UNIVERSITY OF RUHUNA

BACHELOR OF SCIENCE GENERAL DEGREE LEVEL II (SEMESTER I) EXAMINATION 2020 (FEBRUARY 2022)

SUBJECT: Physics

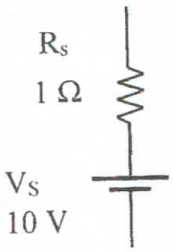
COURSE UNIT: PHY 2112

PART B - 01 hour & 15 minutes

Answer FIVE questions only.

All symbols have their usual meaning.

01. (a) A practical voltage source of 10 V with 1 Ω internal resistance is shown in the following figure.

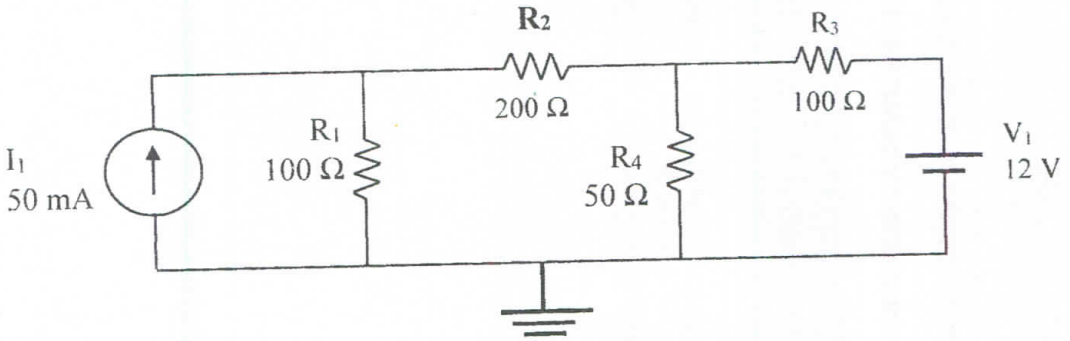


i. If a load resistor is connected with the above voltage source, sketch the voltage across the load (V_L) as a function of the current (I_L) passing through the load.

[2 marks]

ii. Calculate the short circuit current and the internal resistance of the practical current source, which is equivalent to the above voltage source. **[2 marks]**

(b) Consider the following circuit network and calculate,



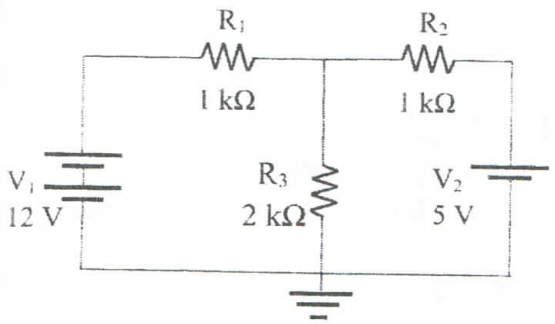
i. the voltage drop across the resistor R_2, and

ii. the current flowing through the resistor R_2.

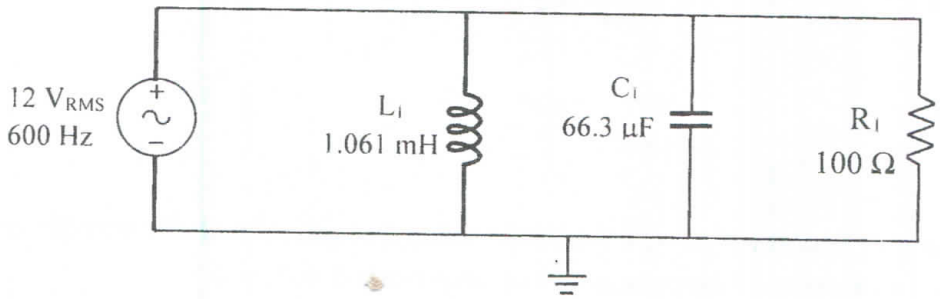
[6 marks]

02. (a) Calculate the current flowing through and the voltage across the resistor R_3, in the following circuit.

[4 marks]



(b) Consider the following parallel LCR circuit and calculate;

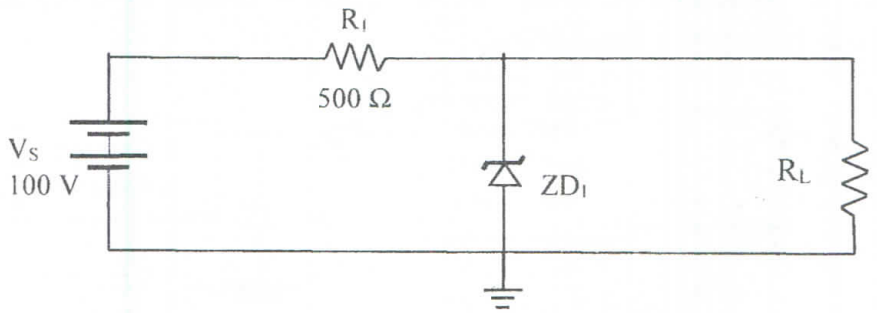


i. the reactance of the capacitor.
ii. the reactance of the inductor.
iii. the RMS value of the current drawn from the source.

[6 marks]

03. (a) Answer the following questions regarding the circuit given below (Zener diode parameters are given in the table).

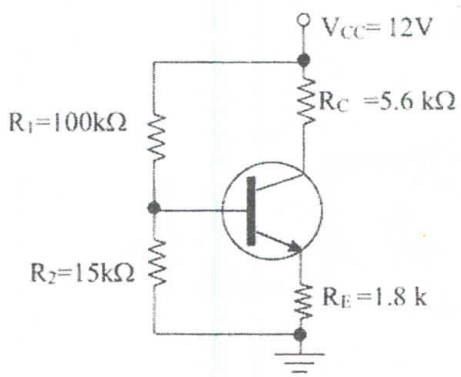
Parameter	Value
Zener Voltage (V_Z)	10 V
Maximum power	1 W
The minimum Zener current required to operate in the linear mode ($I_{Z(min)}$)	2 mA



i. Find the maximum current that can be handled by the Zener diode ($I_{Z(max)}$). **[1 mark]**

ii. If the battery has no internal resistance, find the range of load resistor (R_L) values in which the Zener is in its Zener action. **[4 marks]**

(b)



Assume that V_{BE} = 0.6 V, when the BE junction is forward biased.

i. Calculate voltages measured at each terminal of the transistor.

ii. In which region does this transistor operate?

[5 marks]

04. A 1 kΩ load resistor is connected to a centre tapped transformer-based full-wave rectifier circuit with two diodes. RMS value and the frequency of the primary voltage of the transformer are 240 V_{AC} and 50 Hz, respectively. The turn ratio of the transformer is 10:1:1 (Assume that the transformer and diodes are ideal).

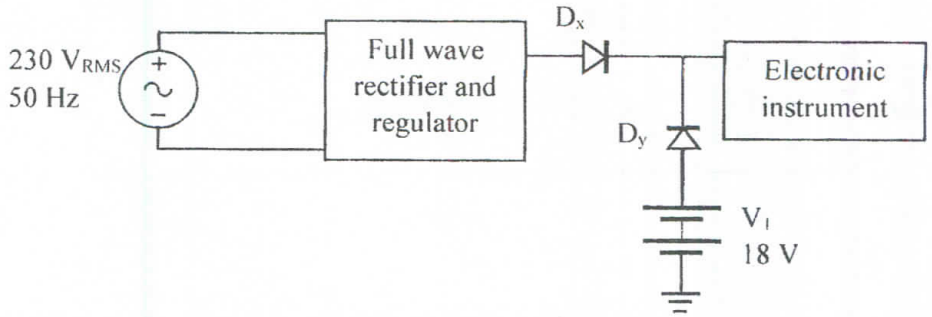
i. Draw a suitable circuit diagram for the above full-wave rectifier. **[2 marks]**

ii. Sketch the voltage across the load resistor (V_L) as a function of time. **[2 marks]**

iii. Calculate the peak value of the voltage across the load resistor ($V_{L(max)}$). **[2 marks]**

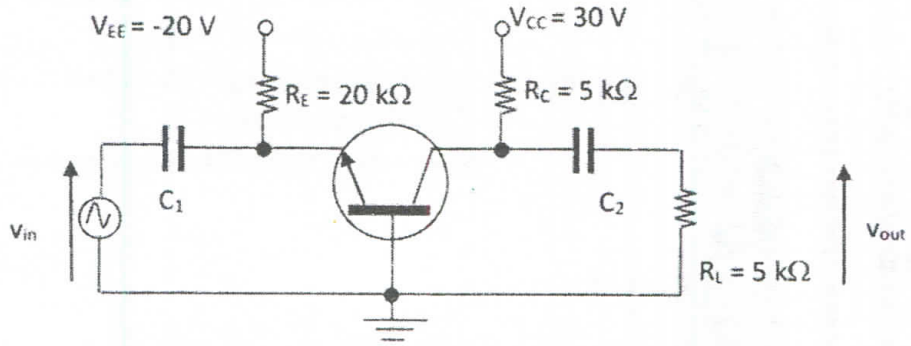
iv. Draw an appropriate circuit diagram to regulate the voltage across the load resistor to obtain a constant dc voltage. **[2 marks]**

v. Assume that the generated dc voltage is 20 V, and it is used to power an electronic instrument according to the figure below.



Describe the operation according to the above diagram, when the ac power is ON, and ac power is breaking down (assume that D_x and D_y are ideal). **[2 marks]**

05. Consider the following amplifier circuit.



(a) Draw the dc equivalent circuit and find the I_E (current flowing through the resistor R_E) in the above circuit (neglect V_{BE}).

[3 marks]

(b) Draw the ac equivalent circuit of the above amplifier (consider $r_e' = \frac{25\ mV}{I_E}$) and calculate the;

i. input resistance.

ii. output resistance.

iii. ac voltage gain.

[5 marks]

(c) What are the purposes of C_1 and C_2? **[2 marks]**

06. (a) Draw circuit diagrams using Operational Amplifiers for the following requirements and obtain the relationship between input and output voltages in close loop configuration.

i. Amplify a signal without inverting. **[3 marks]**

ii. Amplify a signal with inverting. **[3 marks]**

(b) Design a suitable circuit using Operational Amplifiers to obtain an output according to the following relationship (Use resistors in kΩ range),

$$Y = X_1 + 2X_2 - 6X_3$$ **[4 marks]**

07. (a) Show that

i. $A.(\overline{A} + B) = A.B$

ii. $A.B + A.B.C + A.B.\overline{C} = A.B$

iii. $(A + B + C).(A + B) = A+B$

[6 marks]

(b) Consider the following truth table,

A	B	C	output
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

i. Obtain a simplified Boolean expression in between the inputs and the output.

ii. Draw a logic gate diagram for the simplified Boolean expression.

[4 marks]

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