Total number of printed pages: 03

UG/5th/UECE 515C

2023

Linear Integrated Circuits and Systems

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1. a) Implement a VCCS (grounded load) with an opAmp, derive the expression for the load current. 6

   b) Draw a opAmp based circuit diagram that can take 2 inputs $v1$, $v2$ and deliver output voltage of the form of; $v_{out}= \frac{k.T}{q} ln\left(\frac{v1}{v2}\right)$. Explain the mathematical derivations leading to output voltage. 8

   c) Draw the circuit diagram of the non-saturating half wave precision rectifier, for second quadrant operations. Explain it's operation, plot: the input, output voltage and output of op-amp and the voltage transfer characteristics. 6

2. a) 6

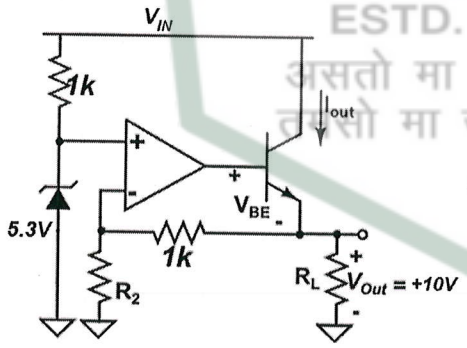


Figure 2 a

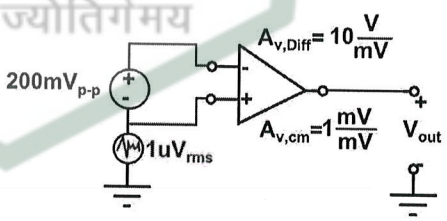
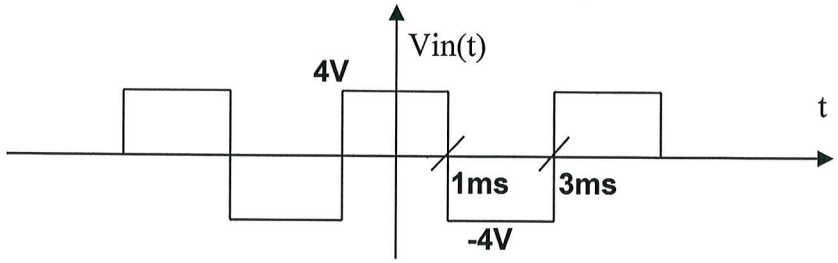


Figure 2 b

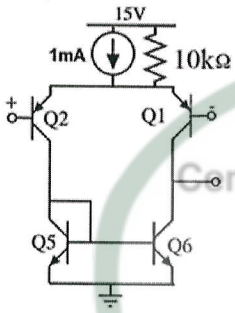
For the voltage regulator circuit shown in Fig 2. (a), the line voltage $V_{IN} = 20V \pm 20\%$ and regulated ouput voltage V_{OUT} is shown. Find the value of the resistor R2, and also the maximum power appearing across the Q1 transistor. Q1has $V_{BE} = 0.7V$ and high value of β.

   b) An op amp based circuit is shown in Fig. 2 (b). Find the expression for the output voltage of the circuit. Find the values of CMRR and express it in dB? 2+2 = 4

c) Determine the output waveform from a true integrator for the input waveform as shown, which is governed by the equation: $Vout(t) = \int_0^t Vin(t) + Vout(0)$. Assume capacitor is initially relaxed. 10



3. a) 8



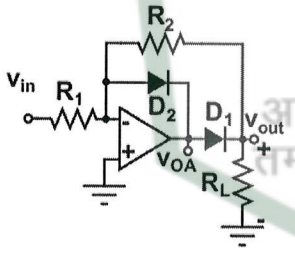
Find differential voltage gain of circuit Refer Fig. 1 (b), if parameters of transistors are as; npn transistors: Is=2 fA, βF =200, VA=100V & pnp transistors: Is=1fA, βF =50, VA=50 V.

b) 2X2 = 4

i) Draw the output waveform for a differentiator [R1=5kΩ, C1=10nF], if the input is a 3V peak, 4 kHz triangle wave?

ii) Draw the frequency response for the circuit.

c) 4+2+2

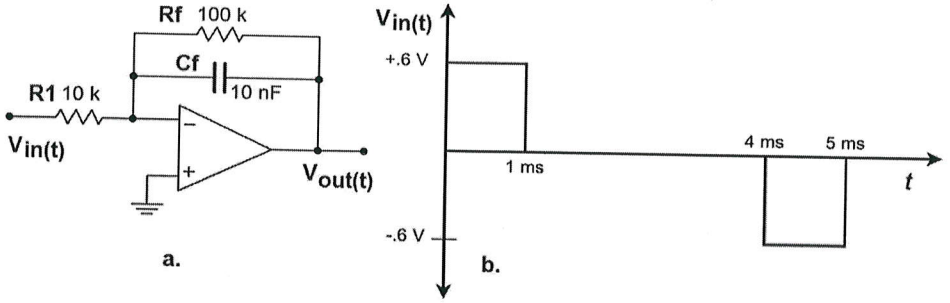


Explain the operation of the circuit by taking a sine wave input, draw the waveforms for $V_{in}(t)$, $V_{Out}(t)$, $V_{OA}(t)$. Plot the voltage transfer characteristics.

4. a) Describe the operation of saturated precision rectifier for first quadrant operation with proper circuit diagram and plot the voltage transfer characteristics. 2+4 =6

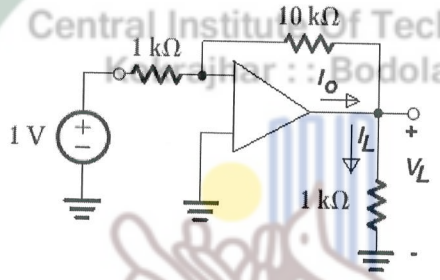
b) Draw the design flow of electronic system. 6

c) Derive the expression for the transfer function, plot the gain response vs frequency and sketch the output waveform for the input shown. [4+4]



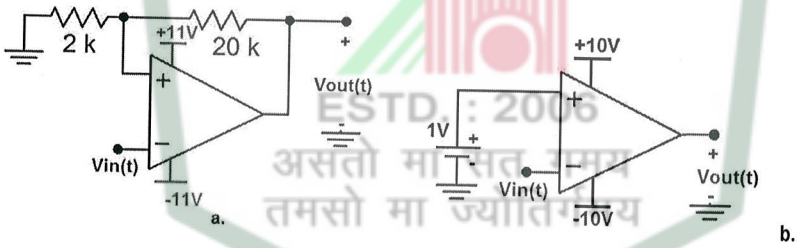
5. a) What do you mean by offset voltage? Mention the causes of offset in op-amp. Find the expressions for the input offset voltage of a differential pair. 2+2+6

b) Find the values of the output voltage, Io, IL, Rin, Rout for the circuit 10



shown here.

6. a) Draw the time domain waveforms: $v_n(t), v_P(t), v_{out}(t)$, of the circuit diagram shown below Fig. (a) and plot the voltage transfer characteristics, when it is driven by an input: $Vin(t) = 4V\cos 2000\pi t$. 8



b) Draw the circuit diagram of a VCVS with infinite input impedance. Find the expression for the output of circuit, if the input analog signal is $Vin(t) = 3\cos 50\pi t + 1.5\sin 300\pi t - 3.5\cos 100\pi t$ and R_f =3kΩ, R_1=1kΩ. 2+6

c) Draw the output of the circuit above Fig (b) and find the duty cycle of the output, while input is 5Vpeak 1kHz *sine* wave. 4

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