(b) An operational amplifier is used as a comparator in the following configuration: $V_{in}(t) = 4\sin(1000\pi t)$ V, V_{ref} = 2 V, V_{cc} = ± 10 V. Calculate the output voltage of the Op-Amp. Draw the output voltage waveform of the Op-Amp, when the input signal crosses V_{ref} = 2V. (7)

5. (a) Design an astable multivibrator circuit using a 555 timer to generate a rectangular wave of frequency 1 kHz with a duty cycle of 60%. Calculate the values of resistors R_1 and R_2. Assume C = 0.1 μF for calculations. If the timing capacitor C is doubled, calculate the time period of the output waveform? (8)

(b) Compare the behaviour of RC integrator and differentiator in terms of their frequency response. Describe scenarios where you would use a low-pass filter versus a high-pass filter. (7)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 3069 **I**

Unique Paper Code : 2224002001

Name of the Paper : Introduction to Electronics (GE Paper)

Name of the Course : **B.Sc. Hons.-(Physics)_NEP: UGCF-2022**

Semester : III

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question **(1)** is compulsory.
3. Attempt any **three** of the remaining four questions.
4. **All** questions carry equal marks.

1. Answer any **five** of the following questions. (5×3=15)

(a) Define the term "cut-off frequency" in an RC circuit with proper diagram.

(b) Describe the working principle of a light-emitting diode (LED) with the help of an appropriate diagram.

(c) The ac input to a diode clamper is a sinusoidal waveform of V_{PP} = 8V and f = 1KHz. Draw circuit diagram of a diode Clamper circuit that inserts a positive dc level (+1V) in the output wave-form. Also draw the waveform.

(d) A transistor operating in the common-emitter configuration has I_c = 4.5 mA, and I_b = 0.1 mA. Calculate the common-emitter current gain (β) and common-base current gain (α).

(e) Convert the decimal number 5.75_{10} into binary and octal equivalent.

(f) A differential amplifier has a CMRR of 80 dB, a differential gain (A_d) of 10,000 and a common-mode input signal (V_{cm}) of 1 V. Calculate the output voltage contributed by the common-mode signal.

2. (a) Derive the expressions for the DC output voltage (V_{dc}) and peak inverse voltage (PIV) of a full-wave bridge rectifier with the help of a suitable diagram. Draw the output waveform when a C-filter is used in the above circuit. (8)

(b) A Zener diode has a breakdown voltage of 6V. It is connected in reverse bias configuration across a load resistance R_L = 1kΩ. The series resistance R_S = 330Ω. The input voltage varies between 8 V and 12 V. Calculate the Zener current at V_s = 8 V and V_s = 12V. Also calculate the power dissipated in the Zener diode when V_s = 12V. (7)

3. (a) Explain the working of a Bipolar Junction Transistor (BJT) circuit as a switch. Draw the input-output characteristics of a BJT acting as a switch. Label the cut-off and saturation regions on the graph. (8)

(b) Derive the Boolean expressions for the Difference and Borrow outputs of a Full Subtractor logic circuit. Implement the circuit using minimum number of 2-input NAND gates. (7)

4. (a) An operational amplifier is connected in a subtractor configuration with V_1 = 15 V, V_2 = 5 V, R_1 = 20 kΩ, R_2 = 10kΩ and R_f = 40 kΩ. Calculate the output voltage. If the resistor R_1 is increased to 40 kΩ, how will the output voltage change? Explain the effect of resistor values on the output voltage. (8)