

CBCS SCHEME

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18EC42

Fourth Semester B.E. Degree Examination, June/July 2023 Analog Circuits

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. What is meant by biasing of a transistor? Explain the classical bias arrangement for BJT and derive the expressions for collector current and collector-emitter voltage. (08 Marks)
- b. Design a collector-base feedback bias circuit to obtain $I_E = 1 \text{ mA}$ and $V_{CE} = 2.3 \text{ V}$, assuming $V_{CC} = 10 \text{ V}$, $\beta = 100$ and $V_{BE} = 0.7 \text{ V}$. (06 Marks)
- c. For the conceptual amplifier circuit shown in Fig. Q1 (c), draw the hybrid - π model. Suppose if $I_C = 1 \text{ mA}$, $\beta = 100$ and $V_T = 26 \text{ mV}$, calculate the input resistance at the base and voltage gain.

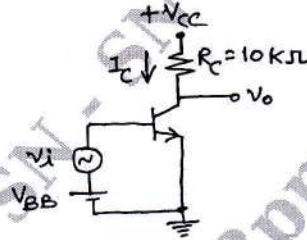


Fig. Q1 (c)

(06 Marks)

OR

- 2 a. In the classical MOSFET bias arrangement, explain how the source resistor provides negative feedback action. How does this stabilize the variations in the bias current? (04 Marks)
- b. Design a voltage divider biasing arrangement to establish a drain current of 2 mA. The MOSFET has $V_t = 1 \text{ V}$, $K'_n W/L = 1 \text{ mA/V}^2$. Assume $V_{DD} = 12 \text{ V}$, $V_{DS} = 5 \text{ V}$ and $V_S = 2 \text{ V}$. (10 Marks)
- c. Starting from the conceptual MOSFET amplifier circuit, draw the small-signal model of MOSFET with $\lambda \neq 0$ and derive the expressions for g_m and A_v . (06 Marks)

Module-2

- 3 a. With a neat circuit diagram and ac equivalent circuit, derive the expressions for R_{in} , R_o , A_{vo} and A_v in a common-source MOSFET amplifier with un-bypassed source resistor. (07 Marks)
- b. For the common drain circuit shown in Fig. Q3 (b), if $I_D = 8 \text{ mA}$, $V_{OV} = 1 \text{ V}$ and $\lambda = 0$, determine the values of R_{in} , R_o , A_{v0} and A_v . Draw the ac equivalent circuit.

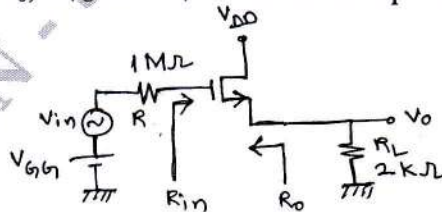


Fig. Q3 (b)

(07 Marks)

- c. For n-channel MOSFET with $t_{ox} = 10 \text{ nm}$, $W = 10 \text{ } \mu\text{m}$, $L = 1 \text{ } \mu\text{m}$, $L_{OV} = 0.05 \text{ } \mu\text{m}$, $C_{Sbo} = C_{dbo} = 10 \text{ fF}$, $V_O = 0.6 \text{ V}$, $V_{SB} = 1 \text{ V}$ and $V_{DS} = 2 \text{ V}$, calculate C_{OX} , C_{OV} , C_{gs} , C_{gd} , C_{sb} and C_{db} in saturation region. Assume $\epsilon_{OX} = 3.45 \times 10^{-11} \text{ F/m}$. (06 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

OR

- 4 a. Draw and explain the high frequency response of a common-source amplifier. Derive the expression for its upper cut off frequency. (10 Marks)
- b. Design an RC phase-shift oscillator using MOSFET having $g_m = 5000 \mu S$, $r_d = 40 K\Omega$ and feedback circuit resistor $R = 10 K\Omega$. Select the value of capacitor to get 1 kHz oscillations. Find R_D to get a gain of 40. (06 Marks)
- c. Explain the series and parallel resonance actions with equivalent circuits and expressions of a crystal oscillator. (04 Marks)

Module-3

- 5 a. Draw the four basic negative feedback topologies and explain each in brief. (12 Marks)
- b. Determine the voltage gain, input resistance and output resistance with feedback for a voltage series feedback amplifier having $A = 10,000$, $R_i = 10 K\Omega$ and $R_o = 20 K\Omega$ if $\beta = 0.5$. (04 Marks)
- c. By deriving the relevant expressions, prove that negative feedback de-sensitizes the gain and increases the bandwidth. (04 Marks)

OR

- 6 a. What is the function of output stage? Discuss the classification of output stage based on the collector current. (10 Marks)
- b. A transformer coupled class-A amplifier draws a current of 200 mA from the collector supply voltage of 10 V, when the signal is not applied. If the load across the secondary is 10Ω and the turns ratio is 5 : 1, determine (i) max output power (ii) max collector efficiency. (04 Marks)
- c. Explain the class-B output stage. Prove that the maximum conversion efficiency of class-B transformer coupled amplifier is 78.5%. (06 Marks)

Module-4

- 7 a. With circuit diagram and waveform, explain the inverting amplifier using op-amp. Derive the expressions for the exact and ideal closed-loop voltage gains. (08 Marks)
- b. An op-amp having $A = 2 \times 10^5$, $R_i = 2 M\Omega$, $R_o = 75 \Omega$, $f_o = 5 \text{ Hz}$ is connected as non-inverting amplifier with $R_f = 47 K\Omega$ and $R_1 = 2.2 K\Omega$. Compute the values of A_f , R_{if} , R_{of} and f_f . (08 Marks)
- c. Give two reasons why an open loop op-amp is not suitable for linear applications. How is this overcome by using negative feedback? (04 Marks)

OR

- 8 a. With circuit diagram, explain the working of inverting scaling amplifier, averaging circuit and summing amplifier. Derive the expressions for output voltage. (07 Marks)
- b. Explain the operation of instrumentation amplifier using transducer bridge, with diagram and relevant expressions. (08 Marks)
- c. Draw and explain the basic non-inverting comparator circuit with waveform. (05 Marks)

Module-5

- 9 a. Explain the working of R-2R DAC with circuit diagram, graph and expressions. (06 Marks)
- b. For a 4-bit binary weighted resistor DAC with $R = 10 K\Omega$, $R_f = 1.2 K\Omega$ and $V_R = 5 \text{ V}$, determine the step size and full scale output voltage. (04 Marks)
- c. With circuit diagram and waveform, explain the working of small-signal half wave rectifier using (i) one diode, (ii) two diodes. What is the use of the second diode? (10 Marks)

OR

- 10 a. Define the terms pass-band, stop-band, cut-off frequency and gain roll-off rate with references to the filters. What is the relation between the order and gain roll-off rate? (05 Marks)
- b. Design a second order Butterworth high-pass filter to have a cut-off frequency of 1.2 kHz, choosing $C_1 = C_2 = 4.7 \text{ nF}$. Draw the circuit and plot the frequency response. (10 Marks)
- c. An astable multivibrator circuit using 555 timer has $R_A = 2.2 \text{ K}\Omega$, $R_B = 3.9 \text{ K}\Omega$ and $C = 0.1 \text{ }\mu\text{F}$. Determine the frequency and duty cycle of the output waveform. Draw the circuit diagram. (05 Marks)
