CBCS SCHEME

USN

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 $I_E = 1$ mA and $V_{CE} = 2.3$ V, assuming $V_{CC} = 10$ V, $\beta = 100$ and $V_{BE} = 0.7$ V. **(06 Marks)**

c. For the conceptual amplifier circuit shown in Fig. Q1 (c), draw the hybrid - π model. Suppose if $I_C = 1$ mA, $\beta = 100$ and $V_T = 26$ mV, calculate the input resistance at the base and voltage gain.

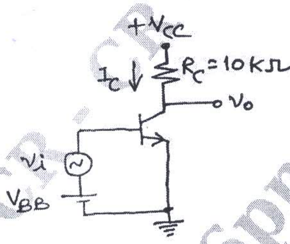

Fig. Q1 (c) **(06 Marks)**

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 $V_t = 1$ V, K_n' W/L = 1 mA/V^2. Assume $V_{DD} = 12$ V, $V_{DS} = 5$ V and $V_S = 2$ 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 $I_D = 8$ mA, $V_{OV} = 1$ V and $\lambda = 0$, determine the values of R_{in}, R_0, A_{VO} and A_V. Draw the ac equivalent circuit.

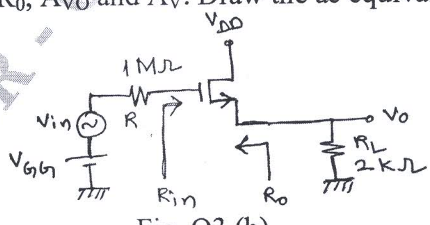

Fig. Q3 (b) **(07 Marks)**

c. For n-channel MOSFET with $t_{OX} = 10$ nm, $W = 10$ μm, $L = 1$ μm, $L_{OV} = 0.05$ πm, $C_{Sbo} = C_{dbo} = 10$ fF, $V_O = 0.6$ V, $V_{SB} = 1$ V and $V_{DS} = 2$ V, calculate C_{OX}, C_{OV}, C_{gs}, C_{gd}, C_{sb} and C_{db} in saturation region. Assume $\varepsilon_{OX} = 3.45\times10^{-11}$ 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 10 Ω 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 $A = 2\times10^5$, $R_i = 2\ M\Omega$, $R_O = 75\ \Omega$, $f_O = 5$ 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)**

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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 $V_R = 5$ 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 $C_1 = C_2 = 4.7$ nF. Draw the circuit and plot the frequency response. **(10 Marks)**

c. An astable multivibrator circuit using 555 timer has $R_A = 2.2$ KΩ, $R_B = 3.9$ KΩ and C = 0.1 μF. Determine the frequency and duty cycle of the output waveform. Draw the circuit diagram. **(05 Marks)**

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