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The Open University of Sri Lanka
B.Sc. Degree Programme – Level 04
Final Examination- 2008
PHU 2144/PHE 4144 - Practical Physics

Duration: Two and a Half ($2^1/_2$) Hours

Date: 07th January 2009 Time: 1.00 am – 3.30 pm

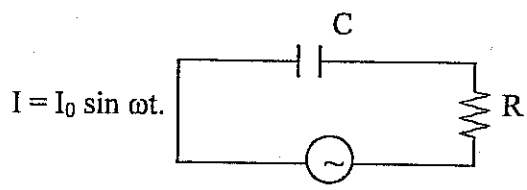
ANSWER FOUR QUESTIONS ONLY

1. You are provided with a transformer (230V/10V, 50 Hz and 1A) and rectifier diodes (IN4001).

   (a) Briefly discuss how you construct a half wave rectifier circuit and full wave rectifier circuit with the above circuit elements drawing the necessary circuit diagrams.
   (b) List the additional circuit elements required to smooth and regulate the output voltage of a full wave rectifier circuit.
   (c) If you want to regulate the output voltage of the full wave rectifier circuit at 6 V, write the details including the number of the circuit element that you need for this purpose.
   (d) Suppose 2 V ripple voltage is observed across the smoothing capacitor when you connect a 1 kΩ load resistor at the output of your power supply. Calculate the value of the capacitor.
   (e) What is the modification need to be done with the secondary winding of the transformer in order to construct a full wave rectifier circuit only with two rectifier diodes? Explain by drawing the circuit diagram.

2 Capacitance of a capacitor could be determined by constructing an alternating current circuit.

   (a) Show that the reactance of a capacitor, X_c is $1/\omega C$ for a AC current, $I = I_0 \sin \omega t$.
   (b) Hence, plot voltage and current variation across a capacitor against time for sinusoidal AC signals in a graph.
   (c) Draw a phasor (vector) diagram for the voltage across the capacitor and the resistor in the following circuit.



(d) Write down the procedure to determine the capacitance of the capacitor of the above circuit by measuring the voltage across the capacitor and resistor connected in series with the signal generator.

(e) Voltages appeared across the resistor (R = 100 Ω) and capacitor of the above circuit for a AC signal of 1 kHz is given in the following table. Calculate the capacitance of the capacitor by plotting a suitable graph.

Voltage across the capacitor (mV)	2	4	6	8	10
Voltage across the resistor (mV)	200	400	600	800	1000

3. You are requested to analyze the input and output characteristics of a transistor.

(a) What are the measuring instruments and circuit elements that you need to carry out this experiment?

(b) Draw a clearly labeled circuit diagram of the experimental arrangement.

(c) Plot the typical input and output characteristic curves of a bipolar junction transistor.

(d) Draw the *h* parameter equivalent circuit of a n-p-n transistor operating in common emitter configuration and derive expression for h_{ie}, h_{re}, h_{fe}, *and* h_{oe}.

(e) Discuss how you are going to determine the *h* parameters experimentally of a transistor operating in common emitter configuration.

4. (a) Draw the basic logic gates and their truth tables. What are the secondary logic gates that can be constructed from them?

(b) What is the difference between the combinational logic circuits and sequential logic circuits?

(c) Write down de Morgan's theorems in words and in Boolean algebraic form.

(d) Draw combinational logic circuits constructed with the basic logic gates that can be used to verify de Morgan's theorems and draw their truth tables.

(e) Using de Morgan's theorem show that all the basic logic gates could be constructed with NAND gates.

5. You are provided with a CA 741 IC, 10 kΩ resistor and a 100 μF capacitor and requested to construct an integrator circuit.

(a) Draw a circuit diagram of an integrator circuit with the above circuit elements.

(b) Derive an expression for the output voltage, when the input is $V_{in} = V_m \cos \omega t$ of this circuit.

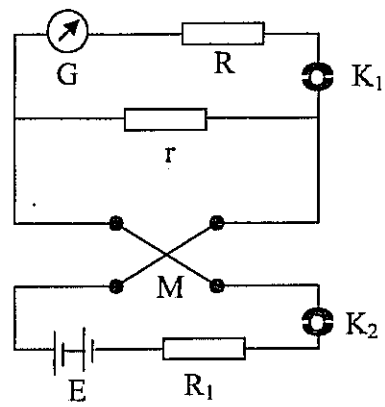
(c) If you want to use this circuit to determine the capacitance of the capacitor, what are the other apparatus you need to carry out the experiment.

(d) Write down the experimental procedure to find the unknown capacitor deriving any necessary equations and clearly indicating the measurements you take.

(e) Following table gives V_{in} and V_{out} at different frequencies of an integrator circuit. Plot a suitable graph and find the unknown capacitor. Take R = 10 kΩ.

Frequency (Hz)	V_{in} (V)	V_{out} (mV)
400	2.0	160
600	2.0	105
800	2.0	80
1000	2.0	60

6. The diagram below shows the experimental arrangement to determine the Ballistic Galvanometer constant.



(a) Identify the components labeled as G, R, r, M, K_1, K_2, E and R_1 in the above circuit.

(b) Explain why the damping of the ballistic galvanometer is very slow.

(c) Derive an expression for the current, I through the ballistic galvanometer.

(d) If the galvanometer constant k is given by, $k = \frac{T}{2\pi}\frac{I}{\theta_m}$, where T is the period of oscillation, I- current through the galvanometer, θ_m- maximum angle of oscillation, describe the experimental procedure to calculate the ballistic galvanometer constant, k.

(e) Following table gives the left and right side maximum deflection of the ballistic galvanometer for different values of R_1. Calculate the ballistic galvanometer constant by plotting a suitable graph.

R_1	θ_L (cm)	θ_L (cm)
650	21.5	22.9
700	20.0	21.5
750	18.8	19.5
800	16.6	17.7
850	16.2	17.4
900	15.2	16.4

You are also given that the ballistic galvanometer takes 1 minute and 18 seconds for 30 oscillations. Take R = 1 MΩ, r = 100 Ω, G = 115 Ω and E = 7.15 V.