CBCS SCHEME

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18EC42

Fourth Semester B.E./B.Tech.Degree Examination, Dec.2025/Jan.2026
Analog Circuits

Time: 3 hrs. Max. Marks: 100

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

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.

Module-1

1 a. Design a voltage divider bias circuit to establish I_C = 1 mA and V_{CE} = 5 V using a BJT having β = 100 and a power supply V_{CC} = +12 V. Select $V_B = V_{CC}/3$ and the voltage divider current $I_2 = I_E/10$. **(08 Marks)**

b. A collector-to-base feedback bias circuit uses R_C = 7.5 KΩ, R_B = 160 KΩ and V_{CC} = 10 V. Draw the circuit and determine the values of I_C and V_{CE} assuming β = 80. **(06 Marks)**

c. For the MOSFET amplifier circuit shown in Fig.Q.1(c), draw the small signal equivalent circuit if V_t = 1.5 V, V_A = 50 V, $K_n' W/L = 0.25 mA/V^2$. Calculate g_m and r_o.

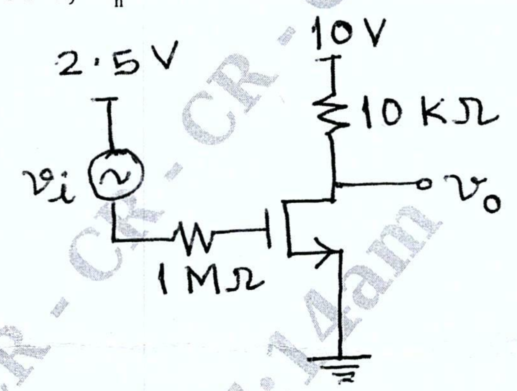

Fig.Q.1(c)

(06 Marks)

OR

2 a. For the circuit shown in Fig.Q.2(a), $R_1 = R_2$ = 22 MΩ, $R_D = R_S$ = 1 KΩ, V_{DD} = 10 V, V_t = 1.0 V, $K_n' W/L = 2 mA/V^2$. Calculate the values of I_D and V_{DS}.

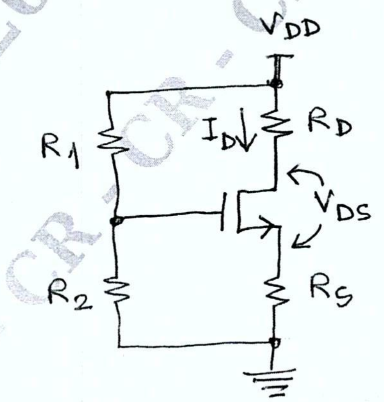

Fig.Q.2(a)

(08 Marks)

b. Design a drain-to-gate feedback bias circuit to get I_D = 0.5 mA, using a MOSFET having V_t = 1 V and $K_n' W/L = 1 mA/V^2$ assuming V_{DD} = 5 V. **(06 Marks)**

c. For the BJT amplifier circuit shown in Fig.Q.2(c), determine the overall voltage gain v_o/v_i assuming β = 100, V_T = 26 mV. **(06 Marks)**

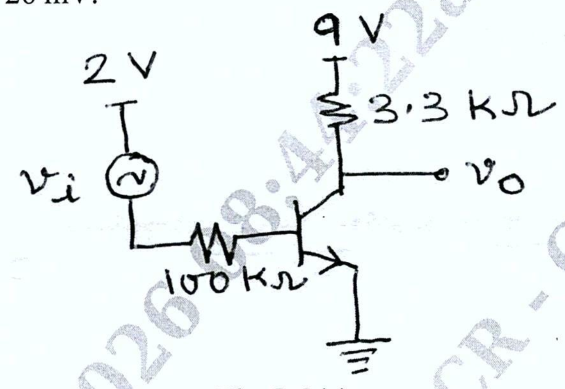

Fig.Q.2(c)

Module-2

3 a. A common-source amplifier has I_D = 0.25 mA, V_{ov} = 0.25 V and R_D = 20 KΩ. The amplifier is fed from a signal source having R_{sig} = 100 K Ω and it is connected to a load resistance R_L = 20 KΩ. Draw the circuit and determine the overall gain of the amplifier. Assume R_G = 10 MΩ. **(08 Marks)**

b. An n-channel MOSFET has t_{ox} = 10 nm. W = 10μm, L = 1 μm, L_{ov} = 0.05 μm, $C_{sbo} = C_{dbo}$ = 10 fF. Calculate the capacitances C_{ox}, C_{ov}, C_{gs} and C_{gd} when the device is in saturation. Assume $\epsilon_{ox} = 34.5 \times 10^{-12}$ F/m. **(06 Marks)**

c. Draw the block diagram of a sinusoidal oscillator and explain how the oscillations are produced and sustained. **(06 Marks)**

OR

4 a. For the CS amplifier shown in Fig.Q.4(a), determine the max gain in dB, lower and upper cut-off frequencies and bandwidth, assuming r_o = 150 KΩ, g_m = 1 m A/V, C_{gs} = 1 pF and C_{gd} = 0.4 pF.

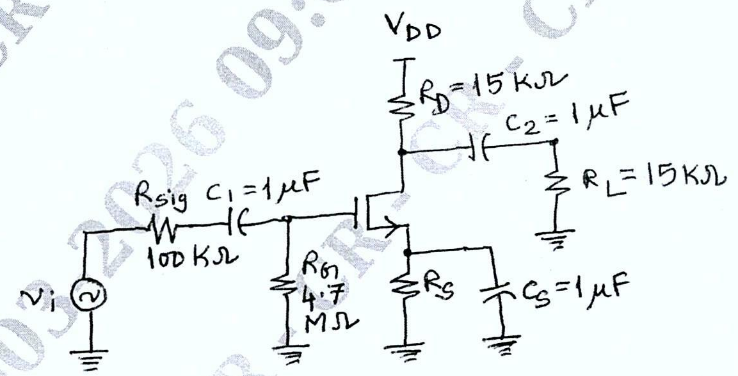

Fig.Q.4(a)

(08 Marks)

b. A Colpitt's oscillator has C_1 = 100 pF, C_2 = 7500 pF and a variable inductor. Determine the range of inductor values required to vary the frequency from 950 kHz to 2050 kHz. **(06 Marks)**

c. Draw the high-frequency model of MOSFET and explain. Simplify it and obtain the model used for manual analysis. **(06 Marks)**

Module-3

5 a. Derive the equations to prove that negative feedback results in de-sensitization of gain and increase in bandwidth. **(08 Marks)**

b. A trans-conductance amplifier employing appropriate feedback topology has a feedback factor $\beta = 0.11$. If the gain of the basic amplifier is 10^5 A/V, input resistance is 1 MΩ and output resistance is 100 Ω, calculate the input and output resistances with feedback. **(06 Marks)**

c. What is meant by cross-over distortion with reference to the transfer characteristics of class-B output stage? How can it be reduced? **(06 Marks)**

OR

6 a. Explain the working of class-B transformer-coupled amplifier with circuit diagram and waveforms. Show that the maximum efficiency is 78.5%. **(08 Marks)**

b. With neat diagrams, explain the working of class-C output stage. Bring out its uses and advantages compared to the class-A stage. **(06 Marks)**

c. Draw the block schematic of shunt-shunt feedback amplifier and derive the equation for output resistance with feedback. **(06 Marks)**

Module-4

7 a. Draw the circuit of non-inverting amplifier having R_1 = 1.6 KΩ and R_F = 5.1 KΩ. The op-amp has open-loop gain of 2,00,000, R_i = 2 MΩ, R_o = 75 Ω, f_o = 5 Hz. Compute the overall gain with feedback, R_{if}, R_{of} and bandwidth. **(08 Marks)**

b. A scaling amplifier has to be designed to get output voltage $V_o = -(10V_1 + 0.5V_2 + 0.1V_3)$ where V_1, V_2 and V_3 are input voltages. Select R_f = 5 KΩ and draw the final circuit diagram. **(06 Marks)**

c. A sinusoidal voltage having 500 mV peak-to-peak is connected to the input of the circuit shown in Fig.Q.7(c). If the saturation voltages are ±13 V, determine the threshold voltages and draw the waveform. **(06 Marks)**

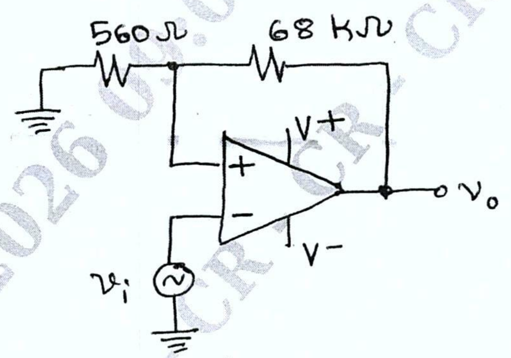

Fig.Q.7(c)

OR

8 a. What is an instrumentation amplifier? What are its applications? With a neat circuit diagram, explain the working of instrumentation amplifier using transducer bridge. **(08 Marks)**

b. Draw the circuit of non-inverting comparator with a negative reference voltage. Sketch the input and output waveforms if v_{in} = 5 V peak-to-peak sinusoidal at 1 kHz and V_{ref} = -1.5 V. **(06 Marks)**

c. Show how an op-amp can be connected to operate as averaging amplifier. Derive the expression for output voltage. **(06 Marks)**

Module-5

9 a. Explain the operation of R – 2R DAC and derive the expression for output voltage. Suppose if R = 10 KΩ, R_f = 20 K Ω and V_{Ref} = 5V, determine the output voltage for the inputs $b_3b_2b_1b_0$ = 1010. **(08 Marks)**

b. Draw the block diagram of 4-bit successive approximation ADC. Illustrate the conversion of analog input V_{in} = 9.2 V to an equivalent 4-bit binary, assuming full-scale output for 15 V. **(06 Marks)**

c. Design an astable multivibrator circuit using 555-timer, to get an output frequency of 5 kHz with 60% duty cycle, choosing C = 0.068 μF. **(06 Marks)**

OR

10 a. Draw the circuit diagram and frequency response of a first order high-pass filter and derive the expression for the magnitude of gain. **(08 Marks)**

b. Design a second order low-pass filter to have a cut-off frequency of 2 kHz and passband gain of 1.586. Choose C = 0.01 μF. **(06 Marks)**

c. Show how a precision inverting half-wave rectifier can be constructed using op-amp and two diodes. Explain the working. **(06 Marks)**

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