COLLEGE OF ENGINEERING AND MINES
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

COURSE CODE	EE F102 F01 (CRN: 34544)
COURSE NAME	INTRODUCTION TO ELECTRICAL AND COMPUTER ENGINEERING
SEMESTER	SPRING
YEAR	2022
TYPE AND NUMBER OF SUBMISSION	HOMEWORK 2
METHOD OF SUBMISSION	ONLINE TO : maher.albadri@alaska.edu
DATE OF ASSIGNMENT	THURSDAY 20 JAN 2022

DUE DATE OF SUBMISSION	FRIDAY 28 JAN 2022	**DUE TIME OF SUBMISSION**	23:59

STUDENT NAME	Jacob Guenther

MAKE THIS FORM A "COVER PAGE" FOR YOUR HOMEWORK SUBMISSION.

FOR THE TA USE ONLY

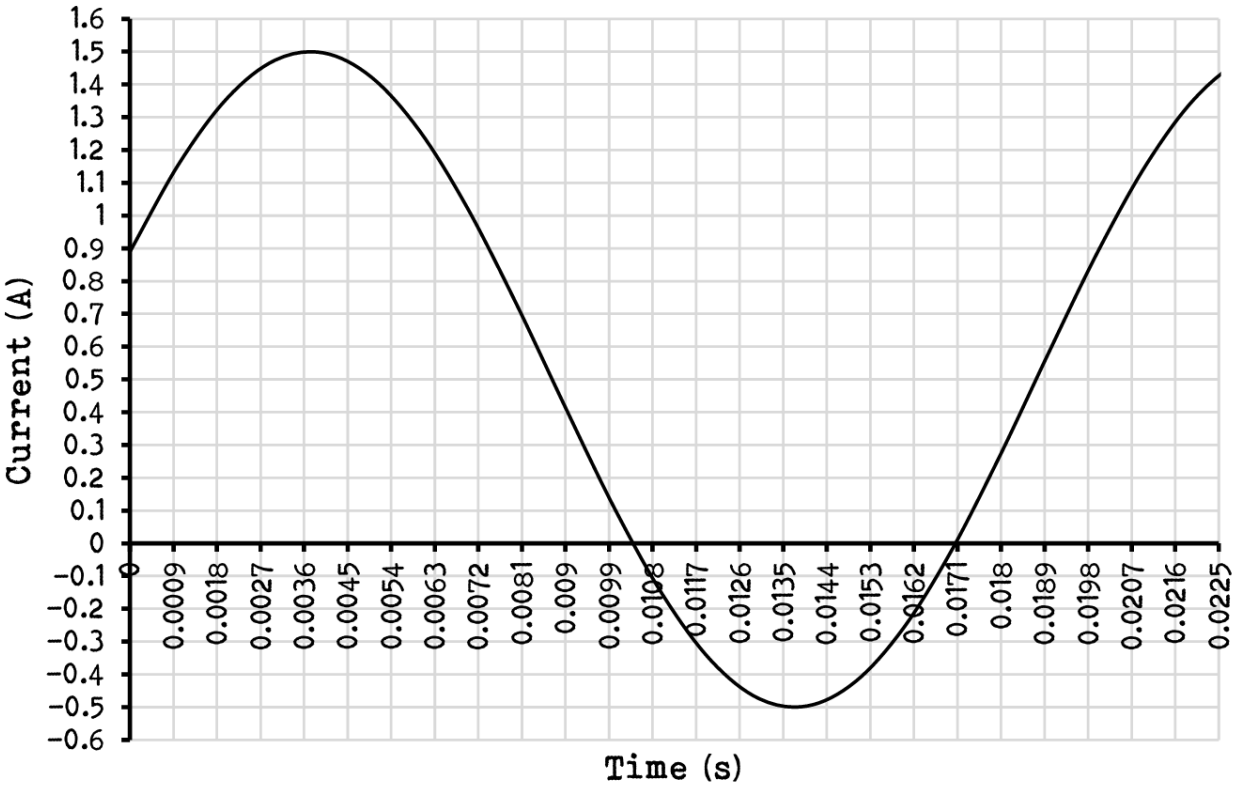
REMARKS:

FOR THE TA USE ONLY		
PROBLEM NUMBER	**MAXIMUM POINTS POSSIBLE**	**POINTS EARNED**
PROBLEM 1	75	
PROBLEM 2	75	
TOTAL	150	

1 Problem HW-1-1

(a) For the current signal shown, determine: 25pts

- The DC offset "A", in amperes
- The amplitude "B", in amperes
- The period "T", in seconds
- The frequency "f", in hertz
- The angular frequency "ω", in rad/s
- The phase shift angle "Φ", in degrees



$$i(t) = \mathrm{A} + \mathrm{B}sin(\omega t + \Phi) \tag{1}$$

Note:

$$2\mathrm{B} = I_{max} - I_{min} \tag{2}$$

$$\mathrm{A} = \frac{I_{max} + I_{min}}{2} \tag{3}$$

$$\mathrm{T} = t_2 - t_1 \tag{4}$$

$$f = \frac{1}{\mathrm{T}} \tag{5}$$

$$\omega = \frac{2\pi}{\mathrm{T}} \tag{6}$$

$$I_{max} = 1.5\mathrm{A}$$

$$I_{min} = -0.5\mathrm{A}$$

$$t_1 = 0\mathrm{s}$$

$$t_2 = 0.0198\mathrm{s}$$

$$i(0) = 0.9\mathrm{A}$$

Solution:

$$
\begin{aligned}
\mathrm{A} &= \frac{1.5\mathrm{A} + (-0.5)\mathrm{A}}{2} \\
&= 0.5\mathrm{A} \\
2\mathrm{B} &= 1.5\mathrm{A} - (-0.5)\mathrm{A} \\
\mathrm{B} &= \frac{1.5\mathrm{A} - (-0.5)\mathrm{A}}{2} \\
&= 1\mathrm{A} \\
\mathrm{T} &= 0.0198\mathrm{s} - 0\mathrm{s} \\
&= 0.0198\mathrm{s} \\
f &= \frac{1}{0.0198s} \\
&= 50.5\mathrm{Hz} \\
\omega &= \frac{2\pi}{0.0198s} \\
&= 317.33\mathrm{rad/s} \\
0.9\mathrm{A} &= 0.5\mathrm{A} + 1.0\mathrm{A}sin(317.33\mathrm{rad/s} \cdot 0\mathrm{s} + \Phi) \\
0.9\mathrm{A} - 0.5\mathrm{A} &= 1.0\mathrm{A}sin(\Phi) \\
\frac{0.4\mathrm{A}}{1.0\mathrm{A}} &= sin(\Phi) \\
\Phi &= sin^{-1}(0.4) \\
&= 0.4115\mathrm{rad}
\end{aligned}
$$

Answer:

- The DC offset A is **0.5 A**
- The amplitude B is **1 A**
- The period T is **0.0198 s**
- The frequency is **50.5 Hz**
- The angular frequency is **317.33 rad/s**
- The phase shift is **0.4115 rad**

(b) 1200 C charge moves uniformly through a conductor for 10 minutes. Calculate the current, in amperes, passing through the conductor. 25pts

Note:

$$I = \frac{\Delta Q}{\Delta t} \tag{7}$$

$$1\text{min} = 60\text{s} \tag{8}$$

Solution:

$$\begin{aligned} t &= 10\text{min} \cdot \frac{60\text{s}}{1\text{min}} \\ &= 600\text{s} \\ I &= \frac{1200\text{C}}{600\text{s}} \\ &= 2\text{A} \end{aligned}$$

Answer: The current passing through the conductor is **2 A**.

(c) A uniform current of 3.5 A flows in a circuit for 30 minutes. Calculate the total charge passed through any point in the circuit. 25pts

Solution:

$$\begin{aligned} t &= 30\text{min} \cdot \frac{60\text{s}}{1\text{min}} \\ &= 1800\text{s} \\ \text{Q} &= 3.5\text{A} \cdot 1800\text{s} \\ &= 6300\text{C} \end{aligned}$$

Answer: The total charge passing through the circuit is **6.3 kC**.

2 Problem HW-1-2

(a) A neutral body has 10^{10} electrons added to it. Then, a negative charge of 0.1 μC was removed from the body. Calculate the body's final charge, in μC. 25pts

Note:

$$\text{electron charge} = -1.602177 \times 10^{-19}\text{C} \tag{9}$$

$$1\text{C} = 1 \times 10^{6}\mu\text{C} \tag{10}$$

$$Q_i = 0\text{C}$$

Solution:

$$\begin{aligned}
Q_e &= (1 \times 10^{10})(-1.602177 \times 10^{-19}\text{C}) \\
&= -1.602177 \times 10^{-9}\text{C} \cdot \frac{10^{6}\mu\text{C}}{1\text{C}} \\
&= -0.001602177\mu C \\
Q_c &= -(-0.1\mu C) \\
&= 0.1\mu C \\
Q_f &= Q_i + Q_e + Q_c \\
&= 0\mu\text{C} + -0.001602177\mu C + 0.1\mu C \\
&= 0.098397823\mu\text{C} \\
&= 0.098\mu\text{C}
\end{aligned}$$

Answer: The body's final charge is **0.098 μC**

(b) A battery rated at 60 Ah supplies 1.0 mA to a resistive load. Determine the battery life in hours. 25pts

Note:

$$\text{life[h]} = \frac{\text{capacity[Ah]}}{\text{drain[A]}} \tag{11}$$

$$1\text{A} = 1000\text{mA} \tag{12}$$

Solution:

$$\begin{aligned} \text{drain} &= 1.0\text{mA} \cdot \frac{1\text{A}}{1000\text{mA}} \\ &= 0.001\text{A} \\ \text{life} &= \frac{60\text{Ah}}{0.001\text{A}} \\ &= 60000\text{h} \end{aligned}$$

Answer: The battery's life is **60000 h**

(c) Electric potential of 120 V is established when energy is utilized to move 10^{20} electrons from point A to point B. Calculate the value of the energy, in kJ, used to do the work. 25pts

Note:

$$E = V \cdot Q \tag{13}$$

Solution:

$$\begin{aligned} Q &= 10^{20} \cdot 1.602177 \times 10^{-19}\text{C} \\ &= 16.02177\text{C} \\ E &= 120\text{V}16.02177\text{C} \\ &= 1922.6124\text{J} \\ &= 1.9226124\text{kJ} \\ &= 1.9\text{kJ} \end{aligned}$$

Answer: The energy used to move the electrons between points A and B is **1.9 kJ**

3 References

[1] Denise Thorsen, Maher Al-Badri, INTRODUCTION TO ELECTRICAL AND COMPUTER ENGINEERING, University of Alaska Fairbanks, 2022.