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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING,
ANNA UNIVERSITY, CHENNAI

B.E / B. Tech (Full Time) END SEMESTER EXAMINATIONS – NOV/DEC 2024

EE 23304 Analog Electronics (Regulation 2023)

Time: 3 Hr. Answer ALL Questions Max. Marks 100

COURSE OUTCOMES:

CO1: Understand the structure and underlying semi-conductor physics concepts.

CO2: Design circuits employing electronic devices.

CO3: Understand the characteristics of OPAMP and its internal components.

CO4: Analyze, comprehend and design of analog electronic circuits involving OP-AMPs

CO5: Analyze, comprehend and design of analog electronic circuits involving timer 555

CO6: Analyze, comprehend and design of analog electronic circuits involving PLL,Volt.regulators & other special ICs.

PART- A (10 x 2 = 20 Marks)

Q.No	Quesions	Marks	CO	
1.	Distinguish between the drift current and diffusion current?	2	CO1	L2
2.	What are the characteristics of an ideal OPAMP?	2	CO3	L2
3.	Considering Silicon at T = 300 K doped with arsenic atoms at a concentration of $N_d = 10^{16}$ cm^{-3}, evaluate the drift current density. Given that μ_n= 1350 $cm^2/V\text{-}s$ and μ_p= 480 $cm^2/V\text{-}s$. The electric field intensity E = 65 V/cm	2	CO1	L4
4.	What is R-2R ladder type DAC ?	2	CO4	L2
5.	What is a 'PLL'? What are its components?	2	CO6	L1
6.	What do you understand by a 'current mirror circuit'?	2	CO2	L3
7.	In a 555 timer IC based astable multi-vibrator, normally T_{on} is greater than T_{off}. How would you achieve both of these time intervals equal?.	2	CO5	L4
8.	Draw the circuit diagram of a 2-OPAMP based Differential amplifier. How is it better than single OPAMP based Differential amplifier?	2	CO4	L3
9.	Given 10 kΩ, 20 kΩ, 30 kΩ resistors (one number each) and one 0.1 μF capacitor apart an OPAMP, draw circuit which would generate square wave. What is the frequency of the square waveform generated?	2	CO3	L4
10.	Draw the circuit diagram of an OPAMP based integrator circuit? Show that its output voltage is proportional to the integral of the input voltage?	2	CO4	L2

PART- B (5 x 13 = 65 Marks)

Q.No	Questions	Marks	CO
11.	a) For a transistorized differential amplifier, show that the output voltage v_o is proportional to the value of : $\tanh(v_d/2v_T)$, where v_d –is the differential input voltage and v_T – is the voltage equivalent of the ambient temperature?	13	CO2
	OR		
	b) i) How is 'collector –to-base bias' better than fixed bias circuit? ii) What do you understand from 'voltage divider bias' with reference to transistor biasing circuits? Considering a NPN transistor, design a voltage divider biasing circuit with v_{CE} = 5.0 V , v_E = 5.0 V and I_c = 1.8 mA. The supply voltage is 15 V. Assume that $V_{BE(ON)}$ = 0.7 V and that β = 65. (3 + 10)	13	CO2
12.	a) Show that the gain of an OPAMP based inverting amplifier is ' $-R_2/R_1$' by employing i) golden rules and ii) voltage shunt feedback concept. (5 + 8)	13	CO4

	OR		
	b) i) A first order low pass filter with a cut-off frequency of 100 kHz and a first order high pass filter with a cut-off frequency of 1 kHz are cascaded. What is the characteristics of the resulting filter? Why does the 'gain-frequency character-istics' of a CE amplifier seem similar to this? ii) For an OPAMP based non-inverting amplifier, show that the gain is '$1+R_2/R_1$' by employing the concept of 'Voltage-Series feedback'? (4 + 9)	13	CO2 CO4
13.	a) After deriving the relevant expression, design a sine-wave generator for a frequency of 1 kHz. Make suitable assumptions for the design and derivation. You may consider either Wien bridge type or RC phase shift based oscillator. Assume C = 0.1 µF.	13	CO4
	OR		
	b) Design a tri-angular waveform generator for a frequency of 500 Hz. Assume that the peak to peak output voltage required is 18 V and that the OPAMPs are powered from +/- 15 V d.c. supply. Assume C = 0.1 µF.	13	CO4
14.	a) i) What is a 'Sallen-Key filter'? Derive an expression for its gain function (V_o/V_{in}). ii) Discuss the working principle of a 'Dual - slope type ADC'? (8 + 5)	13	CO3 CO4
	OR		
	b) i) Using only one OPAMP apart from few resistors, design an adder-subtractor circuit, whose output voltage is $v_o = -1.5\ v_1 + 1.75\ v_2 + 2.0\ v_3$, where v_1 , v_2 and v_3 are the input voltages. ii) What is 'successive approximation type' ADC? Explain. (8 + 5)	13	CO3 CO4
15.	a) i) What is a VCO ? In the circuit employing VCO IC 566, when the control voltage is 75% of the supply voltage, deduce an expression for the output frequency? ii) Based on symbol, structure and biasing, distinguish between JFET and a MOSFET? (8+5)	13	CO6 CO1
	OR		
	b) i) Show how would you achieve a regulated voltage of 7.6 V from a varying voltage source of (10 to 15 V), using 7805 IC? Assume I_Q to be 8 mA. ii) What is a 'wave shaping' circuit? Bring out the significance of the diode(s) in designing its transfer characteristics? (8 + 5).	13	CO6 CO1

PART- C (1 x 15 = 15 Marks)

(Q. No 16 is Compulsory)

Q.No	Question	Marks	CO
16.	i) What is an 'instrumentation amplifier'? What are the desirable features of an instrumentation amplifier? Given three number of OPAMPs along with required resistors, how will you implement an instrumentation amplifier? Give an example application for instrumentation amplifier?	15	CO4
	ii) A 555 timer IC based astable multi-vibrator circuit is making use of R_A = 10 kΩ ,R_B = 5 kΩ and C = 0.1 µF. Evaluate T_{on} and T_{off}. Also; sketch the voltage waveform, available at pins 2 and 3 with reference to pin 1.		CO5
	iii) A part of the internal circuit of the OPAMP MC 1435 is shown →. Evaluate the output voltage of this part, considering that both non-inverting and inverting input terminals are grounded. (5 + 5 + 5)		CO3