Total number of printed pages–5

53 (EC 403) LICR

2021

LINEAR INTEGRATED CIRCUIT

Paper : EC 403

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

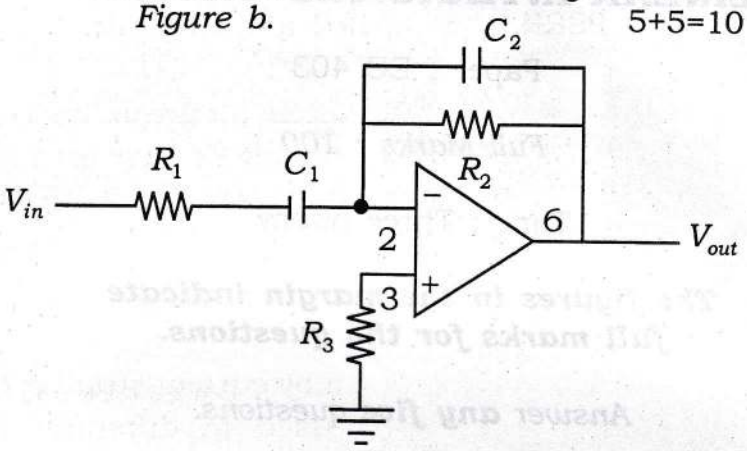
1. *(a)* Derive the expression for voltage gain (differential and common mode) in Dual input unbalanced output. 5+5=10

   (b) Why are level shifters necessary in multistage amplifiers ? Show different types of level shifter circuits. Calculate the expression for output voltage for each circuit. Explain, what will happen, if level shifters are not used in the multistage amplifiers. 2+6+2=10

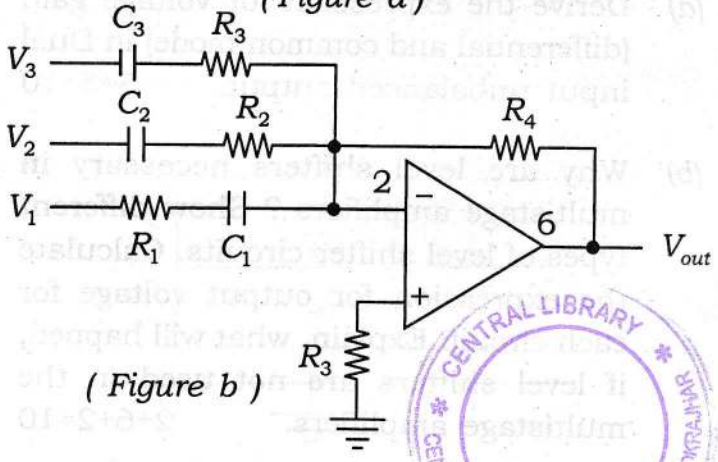
Contd.

2. *(a)* Explain the need of voltage bias generator. Show different types of circuits and calculate the expression for output voltage for each circuit. 4+6=10

(b) Derive the expression for the output voltage of the circuit in *Figure a* and *Figure b*. 5+5=10



(Figure a)



(Figure b)

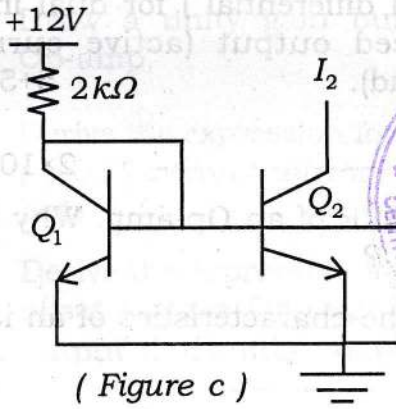
3. *(a)* Mention different types of output stages of Op-Amp, draw the circuit diagram. Mention the importance of protection circuitry in those stages. 5

(b) Define the following terms : 5

PSRR, VIO, CMRR and IOS, SR.

(c) Calculate the reference current in Q_1 (*figure c)* . If Q_2 has an Emitter area 3 times that of Q_1 and Q_3 has 2 times than the Q_1, then calculate the currents I_1 and I_3. Assume β is larger. 5

(d) What do you mean by current steering? How can it be used in differential amplifier, explain with circuit diagram? 5



(Figure c)

4. *(a)* *(i)* Differentiate between single-ended and differential signalling techniques.

(ii) Why is compensation necessary ? Mention the different frequency compensation techniques. 5+5=10

(b) Draw the Internal (simplified) schematics of μA 741 op-amp and describe function of transistor circuits used in the various stages. 10

5. *(a)* Prove that the closed-loop gain of an inverting amplifier is $(-R_f/R_1)$, whereas for a Non-inverting amplifier it is $(1+R_f/R_1)$. 5+5=10

(b) Derive the voltage gain (both common mode and differential) for dual input unbalanced output (active current mirror load). 5+5=10

6. 2×10=20

(a) Define CMRR of an Op-amp. Why is it important ?

(b) Mention the characteristics of an ideal Op-amp.

(c) Mention *two* linear applications of Op-amps.

(d) Draw the diagram of the $R-2R$ ladder type DAC. (3-*bit*)

(e) Mention the various architectures of ADC.

(f) Calculate the LSB and MSB for an 8-*bit* ADC for 0-10V range.

(g) Draw the circuit diagram of a single-input balanced output amplifier and dual-input unbalanced output differential amplifier.

(h) CMRR of an emitter coupled differential pair is controlled by which parameters ? Mention.

(i) Draw the circuit diagram of a voltage source based on a VBE multiplier.

(j) Draw a unity gain buffer using 741 Op-amp.

7. (a) Derive the expression for output current for BJT current mirror, assuming large beta. 10

(b) Derive the expression for input referred offset voltage for dual-input balanced output differential amplifier. 10