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MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

# DEPARTMENT OF MECHATRONICS IV SEMESTER B.TECH. (MECHATRONICS)

### END SEMESTER EXAMINATIONS, MAY 2023

## SUBJECT: Linear Integrated Circuits and Applications [MTE 2254]

(22/05/2023)

#### **Time: 3 Hours**

#### MAX. MARKS: 50

#### **Instructions to Candidates:**

Answer **ALL** the questions.

Data not provided, may be suitably assumed

Q.		Μ	CO	РО	LO	BL
1A.	You are tasked with designing an audio mixer for a live music performance. The mixer needs to combine four different audio signals from various instruments and provide adjustable volume control for each input. Design an op-amp based summing amplifier that adds four input voltages: V1, V2, V3, and V4. The amplification factor for each input voltage should be -2, 1, 3, and -4, respectively. Provide the circuit diagram and calculate the resistor values required.	5	1	3	2	5
1B.	A team is working on designing a precision current control system for an LED lighting application. The LED module necessitates a controlled current source to maintain stable and accurate illumination levels. To accomplish this, the team decides to integrate a voltage-to-current (V-I) converter using an op-amp. Explain how the V-I converter circuit operates within the LED lighting application to deliver precise current control for the LED module based on the provided control voltage.	3	1	3	2	4
1C.	Describe two practical applications where the integration of a 555 timer and an op-amp circuit is commonly used. Discuss the specific roles and functionalities of the 555 timer and op-amp in each application.	2	2	2	2	3
2A.	A battery voltage monitor for a portable electronic device is to be designed. The device operates with a battery voltage that can vary between 0V and 5V. It is crucial to ensure that the device functions correctly within a safe voltage range. To achieve this, an op-amp based Schmitt trigger with specific threshold voltages is used. Design an op-amp based Schmitt trigger circuit that detects when the battery voltage exceeds 3V and drops below 2V. Draw the circuit diagram and calculate resistor values required.	4	1	3	2	5
2B.	An audio system installed for a recording studio, need to incorporate a high-pass filter to remove unwanted low-frequency noise and improve	3	3	3	3	5

	the clarity of the audio signals. The cutoff frequency should be 1 kHz.					
	and the gain at the cutoff frequency should be -3 dB. Design a first-					
	order high-pass filter using an op-amp. Calculate the resistor and					
	capacitor values required to design the system.					
2C.	Sketch the output waveform for the circuit is shown in Fig O. 2C How					
	does the choice of component values in an op-amp based triangular wave					
	generator affect the characteristics of the output waveform?					
	generator alle enaluerensites of the output waverennin					
	→15v 0.05uF					
		3	1	2	2	4
	Fig Q. 2C					
3A.	Analyze the working principle of an instrumentation amplifier and					
	evaluate its significance in signal conditioning applications, considering	5	1	2	2	4
	its advantages and limitations.					
<b>3B.</b>	Design an adjustable voltage regulator (LM317) to satisfy the following					
	specifications:	2	2	2	2	5
	Output Voltage $V_0 = 5$ to 12 V	3	3	2	2	5
	Output current $I_0 = 1.0$ A					
<b>3C.</b>	Draw the frequency response of a third order low pass opamp	2	2	2	2	2
	Butterworth filter.	2	3	2	2	3
<b>4</b> A.	Design a wide band pass filter with $f_L = 400$ Hz, $f_H = 2$ kHz, and					
	passband gain = 4. Also draw an approximate frequency response plot	5	3	3	2	5
	for the filter.					
<b>4B.</b>	Explain the significance of Phase-Locked Loops (PLL) in					
	telecommunications systems and provide an example of how PLLs are	3	3	2	2	4
	used to ensure accurate and synchronized data transmission between	5	5	-	2	-
	devices.					
<b>4C.</b>	Describe the working principle and applications of an all-pass filter,	2	3	2	2	3
	highlighting its unique characteristics compared to other filter types.	4	5	-	2	5
5A.	Compare and contrast the R-2R DAC and the weighted binary DAC in					
	terms of their working principles, applications, advantages, and					
	limitations. Explain how these two digital-to-analog conversion	4	4	3	2	4
	techniques differ in their implementation and performance					
	characteristics.					
5B.	Analyze how flash-type ADC and the successive approximation-type					
	ADC architectures differ in their operation and performance					
	characteristics, and assess the advantages and limitations of each in real-	4	4	3	2	4
	world applications such as communication systems, industrial					
	automation, and medical devices.					
5C.	State two key advantages of using the 78xx series voltage regulator and	2	3	2.	2	2
	the 79xx series voltage regulator in electronic circuits	-		_	_	-