Reg. No: 24BEC0294

Y/K/TY

Final Assessment Test – November 2025

VIT Vellore Institute of Technology

Course: BECE206L - Analog Circuits | Slot: D1+TD1

Class NBR(s): 0476 / 0480 / 0482 / 2657 / 2660 / 2667 | Max. Marks: 100

Time: Three Hours

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Design the BJT and MOSFET amplifier circuits using suitable biasing techniques and analyze their frequency response characteristics.
CO2	Distinguish among different classes of MOSFET power amplifiers and employ them for various applications.
CO3	Analyze the different active biasing techniques and MOSFET-based differential amplifiers and their frequency response characteristics.
CO4	Comprehend the ideal characteristics of OP-AMPs and design the fundamental circuits based on OP-AMPs.
CO5	Design and analyze different waveform generator circuits using operational amplifiers.
CO6	Analyze the basic concept of filter circuits, multivibrators using 555 timer, and data converter circuits.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Consider an NPN transistor in the common-emitter configuration with the voltage divider biasing using the following values: $V_{CC} = 12\ \text{V},\ R_C = 2.0\ \text{k}\Omega,$ $R_E = 1.0\ \text{k}\Omega, R_1 = 47\ \text{k}\Omega\ (top),\ R_2 = 13\ \text{k}\Omega\ (bottom), V_{BE} = 0.7\ \text{V},$ $\beta = 100.$ **CO1 BL3**

   (i) Find Thevenin's equivalent voltage and resistance (V_{Th}, R_{Th}).

   (ii) Calculate the Q-point (I_B, I_C, I_E, V_{CE}).

   (iii) Prove that approximate analysis cannot be applied to this problem.

2. For the common source amplifier circuit shown in Fig.1., draw the small signal equivalent circuit and determine the small signal parameters and mid-band voltage gain. Given, $V_t = 1.5\ V, K_n = 0.25 mA/V^2, V_A = 50\ V,$ $I_D = 1.06\ mA, V_{GS} = V_{DS} = 4.4\ V.$ **CO1 BL3**

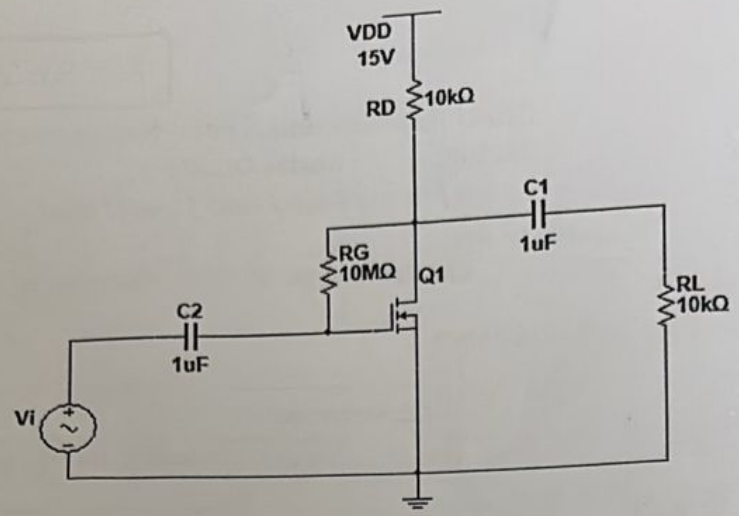

Fig.1

3.(a) Consider the Class A output stage circuit shown in Fig.2. CO2

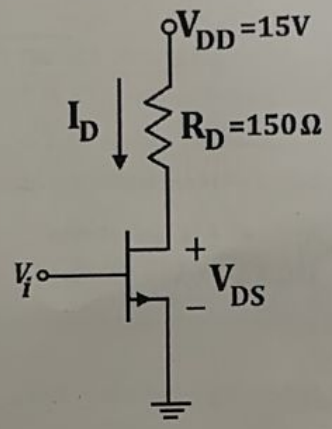

Fig.2

If the instantaneous output voltage swing is limited within the range of $2.4\ V \leq V_{DS} \leq 7V$.

(i) Find the quiescent current (I_{DQ}), voltage (V_{DsQ}) and peak amplitude of the sinusoidal output voltage.

(ii) Determine the power delivered to the load (P_L) and power supplied to the circuit (P_S).

(iii) Calculate the power conversion efficiency.

OR

3.(b) Derive the expression for the power conversion efficiency of a Class-B MOSFET power amplifier in terms of the output voltage and supply voltage. Calculate its power conversion efficiency and power dissipation in each transistor when the amplifier operates with a supply voltage of ±20 V and delivers 10 W of power to an 8 Ω speaker. CO

4. For the MOSFET differential pair with $V_{DD} = V_{SS} = 10V$, $K_n'(W/L) = 4mA/V^2$, $V_{th} = 0.8V$, $I = 1mA, R_D = 10k\Omega$ and neglect channel-length modulation. CO3 BL

(i) Find the value of V_{id} that causes transistor Q_1 to conduct the entire current I and the corresponding values of V_{D1}, and V_{D2}

(ii) Find the value of V_{id} that causes transistor Q_2 to conduct the entire current I and the corresponding values of V_{D1}, and V_{D2}.

(iii) The corresponding range of differential output voltage.

5. a) Determine the amount of current from point **A** to point **B** in the Fig. 3, and the output voltage of the operational amplifier. [6] CO4 B

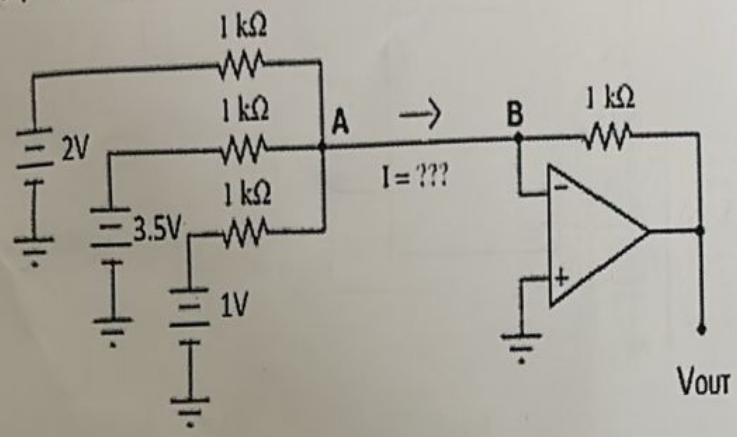

Fig.3

b) What is thermal drift in the context of DC characteristics of an Op-Amp? Mention two ways it can impact circuit performance. [4]

6. Design a three-op-amp instrumentation amplifier to provide a differential gain of 50. The amplifier is used to measure the voltage difference between two sensor outputs, where $V_1 = 12.05mV$ and $V_2 = 8.05mV$. Assume all resistors R_1=R_2=R_3=R_4=100 kΩ. CO4

(i) Determine the value of the gain resistor R_G.

(ii) Calculate the output voltage V_o.

(iii) Verify the common-mode rejection if both inputs increase by 1 mV simultaneously.

7. Derive the expression for the output frequency of a Wien bridge oscillator. Then, design a Wien bridge oscillator circuit (with a neat circuit diagram) to produce an output frequency of 10 kHz, assuming C = 0.1 μF. CO5

8.(a) Design a second order Butterworth low pass filter with a cut off frequency of 3 kHz and plot its frequency response. CO6

OR

8.(b) Design a second order Butterworth high pass filter with a cut off frequency of 4 kHz and plot its frequency response.

9. Explain the operation of a 3- bit R-2R ladder DAC with a neat circuit diagram and transfer characteristics.

10. Consider the astable multivibrator circuit using the IC 555 timer given in the following Fig.4. For R_A= 6.8 kΩ, R_B= 3.3 kΩ and C = 0.1 μF, calculate a) t_{HIGH}, b) t_{LOW} c) free running frequency d) duty cycle.

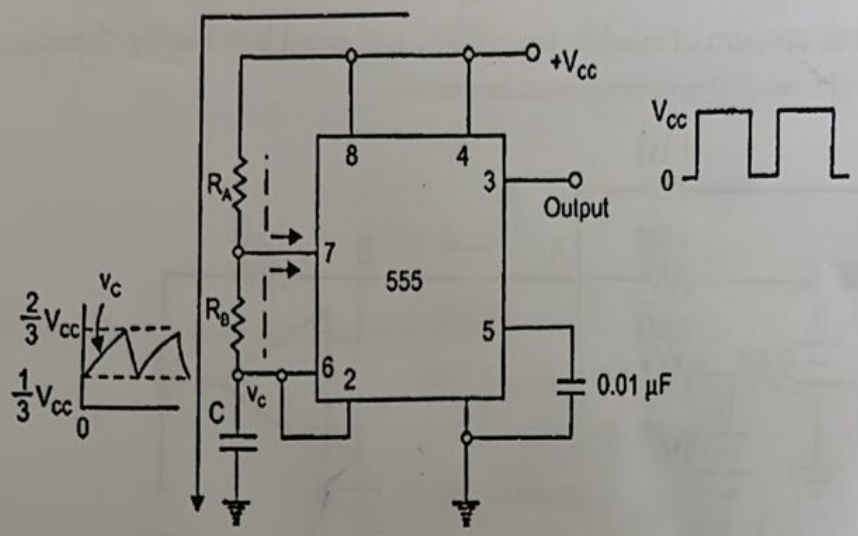

Fig.4

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