SOLN

Name: Roll No. Section:

Midsem Exam Room No. : Seat No.:

MS101 – Makerspace
2022-23/I (Autumn Semester)

Dec 20, 2022 (Tue) **Midsemester Examination (EE)** **Time: 40 min**

Marks: 30

1. This **Question-cum-Answer Booklet** has 4 pages.
2. Write your **answers only in the space provided for answers**. Answers written at any other place will not be checked.
3. No explanations/clarifications will be given to any of the questions.
4. You must show steps of your answers/calculations inside the booklet in the space provided. You may use the additional "Supplementary Sheet" given to you for any extra work. You have to compulsorily attach the Supplementary Sheet along with the Booklet.
5. No negative marks for wrong answers.

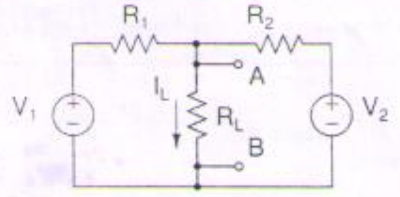
1. Out of the following devices, **choose ALL the ones** which are single-port devices
   a. Inductor
   b. Transformer
   c. Diode
   d. Bipolar Junction Transistor
   e. Capacitor

Marks: 1

Answer(s):
(a)
(c)
(e)

Deduct 0.5 for every wrong option (2 options correct → 0.5 marks)

2. In the resistive network shown below, $V_1 = 10$ V, $V_2 = 15$ V, $R_1 = 2$ kΩ and $R_2 = 3$ kΩ.
Apply Thevenin's theorem across nodes A and B, and calculate current I_L **in mA** for $R_L = 2.8$ kΩ and $R_L = 1.3$ kΩ.
Show your steps in the space below.



Marks: 4 (=1+1+1+1)

Answers:

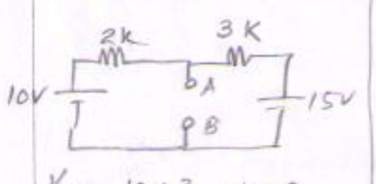
$V_{Th} =$ 12 V

$R_{Th} =$ 1.2 kΩ

I_L (for $R_L = 2.8$ kΩ) = 3 mA

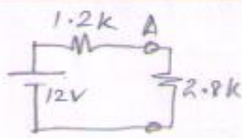
I_L (for $R_L = 1.3$ kΩ) = 4.8 mA

Write Steps below:

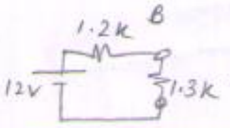


$V_{Th} = \frac{10 \times 3}{5} + \frac{15 \times 2}{5}$
$= 6 + 6 = 12V$

$R_{Th} = \frac{2 \times 3}{5} = 1.2K$

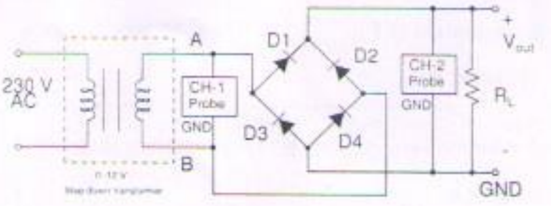


$I_L = \frac{12}{4k} = 3\,mA$



$I_L = \frac{12}{2.5k} = 4.8\,mA$

3. The circuit diagram of the bridge rectifier used in Expt 2 is shown below. One MS101 student wanted to see both V_{AB} and V_{out} of the bridge rectifier circuit on the DSO. Hence, he connected CH-1 of the DSO through the DSO probe to the transformer secondary terminals (see the figure). He then connected CH-2 of the DSO through another DSO probe to V_{out} (see the figure).

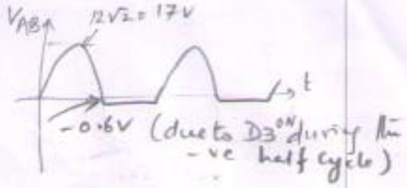


a) Sketch the V_{AB} and V_{out} waveforms that he would see on CH-1 and CH-2 channels (with the connections as described).

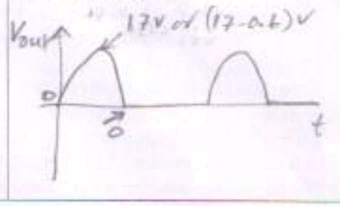
Marks: 2x2 = 4

Answers

V_{AB} waveform



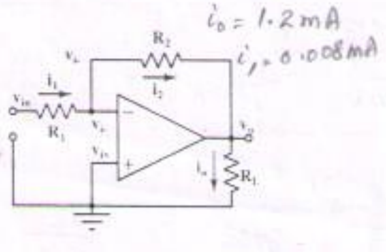
a) V_{out} waveform



4. Choose the correct option by indicating the letter corresponding to the correct statement.	Marks: 1
An ideal op amp has finite output voltage with zero differential voltage because it has: (A) infinite differential voltage gain. (B) infinite input resistances for the two inputs. (C) infinite common-mode rejection ratio. (D) dual supply voltages.	Answer: A

For the following two questions, state whether the statement is '**True**' or '**False**'.	Marks: 2x1 = 2
5. Noise is always a random waveform.	Answer: False
6. The two supply voltages in a dual-supply amplifier have to be equal.	Answer: False

7. The circuit in the figure has a load resistance R_L connected between the amplifier output and ground, and the output current i_o flows into this load. R_1 = 15 kΩ, R_2 = 150 kΩ, R_L = 1 kΩ



Marks: 4x1 = 4

(A) For v_{in} = + 120 mV, i_2 = 0.008 mA.

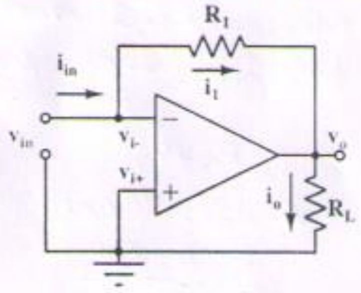
(B) For v_{in} = −120 mV, v_o = 1200 mV.

(C) Current gain A_i = 150.

(D) Power gain A_p = 1500

Explanation for Question 3: Because of the GND connection through the CH-1 Probe, D4 gets shorted. Hence, in the positive half-cycle only D1 conducts. In the negative half-cycle, D3 would get forward-biased and gets connected across the secondary winding. Hence, V_{out} waveform will be a half-wave rectified waveform (corresponding to the conduction of D1). V_{AB} waveform will be same as of the transformer secondary for the +ve half-cyle. However, for the -ve half-cycle, V_{AB} will be at a negative voltage, say -0.6 V, corresponding to the forward drop of diode D3.

8. The circuit in the figure has a load resistance R_L connected between the amplifier output and ground. The output current i_o flows into this load. $R_1 = R_L = 800\ \Omega$.



Marks: 2x1 = 2

For this circuit,

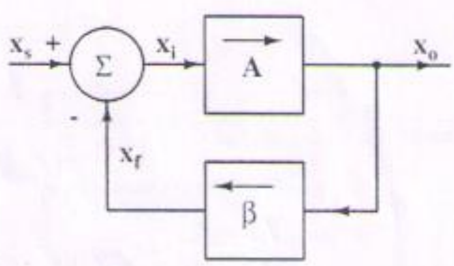
(A) R_{in} = 0 kΩ.

(B) For i_{in} = 2 mA, i_o = −2mA mA.

Deduct 0.5 marks for wrong sign.

$V_o = -2mA \times 0.8k = -1.6V$

9. In the general feedback structure in the figure,



Marks: 4 (= 1+ 1 +1 +1)

(A) $x_o = x_s \cdot \left(\frac{A}{1+A\beta}\right)$
(write x_o in terms of x_s, A and β)

(B) Loop-gain = $A\beta$

(C) Closed-loop gain $A_f = \frac{A}{1+A\beta}$

(D) For $A \gg 1/\beta$, $A_f = \frac{1}{\beta}$

For the following two questions, choose the correct option by indicating the letter corresponding to the correct statement. — Marks : 1

10. What will happen if the power terminals of a DC motor are reversed?
(A) Very high current will flow through the motor and possibly damage the motor
(B) DC motor has 'reverse polarity protection' and hence no damage will be done, but the motor will not start.
(C) The motor will rotate in the opposite direction.
(D) The motor will stall (will not be able to move).

Answer: (C)

Marks : 1

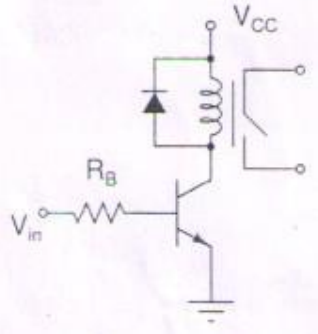
11. While representing the transistor ac amplifier operation on the VCE-IC graph, the operating point moves along the.........
(A) 'V_{CE}=constant' line
(B) Saturation region line
(C) 'I_C=constant' line
(D) Load line

Answer: (D)

12. A BJT based relay circuit is shown below which uses an *npn* transistor. The relay requires a minimum of 20 mA to operate.

(a) Calculate the minimum value of V_{in} required to operate the relay.

Given: $V_{CC} = 12$ V, $R_B = 10$ kΩ, $V_{BE} = 0.7$ V, $\beta = 50$, $R_{Coil} = 400$ Ω, $V_{CEsat} = 0.2$ V
(R_{Coil} is the resistance of the relay coil)



Marks: 3

Space for steps and answer

Min relay current req'd = 20mA = I_C

Correspond. $I_B = \frac{I_C}{\beta} = \frac{20mA}{50} = 0.4mA$

$V_{in} = I_B R_B + V_{BE}$

(partial credit) 1

$\therefore$ Min. V_{in} req'd = $(0.4mA)\,10k + 0.7$

$= \underline{\underline{4.7V}}$

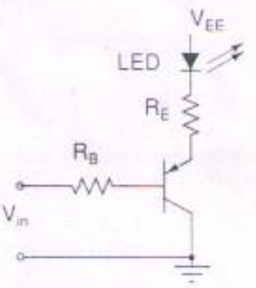
(a) Minimum value of V_{in} required = 4.7 V

13. The switching circuit shown below uses a *pnp* transistor. Calculate the current through the LED **in mA** when:

i) $V_{in} = 0$ V and ii) $V_{in} = V_{EE}$.

You may neglect the base current.

Given: $V_{EE} = 12$ V, $V_{BE} = -0.7$ V, $R_B = 20$ kΩ, $R_E = 2$ kΩ, $V_{LED} = 2$ V
(V_{LED} is the voltage drop across the LED when it is ON)



Marks: 3

Show steps of your calculation:

$V_{in} = 0$

BJT is Active

$\therefore V_E = 0 - V_{BE} = 0.7V$

$\therefore I_{LED} = \frac{V_{EE} - 0.7 - 2}{R_E}$

$= \frac{12 - 2.7}{2k} = 4.65mA$

1 Partial credit

ii) BJT is OFF as with $V_{in} = V_{EE}$, BE jn is reverse biased

Answers:

(i) 4.65mA

(ii) 0