

Roll No																			
---------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



**PRESIDENCY UNIVERSITY  
BENGALURU**

**SET-B**

**SCHOOL OF ENGINEERING  
END TERM EXAMINATION – MAY/JUNE 2024**

**Semester :** Semester IV

**Course Code :** ECE3001

**Course Name :** Linear Integrated Circuits

**Program :** B.Tech.

**Date :** Jun 10, 2024

**Time :** 9:30 AM - 12:30 AM

**Max Marks :** 100

**Weightage :** 50%

---

**Instructions:**

- (i) Read all questions carefully and answer accordingly.
  - (ii) Question paper consists of 3 parts.
  - (iii) Scientific and non-programmable calculator are permitted.
  - (iv) Do not write any information on the question paper other than Roll Number.
- 

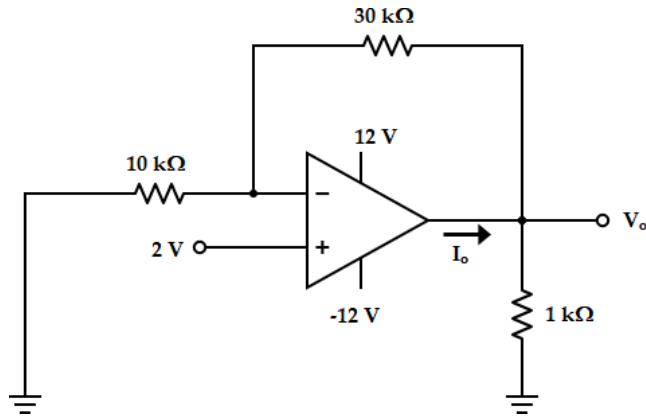
**PART A**

**ANSWER ANY THREE QUESTIONS**

**(3 Q X 5 M = 15 M)**

1. Operational amplifiers (op-amp) are amplifiers with a very high gain having two inputs and one output. Draw the pin diagram of 741 IC which is a very common operational amplifier.  
(CO1) [Knowledge]
2. An operational amplifier is a multistage high gain amplifier which has two inputs and one output. Parameters of an op-amp are very important while selecting an op-amp. Define the following parameters. What should be the value of these parameters if an ideal op-amp is used. Also list the value of each parameter for 741 IC.  
(a) Slew rate  
(b) CMRR  
(CO1) [Knowledge]

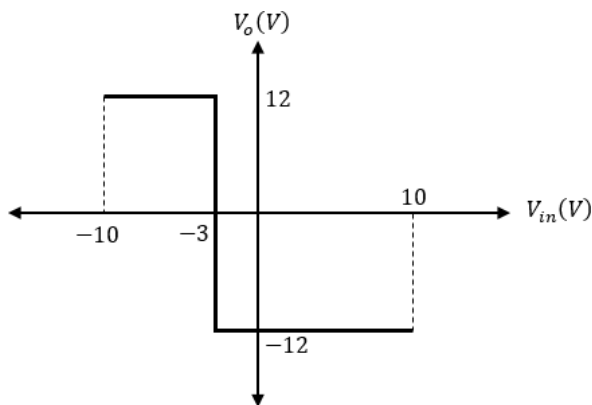
3. Consider the following circuit having an ideal op-amp.



Identify the circuit and evaluate the current marked  $I_o$ .

(CO2) [Knowledge]

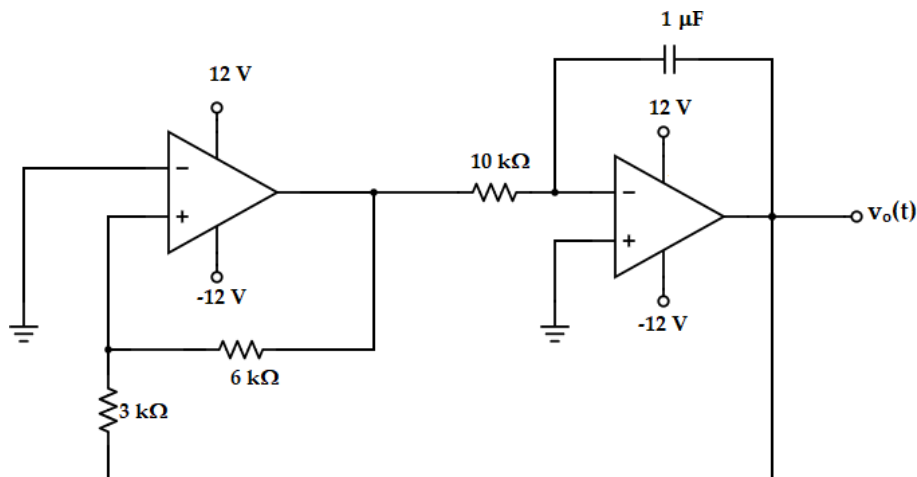
4. Mr. Kiran is working with a circuit having an op-amp. He noticed that the transfer characteristic of the circuit is as shown below:



Identify the circuit and draw the circuit. Draw the input and output waveform if the input is a sine wave of frequency 400 Hz. Briefly explain the working.

(CO3) [Knowledge]

5. Dr. Vijay has wired the following circuit.



Identify the circuit that is being wired. Draw the output waveform that will be obtained. Mark the time axis and voltage axis properly. Values should be clearly marked.

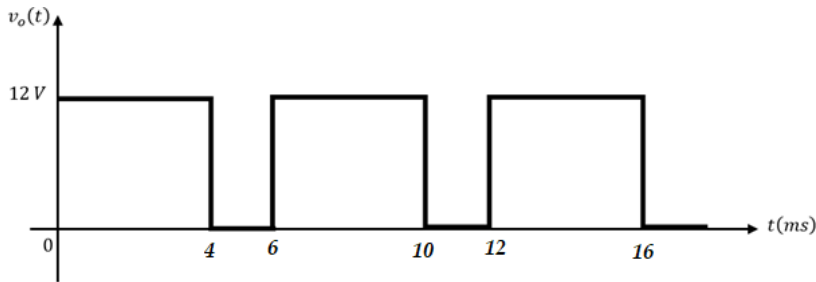
(CO3) [Knowledge]

## PART B

**ANSWER ANY TWO QUESTIONS**

**(2 Q X 20 M = 40 M)**

6. 555 timer ICs can be used to generate accurate time delays. Explain with the help of a circuit diagram and the internal block diagram, how the 555 timer can be used as an astable multivibrator. [7 Marks]  
 Derive an expression for the ON time and the OFF time. [6 Marks]  
 Suppose you want to generate the following waveform using a 555 timer. Draw the circuit and estimate the component values that he should use for generating the waveform. Use a  $1 \mu F$  capacitor. [4 Mark]  
 Draw the waveform generated across the capacitor. [3 Marks]



(CO3) [Comprehension]

7. Mr. Gopalakrishnan is a design engineer at Texas Instruments®. He has an input signal coming from some system which is given below.

$$v_{in}(t) = 3 + \sin(20\pi t) + \sin(100000\pi t)$$

He wants to remove only the highest frequency component in the signal. He has the components available for following filters.

1. First order Active Low Pass Filter with a cut off frequency of 60 kHz and pass band gain of 3
2. First order Active Low Pass Filter with a cut off frequency of 1800 Hz and pass band gain of 3
3. First order Active High Pass Filter with a cut off frequency of 60 kHz and pass band gain of 3
4. First order Active High Pass Filter with a cut off frequency of 1800 Hz and pass band gain of 3

Task 1: Identify the filter (ONLY ONE IS CORRECT) that he could use to meet the specification? [2 Marks]

Task 2: Draw the circuit diagram of the identified filter. [5 Marks]

Task 3 : Estimate the resistor values to be used, if the capacitor value available is 1 nF. [4 Marks]

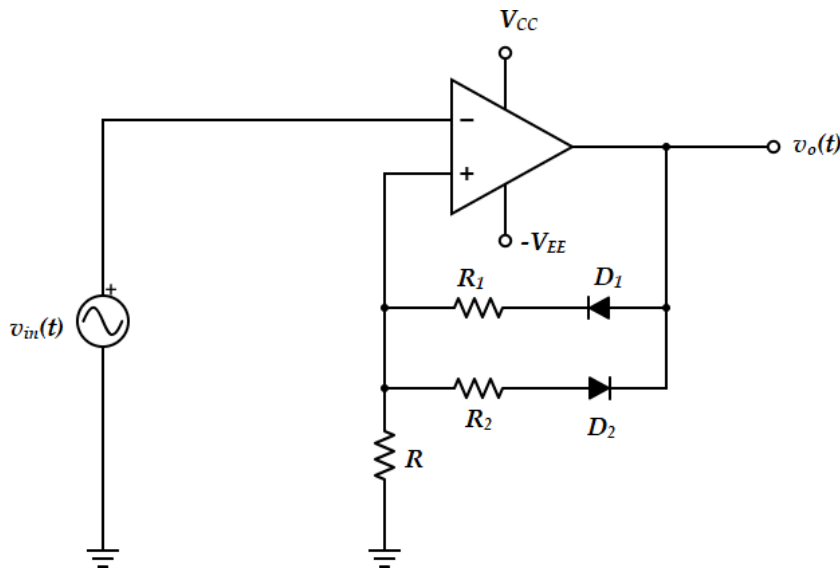
Task 4: Draw the magnitude response of the designed filter by considering the frequencies below [6 Marks]

f(Hz) 10 100 500 1000 2000 5000 7000 10k 20k 70k 100k 500k

Task 5: Infer the steady state output expression when the given input is applied to the designed filter. [3 Marks]

(CO3) [Comprehension]

8. Mr. Kiran designed a modified Inverting Schmitt Trigger by connecting two diodes as shown below:



Considering that the diodes and the op-amps are ideal, derive an expression for the triggering voltages. Explain how the circuit works. Determine the component values to be used such that the upper triggering occurs at 4 V and the lower triggering occurs at -8 V. Assume a saturation voltage of 12 V. Draw the input and output waveform and the transfer characteristics if the input is given as  $v_{in}(t) = 10 \cos(1000\pi t)$ .

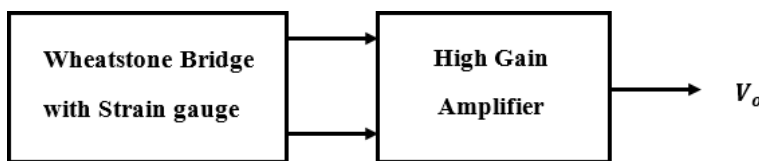
(CO3) [Comprehension]

### PART C

ANSWER ANY THREE QUESTIONS

(3 Q X 15 M = 45 M)

9. Mr. Vivek is working as a design engineer at Kuka Robotics. He is working with a strain gauge. A strain gauge is a device which can be used to measure force. The strain gauge is connected as one arm of a Wheatstone bridge. The output from the Wheatstone bridge is a differential voltage, which has to be given to an amplifier with two inputs and having a high input impedance, and whose gain can be controlled using a single variable control as shown in the block diagram below.



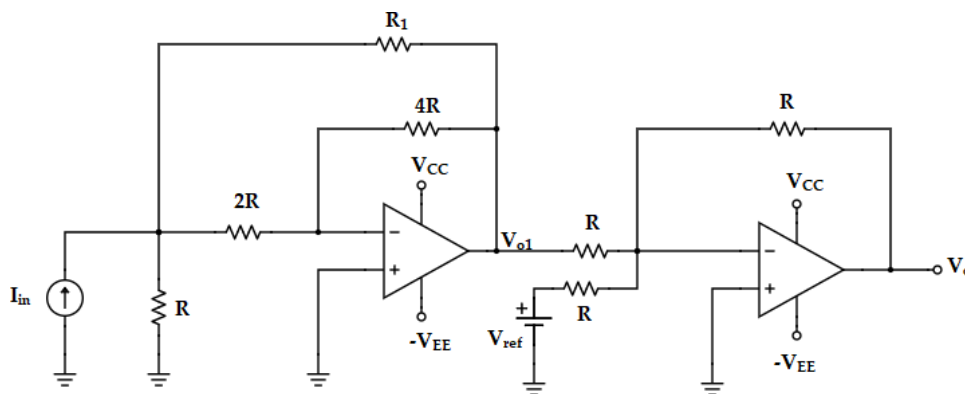
Which amplifier should he use? [2 Mark]

Draw the circuit and derive an expression for the output voltage. [8 Marks]

Estimate the component values to be used if the gain required is between 500 and 3000. [5 Marks]

(CO2) [Application]

10. Mr. Suraj is a control engineer in Kochi Refineries Limited. He wants to use a current to voltage converter, so that he can use it to convert the current signal transmitted from the plant to the control room into an equivalent voltage. The circuit that he is planning to use is given below:



He wants the output voltage of the first op-amp to be in the form of  $V_{o1} = -RI_{in}$ .

Estimate the value of the resistor  $R_1$  in terms of  $R$  to be used so as to satisfy the above condition. [8 Marks]

Now find an expression for the final output. [2 Marks]

The current signal coming from the plant is in the range of 4 mA - 20 mA. This current signal has to be converted to an equivalent voltage in the range 0 - 5 V. This means that, when the input current is 4 mA, the final output should be 0 V and when the input current is 20 mA, the final output should be 5 V. Determine the value of the resistor  $R$  and the reference voltage  $V_{ref}$  to be used. [5 Marks]

(CO2) [Application]

11. **Part (a):** In a certain transmission, we are planning to transmit an analog data as digital data of 3 bits. In the receiver side, we have to convert the 3 bit digital data into its equivalent analog data. So we have to use an Digital to Analog Converter to convert the digital data received into its equivalent analog data. You are planning to use a binary weighted resistor DAC for this purpose. List the resistor values required in this case if the minimum resistor value to be used is  $20\text{ k}\Omega$ . Draw the circuit that will do the required operation. Analyze the circuit and find the output equation. Tabulate the voltage that will be produced in each case if the reference voltage used is  $2\text{ V}$

**Part (b):** In a certain application, it is required to convert an analog voltage to its equivalent 2 bit digital voltage using a method that is the fastest. You have an option of Flash ADC and SAR ADC. Which ADC will you chose? Draw the complete circuit of the ADC and explain.

(CO3) [Application]

12. Speed control of DC motors are realized using Pulse Width Modulation (PWM). PWM is a technique wherein the duty cycle of a square wave is modified. We can generate square waves with different duty cycles using an op-amp.

Draw the circuit diagram of a squarewave generator using op-amps which will generate a square wave with a frequency of 4 kHz and a duty cycle of 20%. Explain the working of the circuit.

Determine the component values to be used if the capacitor to be used is  $0.01\ \mu\text{F}$ . Draw on a graph sheet with proper scale, the output voltage and the voltage developed across the capacitor if the saturation voltage is 12 V.

(CO3) [Application]

