UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: FGE 1324
COURSE	: PHYSICS II
SEMESTER/SESSION	: 2-2022/2023
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise up your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 8 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Describe Coulomb's First Law. (2 marks)

b) Three-point charges are in a straight line as shown in Figure 1. Their charges are $Q_1 = +3 \times 10^{-9}C$, $Q_2 = +1 \times 10^{-9}C$ and $Q_3 = -3 \times 10^{-9}C$. The distance Q_1 and Q_2 is 2×10^{-2} m and the distance between Q_2 and Q_3 is 4×10^{2} m.

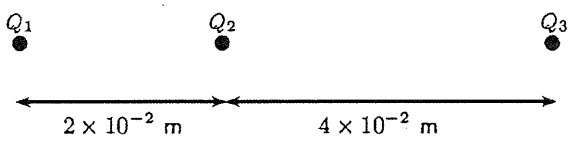

Figure 1

i. State the nature of the interaction between Q_1 and Q_2. (1 mark)

ii. State the nature of the interaction between Q_2 and Q_3. (1 mark)

iii. Determine the net electrostatic force on Q_2 due to the other two charges. (8 marks)

c) Figure 2 shows combination capacitors when the capacitances are $C_1 = 4.5$ μF, $C_2 = 3.0$ μF and $C_3 = 6.0$ μF.

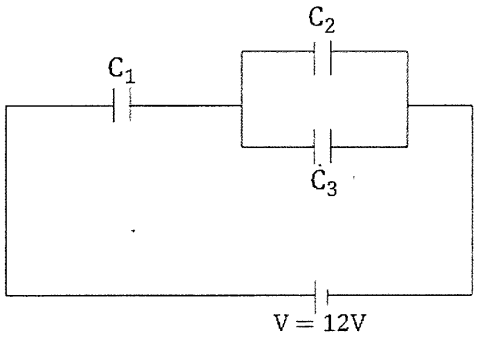

Figure 2

Calculate:

i. The total capacitance, C_T. (5 marks)

ii. The total charge for the capacitor. (3 marks)

iii. The total energy stored in the capacitor. (2 marks)

QUESTION 2

a) Define direct current. (3 marks)

b) A copper wire carries a current of 5 A. The cross section of the wire is 4.0 mm^2 and its length is 50 m. The density of the free electron in the wire is 8.5×10^{28} m^{-3}. (Given the resistivity of copper is 1.68×10^{-8} Ω m and charge of electron, e = 1.60×10^{-19} C).

Determine:

i. The current density, J. (3 marks)

ii. The drift velocity of the electrons, v. (3 marks)

iii. The resistance of the wire, R. (2 marks)

iv. The potential difference across the wire, V. (2 marks)

c) Figure 3 shows an unbalanced of Wheatstone Bridge.

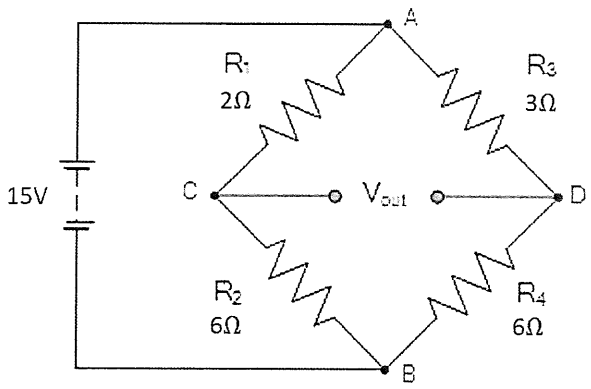

Figure 3

Calculate:

i. The output voltage across point C and D. (7 marks)

ii. The value of resistor R_4 required to balance the bridge circuit. (2 marks)

QUESTION 3

a) Define terms below:

i. Alternating Current (AC) (2 marks)

ii. Average current, I_{ave} (2 marks)

iii. Root-mean square current, I_{rms} (2 marks)

b) Based on Figure 4, determine

i. Amplitude, A (1 mark)

ii. The period, T (1 mark)

iii. The peak voltage, V_P (1 mark)

iv. The rms voltage, V_{rms} (2 marks)

v. The average voltage, V_{ave} (2 marks)

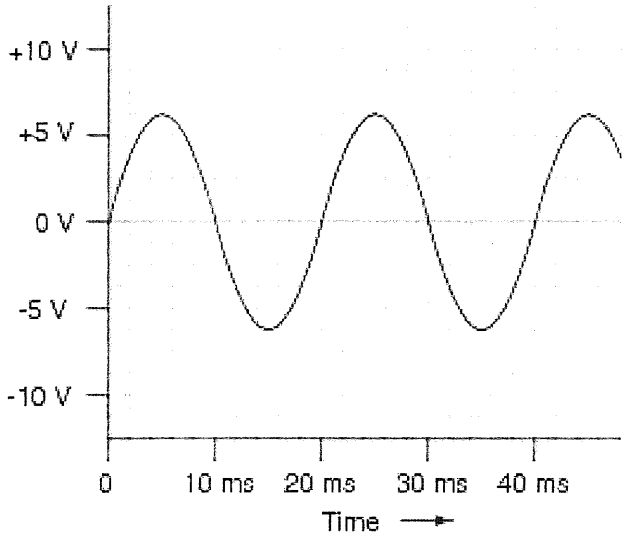

Figure 4

c) A 10μF capacitor, a 2.0 H inductor and a 20Ω resistor are connected in series with an alternating source given by the equation below:

$$V = 300 \sin 300t$$

Calculate:

i. The frequency of the source, f. (3 marks)

ii. The capacitive reactance, X_c. (2 marks)

iii. The inductive reactance, X_L. (2 marks)

iv. The impedance of the circuit, Z. (2 marks)

v. The peak current in the circuit, I_p. (3 marks)

vi. The phase angles, $\emptyset$. (3 marks)

vii. The average power dissipated in the circuit, P_{ave}. (4 marks)

viii. The average power dissipated to the surrounding, P_{ave}. (2 marks)

QUESTION 4

a) State two (2) laws of refraction. (4 marks)

b) A person of height 1.75 m is standing 2.50 m in from of a camera. The camera uses a thin biconvex lens of radius of curvature 7.69 mm. The lens made from the crown glass of refractive index 1.52.

i. Calculate the focal length of the lens. (3 marks)

ii. Sketch a labelled ray diagram to show the formation of the image. (4 marks)

iii. Determine the position of the image and its height. (7 marks)

iv. State four (4) characteristics of the image. (4 marks)

----------End of question----------

TABLE OF FORMULAS

Electrostatics			
$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$	$U = \frac{kQq}{r}$	$C = \frac{Q}{V}$
$V_{ab} = kQ\left[\frac{1}{r_a} - \frac{1}{r_b}\right]$	$V = \frac{kQ}{r}$	$V = \frac{Q}{4\pi\varepsilon_0 r}$	$W = \frac{1}{2}CV^2$
$C_{eq} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \cdots + \frac{1}{C_N}}$	$C_{eq} = C_1 + C_2 + \cdots + C_N$	$k = 9 \times 10^9 m/F$	

DC Electricity					
$I = nAvQ$	$J = \frac{I}{A}$	$R = \rho\left(\frac{L}{A}\right)$	$R = \frac{V}{I}$	$E = \frac{W}{Q}$	$V = \frac{W}{Q}$
$R_T = R_1 + R_2 + \cdots + R_N$		$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$			
$P = VI$	$P = \frac{V^2}{R}$	$P = I^2R$	$W = P \times t$		
$V_{out} = \left(\frac{R_2}{R_1 + R_2}\right) \times V_{in}$		$R_4 = \frac{R_2R_3}{R_1}$	$V_{OUT} = (V_c - V_D)$		

AC Electricity			
$I = I_p \sin \omega t$	$V = V_p \sin \omega t$	$I_{ave} = 0.6372I_p$	$V_{ave} = 0.6372V_p$
$I_{rms} = 0.707I_P$	$V_{rms} = 0.707V_P$	$X_C = \frac{1}{2\pi fC}$	$X_L = 2\pi fL$
$Z = \frac{V_{rms}}{I_{rms}}$	$Z = \frac{V_p}{I_p}$	$pf = \cos \emptyset$	$\omega = 2\pi f$

RL Circuit	$Z = \sqrt{R^2 + {X_L}^2}$	$\tan \emptyset = \frac{X_L}{R}$	$P_{ave} = {I_{rms}}^2 R$
RC Circuit	$Z = \sqrt{R^2 + {X_C}^2}$	$\tan \emptyset = \frac{X_C}{R}$	$P_{ave} = V_{rms} I_{rms} \cos \emptyset$
RLC Circuit	$Z = \sqrt{R^2 + (X_L - X_C)^2}$	$\tan \emptyset = \frac{X_L - X_C}{R}$	$P_{ave} = {I_{rms}}^2 Z \cos \emptyset$

Reflection of Light			
Plane mirror	$i = r$	$m = \frac{image\ height,\ h_i}{object\ height,\ h_o} = 1$	
Spherical mirror	$m = \frac{h_i}{h_o} = \left\|\frac{v}{u}\right\|$	$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{2}{r}$	$r = 2f$
Refraction of Light			
$n_1 \sin i = n_2 \sin r$	$n = \frac{c}{v}$	$n = \frac{\lambda_0}{\lambda}$	
Spherical surface	$\frac{n_1}{u} + \frac{n_2}{v} = \frac{\lvert(n_2 - n_1)\rvert}{r}$	$m = \frac{h_i}{h_o} = \left\lvert\frac{n_1 v}{n_2 u}\right\rvert$	
Thin Lens	$m = \frac{v}{f} - 1$	$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$	
	$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$	$m = \frac{h_i}{h_o} = \left\|\frac{v}{u}\right\|$	
Len's maker	$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$		
Lens Combination	$m = m_1 m_2$		