Name: **SOLUTION** **Roll No.** **Batch:**

EE Quiz Room No. : **Seat No.:**

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MS101 – Makerspace
2022-23/II (Spring Semester)

Apr 08, 2023 (Sat) **EE Quiz - 1** **Time: 45 min**

Marks: 40

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. You may use the page margins for rough work.
3. No explanations/clarifications will be given to any of the questions.
4. No negative marks for wrong answers, however steps are required for all numerical answers.

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1. Out of the following, **choose ALL** the two-port devices.
   - Inductor
   - Transformer
   - Zener diode
   - BJT

Marks: 2 (=1+1)

Answer: **Transformer, BJT**
(For each wrong answer deduct 1 mark; in case of two errors, zero marks).

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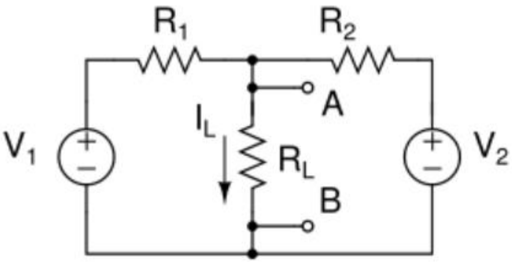
2. A resistive network is shown below.
$R_1 = R_2 = R_L = 1200\ \Omega$.

A) If $V_1 = 9$ V, and $V_2 = 0$ V, calculate V_{AB} in volts and $\mathbf{I_L}$ **in mA.**
B) If $V_1 = 0$ V, and $V_2 = 12$ V, calculate V_{AB} in volts and $\mathbf{I_L}$ **in mA.**
C) If $V_1 = 9$ V, and $V_2 = 12$ V, calculate $\mathbf{I_L}$ **in mA.**

Show your steps in the space below.



Marks: 5 (=2+2+1)

Answers:

A) V_{AB} = **3 V**

I_L = **2.5 mA**

B) V_{AB} = **4 V**

I_L = **3.33 mA**

C) I_L = **5.83 mA**

(For A and B, 1 mark each will be deducted if no steps are shown)

Show steps here:

A) $V_1 = 9$ V, and $V_2 = 0$ V: $V_{AB} = 9 \times ([1200 \| 1200]/(1200 + [1200 \| 1200]) = 9 \times 600/1800 = \mathbf{3\ V}$
$I_L = 3/1200 = 0.0025$ A, i.e. $\mathbf{I_L = 2.5\ mA}$

B) $V_1 = 0$ V, and $V_2 = 12$ V: $V_{AB} = 12 \times ([1200 \| 1200]/(1200 + [1200 \| 1200]) = 12 \times 600/1800 = \mathbf{4\ V}$
$I_L = 4/1200 = 0.00333$ A, i.e. $\mathbf{I_L = 3.33\ mA}$

C) If $V_1 = 9$ V, and $V_2 = 12$ V, $\mathbf{I_L} = 2.5 + 3.33$ mA = **5.83 mA**

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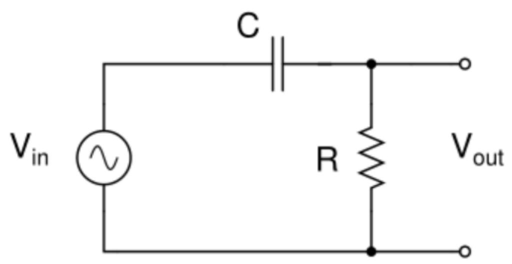
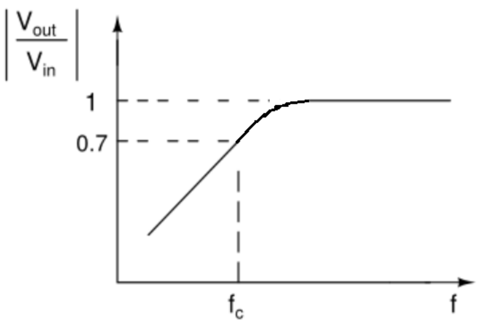
3. In a BJT circuit, the collector current $I_C = 2.50$ mA. If the β of the BJT is 50, calculate its emitter current I_E in mA.

Show steps here: Base current, $I_B = I_C/\beta = 2.50\ \text{mA}/50 = 0.05$ mA
Emitter current, $I_E = I_C + I_B = 2.5 + 0.05 = \mathbf{2.55\ mA}$
Or $I_E = I_C \times ([\beta+1]/\beta) = 2.50 \times 51/50 = \mathbf{2.55\ mA}$

Marks: 2

Answer: $\mathbf{I_E = 2.55\ mA}$

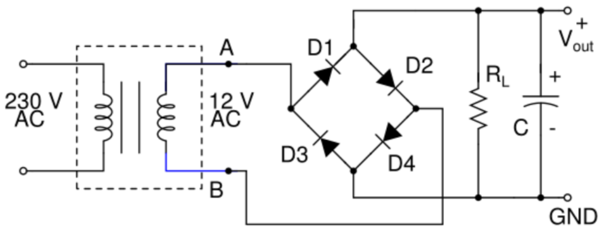
(1 mark will be deducted if no steps are shown)

4. The circuit diagram of an RC high-pass filter is given below. For a sinusoidal input voltage, sketch the magnitude plot of V_{out}/V_{in} as a function of frequency. The cut-off frequency of the filter is $f_c = 1/(2\pi RC)$. The component values are: C = 0.2 μF, R = 2 kΩ. 	Marks: 4 (=2 + 2) Answer: f_c = **398 Hz (Answer range: 397 to 399 Hz)** (answer should be correct within ± 1 Hz) Give 1 mark for answers within 398 ± 4 Hz. **Sketch:**  Marks: 2 (1 mark for the correct shape, 0.5 marks for f_c, 0.5 marks for correct amplitude markings)

5. Is the test signal output of the DSO single-ended or differential?	Marks: 1 Answer: **Single-ended**

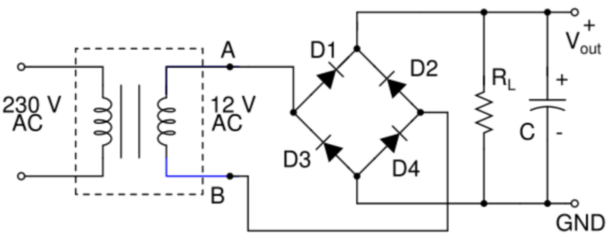
6. In Expt 2, you used a 230 Vrms/12 Vrms step-down transformer. In order to observe the half wave rectifier output properly on CH1 of the DSO, the best setting on the DSO for channel CH1 is: A) coupling mode as DC and vertical scale as 20 mV/division. B) coupling mode as AC and vertical scale as 20 mV/division. C) coupling mode as DC and vertical scale as 5 V/division. D) coupling mode as AC and vertical scale as 5 V/ division.	Marks: 1 Correct option: **C**
7. When a DSO channel coupling mode is put as AC, A) one will be able to observe only the DC voltages as AC voltages are filtered out. B) one will be able to observe only the AC voltages as DC voltages are blocked. C) one will be able to see the waveform as it is with its DC and AC voltage components. D) one will see only the peak value of the waveform.	Marks: 1 Correct option: **B**
8. A student connected a sinusoidal test input of 5 sin (ωt) V (freq = 100 Hz) to the DSO CH1. The student chose 20 μs/div as the horizontal scale and 2 V/div as the CH1 vertical scale. The display on the DSO was a clear one but instead of a sinusoidal waveform it showed a slanted line. In order to display the test signal properly without using the 'AutoSet' option, one should A) use the 'Trigger' menu and chose the 'Trigger Source' as CH1 and adjust the trigger level. B) change the horizontal scale to 2.5 ms/div, CH1 vertical scale to 2 V/div, and adjust the CH1 position as required. C) change the horizontal scale to 200 μs /div, CH1 vertical scale to 0.1 V/div, and adjust the CH1 position as required. D) use the 'Trigger' menu and chose the 'Trigger Source' as CH1, and the horizontal scale to 25 ms/div, CH1 vertical scale to 2 V/div, and adjust the CH1 position as required.	Marks: 1 Correct option: **B**

9. A student connected the following circuit as a bridge rectifier circuit with capacitive filter. Unfortunately, there are mistakes in the circuit. Draw the corrected circuit.



Marks: 3

Corrected circuit:

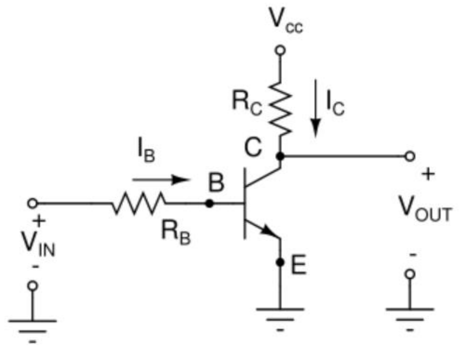


Only two mistakes: D2 and D4 were connected wrongly.

Full 3 marks for the corrected circuit shown above. No partial marks.

10. A BJT circuit is shown below.
$V_{CC} = 8$ V, $R_C = 2$ kΩ, $R_B = 33$ kΩ, $\beta = 50$.
BJT parameters: $V_{BE} = 0.7$ V, $V_{CEsat} = 0.2$ V.
Calculate I_C in mA when $V_{IN} = 4$ V.

Show steps of your calculations.



Marks: 3

Important steps compulsory. **Partial marks shown**

KVL in the base-emitter loop:

$V_{IN} = I_B R_B + V_{BE}$; $I_B = (V_{IN} - V_{BE})/R_B$

Substituting, $I_B = (4-0.7)/33$ kΩ $= (3.3/33)$ mA

$I_C = \beta I_B = 50 \times (3.3/33)$ mA $= 5$ mA : 1 mark

KVL in the collector – emitter loop:

$V_{CC} = I_C R_C + V_{CE}$; $V_{CEsat} = 0.2$ V is the minimum possible value of V_{CE}.

Hence, $I_{Cmax} = (V_{CC} - V_{CEsat})/R_C = (8-0.2)/2$ kΩ $= 3.9$ mA

1 mark

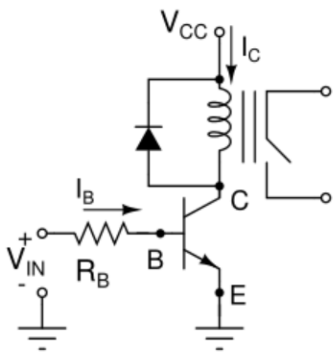
The earlier value of $I_C = 5$ mA $> I_{Cmax}$. Hence it is not correct. It indicates that the BJT is saturated (i.e. actual $I_C < \beta I_B$).

Hence, **$I_C = I_{Cmax} = 3.9$ mA (≈ 4.0 mA)** **1 mark**

(For full marks to be awarded, BJT saturation must be proved first)

11. A BJT based relay circuit is shown below.
$V_{CC} = 12$ V, $R_{Coil} = 500$ Ω, $R_B = 15$ kΩ, $\beta = 40$. Minimum current required for relay to get activated is 20 mA. R_{Coil} is the relay coil resistance.
BJT parameters: $V_{BE} = 0.7$ V, $V_{CEsat} = 0.2$ V.

A) What is the minimum value of V_{IN} required to keep the BJT in saturation?
B) What is the minimum value of V_{IN} required to activate the relay?



Marks: 4 (=2+2)

Important steps compulsory. **Partial marks shown**

A) KVL in the collector – emitter loop,
$V_{CC} = I_C R_{Coil} + V_{CE}$; $V_{CEsat} = 0.2$ V is the minimum possible value of V_{CE}.

Hence, $I_{Cmax} = (V_{CC} - V_{CEsat})/R_{Coil} = (12-0.2)/500\ \Omega = 23.6$ mA

: 1 mark

Corresponding $I_B = I_{Bsat} = 23.6/\beta = 23.6/40 = 0.59$ mA

Min$V_{IN} = I_B R_B + V_{BE}$; $V_{IN} = (0.59\text{ mA} \times 15\text{k}) + 0.7 = 9.55$ V
(No marks for answer without important steps)

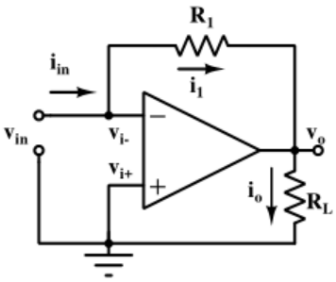
: 1 mark

B) For relay activation, required $I_C = 20$ mA
Hence, required $I_B = 20$ mA$/\beta = 20/40 = 0.5$ mA

Min$V_{IN} = I_B R_B + V_{BE}$; $V_{IN} = (0.5\text{ mA} \times 15\text{k}) + 0.7 = 8.20$ V
(No marks for answer without important steps)

: 2 marks

12. 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 = 1 kΩ, R_L = 500 Ω.



Marks: 4 (= 2+1+1)

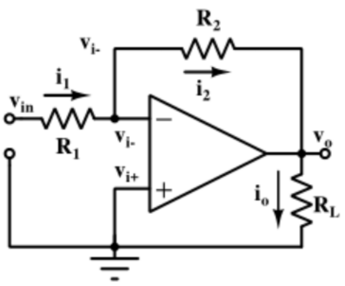
For this circuit,

(A) R_{in} = **0 kΩ.**
(Note that $v_{in} = 0$)

(B) For i_{in} = 3.5 mA, v_o = **- 3.5 V**
(if the sign is +ve, no marks to be given)

and i_o = **-7 mA**.
(no penalty for wrong sign)

13. An op amp amplifier circuit is shown below. R_1 = 10 kΩ, R_2 = 50 kΩ. R_L = 2 kΩ.
Given: +Vcc = +12 V, -Vcc = - 12 V. Assume that the op amp is ideal. Also assume that the maximum and minimum v_o levels are +Vcc and -Vcc respectively.



Marks: 6 (=1 + 1 + 2 + 2)

(A) For v_{in} = + 500 mV, i_o = **- 1.25 mA.**
(no marks if the sign is wrong)

(B) Current gain $A_i = i_o/i_i = -(1.25/0.05) =$ **-25**.
(no penalty for wrong sign)

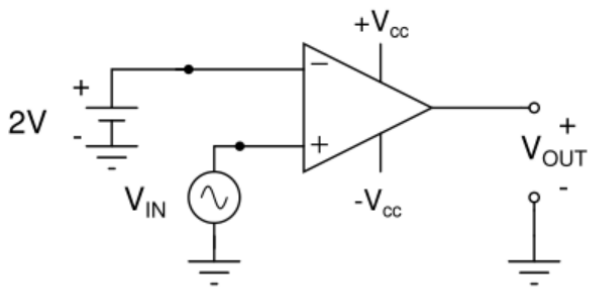
(C) Power gain A_p = **125**.
(no penalty for wrong sign)

(D) Assume that v_{in} = + 500 mV and all resistor values are as given. Now if additionally, a 10 kΩ is connected between the v_{i-} and v_{i+} inputs of the op amp, what will be v_o?

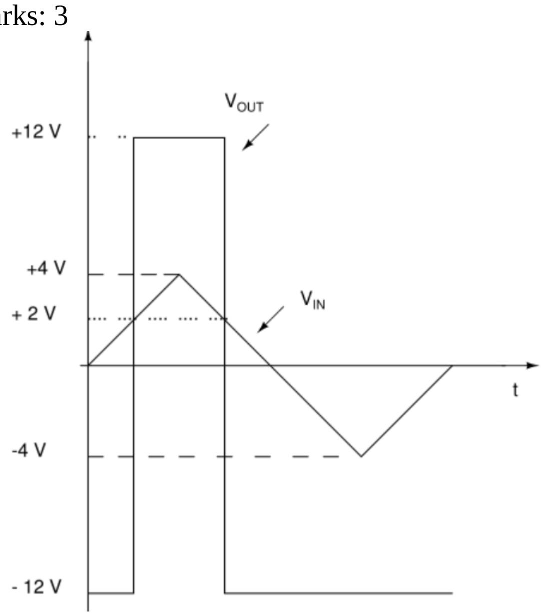
v_o = **- 2.5 V**
(no marks if the sign is wrong)
(the 10 k resistor will have no effect. Explanation not required). No partial marks for this part.

14. An op amp comparator circuit is shown below. Given: +Vcc = +12 V, -Vcc = - 12 V. Assume that the op amp is ideal. Also assume that the maximum and minimum V_{OUT} levels are +Vcc and -Vcc respectively.

For the given V_{IN} waveform sketch the V_{OUT} waveform by superimposing V_{OUT} on V_{IN}.



Marks: 3



2 marks for the correct transition point (+2 V) and the correct shape.
1 mark for the correct V_{OUT} levels.