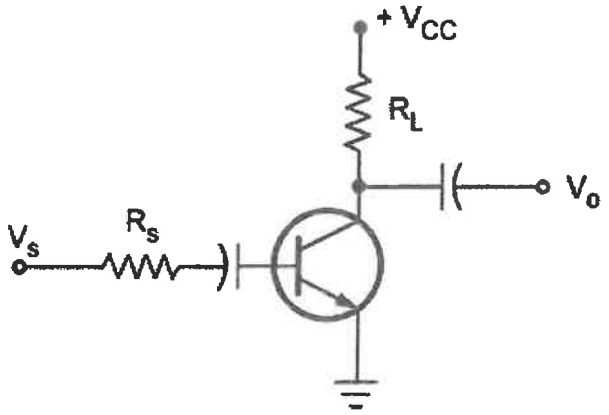


Fig. 3.1

b) Obtain an expression for the current gain (A_I) [6]

c) Calculate the current gain of the transistor given that $h_{fe} = 50$, $h_{oe} = 25\,\mu A/V$, and $R_L = 1.2k\Omega$. [2]

Question 4 **[20 marks]**

(a) Given the alternating voltage signal displayed on an oscilloscope screen as shown in Figure 4.1 below:

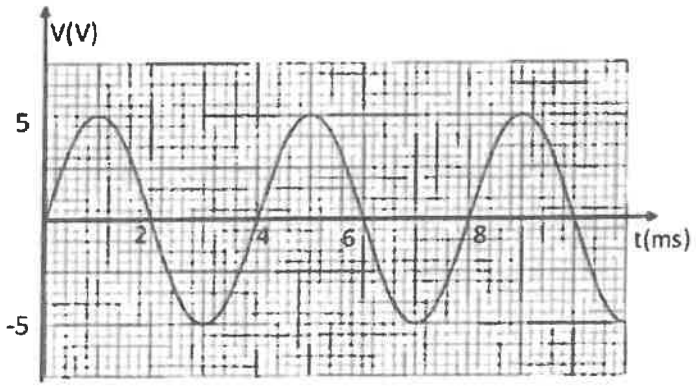


Fig. 4.1

(i) Calculate the frequency of the signal. [2]

(ii) This alternating voltage is used as the input voltage V_1 of the operational amplifier circuit shown below in Figure 4.2. where R_f is a variable resistor.

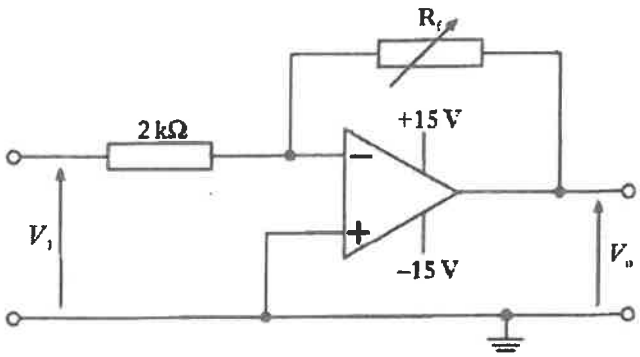


Fig. 4.2

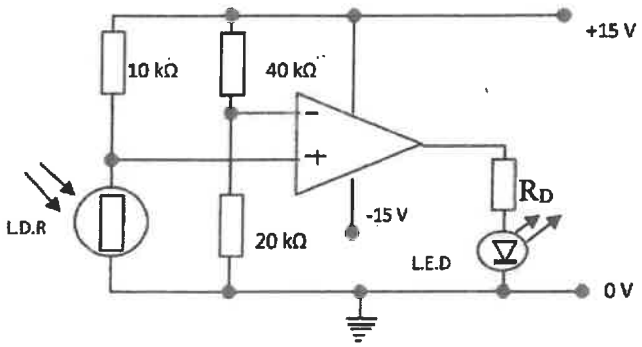
(iii) In which mode is the amplifier operating? [1]

(iv) Calculate the value of output voltage V_0, when the variable resistor R_f is set at 4.0 kΩ. [2]

(v) Calculate the r.m.s value the output voltage [2]

(vi) The resistance of the resistor R_f is gradually increased from 3.0 kΩ to 8.0 kΩ. Describe what happens to the output voltage V_0 during this time. [3]

(b) The circuit below is designed to switch on a light emitting diode (L.E.D) when darkness falls. The circuit uses a light dependent resistor (L.D.R) which has a resistance greater than 1 M Ω in the dark, but less than 1 kΩ when illuminated.



(i) Calculate the potential at the inverting input. [2]

(ii) Calculate the approximate potential of the non-inverting input when the L.D.R is in the dark [2]

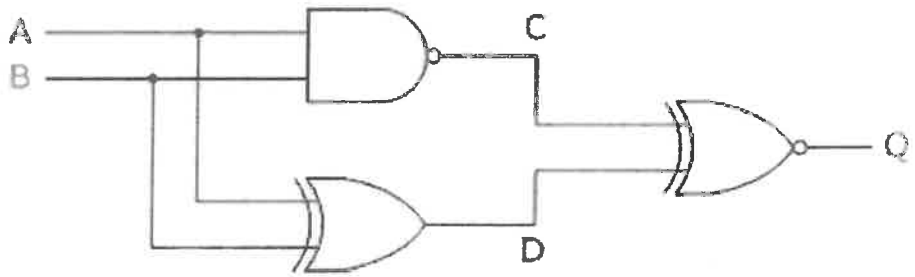
(iii) Calculate the approximate potential of the non-inverting input when the L.D.R is in the in the light [2]

(iv) Why does the L.E.D only light when darkness falls? [2]

(v) What is the use of resistor R_D? [2]

Question 5 **[20 marks]**

(a) The diagram below shows a combinational circuit to perform a certain operation.



Note: You may copy and complete the table below:

(i) Name each logic gate shown in the circuit diagram. [3]

(ii) Construct an overall truth table for the circuit shown at points C, D and Q. [6]

		Output at		
Inputs\Gate				
A	**B**	**C**	**D**	**Q**
0	0			
0	1			
1	0			
1	1			

(iii) Identify a single logic gate that can be used to replace the whole circuit. [1]

(a) Using Boolean Algebra, prove that the Boolean expression:
$(A + B)(A + C) = A + B \cdot C$ [4]

(b) Design a 4-bit, rising edge triggered, binary down counter using D-type flip-flops. [3]

(c) Draw the corresponding timing diagrams for the counter designed in (c) showing the Q outputs. [3]

END OF EXAMINATION PAPER