Fundamental of electrical engineering

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1-1 Introduction

The study of an electrical engineering involves the analysis of the energy transfer from one point to another. So before beginning the actual study of an electrical engineering, it is necessary to understand some important fundamentals about the basic elements of an electrical engineering such as electromotive force, current, voltage, resistance etc. Practically, electrical system is related with number of other types of systems such as mechanical, hermal etc. Therefore, in this lecture we are going to study the basic concepts and review the International System (SI units) of measurement of different quantities such as work, power, energy etc. in various systems together with the definition of related terms.

1-2 Symbols and abbreviation

The system of units used in engineering and science is the (International systemof units), usually abbreviated to SI units, and is based on the metric system.

Quantity	Quantity Symbol	Unit	Unit Symbol
Length	l	metre	m
Mass	m	kilogram	kg
Time	t	second	s
Velocity	v	metres per second	m/s or $m\,s^{-1}$
Acceleration	a	metres per second squared	m/s^2 or $m\,s^{-2}$
Force	F	newton	N
Electrical charge or quantity	Q	coulomb	C
Electric current	I	ampere	A
Resistance	R	ohm	Ω
Conductance	G	siemen	S
Electromotive force	E	volt	V
Potential difference	V	volt	V
Work	W	joule	J
Energy	E (or W)	joule	J
Power	P	watt	W

SI units may be made larger or smaller by using prefixes which denote multiplication or division by a particular amount.

Prefix	Name	Meaning
M	mega	multiply by 1 000 000 (i.e. $\times 10^6$)
k	kilo	multiply by 1000 (i.e. $\times 10^3$)
m	milli	divide by 1000 (i.e. $\times 10^{-3}$)
μ	micro	divide by 1 000 000 (i.e. $\times 10^{-6}$)
n	nano	divide by 1 000 000 000 (i.e. $\times 10^{-9}$)
p	pico	divide by 1 000 000 000 000 (i.e. $\times 10^{-12}$)

1-2-1 electrostatic charge (Q):

In physics, charge, also known as electric charge, or electrostatic charge and symbolized q, is a characteristic of a unit of matter that expresses the extent to which it has more or fewer electrons than protons, The unit of charge is the coulomb (C) where one coulomb is one ampere second. (1 coulomb = 6.24 x 1018 electrons). Thus, charge, in coulombs $Q = It$ where I is the current in amperes and t is the time in seconds.

Example 1: if a current of (5 A) flows for (2 minutes), find the quantity of electricity transferred?

Answer

Quantity of electricity $Q = It$ coulombs

$I = 5A$, $= 2 \times 60 = 120s$,

$hence\ Q = 5 \times 120 = 600C$

Example 2 : Calculate the quantity of electricity pass when a current of 0.45 amps Flows for 25mins?

Answer

Therefore we use the formula $Q=I*t$ to find Q

First convert 25 min into seconds

$t=25*60=1500$ seconds

Q=0.45∗1500

=675C

Example 3 :If 10 coulombs of charge passes a specified point in 2mins, how much current is flowing?

Answer

Current = charge / time

First convert 2 min into seconds

t=2*60 =120s

hence I= 10 / 120

= 0.083 A

1-2-2 Force (F):

The push or pull on an object with mass causes it to change its velocity. Force is an external agent capable of changing a body's state of rest or motion ,The SI unit of force is Newton(N) where one newton is one-kilogram meter per second squared. Thus, force, in Newton's

Where m is the mass in kilograms and a is the acceleration in meters per second squared. Gravitational force, or weight, is mg, where a = 9. 81 m/s.

$$F = ma$$

Example 4: A mass of 4 kg is accelerated at 2 m/s^2 by a force. Determine the force needed?

Answer

Force = mass x acceleration

= 5kg x 2m/s2 = 10 kg m/s2 = 10 N.

1-2-3 Work (W)

In physics, it is the amount of energy to move an object with a force over a distance.

To express this concept mathematically, the work W is equal to the force f times the distance d, or $W = f\,d$. The unit of work or energy is the joule (J) where one joule is one Newton meter.

Example 5: 10 Newton of force is applied on a body which displaces it by 2 meters. Calculate the work done by using the formula for work.

Answer

Given: Force (F) = 10N

Displacement (d) = 2 m

Using Formula for Work,

W = F.d

= (10)(2)

= 20Nm =20 J

1-2-4 Power (w)

is the amount of energy transferred or converted per unit time. In the International System of Units, the unit of power is the watt, equal to one joule per second .

Example 6: A mass of 1000 kg is raised through a height of 10 m in 20 s. What is the power developed?

Answer

Work done = force × distance

and force = mass × acceleration

W =F * d

F = m*a

W = m*a*d

=1000 kg * 9.81 m/s^2 *10 m

= 98100 J

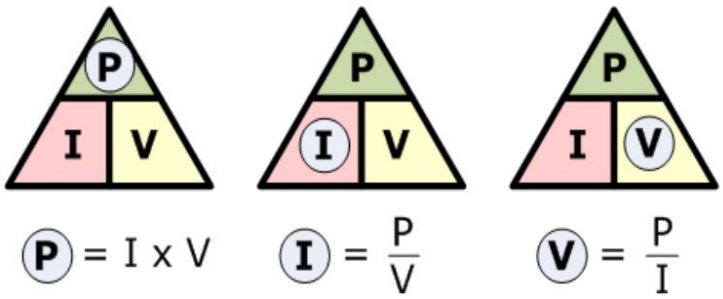
So, the work is W=98100J.

P= W/t

= 98100J/20s

= 4905 W

The power of the person is 4905 W.



Example 7: An electric heater consumes 1.8 M/J when connected to a 250 V supply for30 minutes. Find the power rating of the heater and the current taken from the supply.

Answer

P = W/t

$= \frac{1.8 * 10^6 \text{ J}}{30*60 \text{ s}}$

= 1000W

The power of the person is 1000W.

P = I*V

I = $\frac{P}{V}$

$$=\frac{1000\ W}{250\ V} = 4\text{A}$$

Hence, the current taken from the supply is 4 A

Example 8: The person applies a force of 7 N and moves the crate 3 m. This takes the person 9 seconds. What is the power of the person?

Answer

The first step is to calculate the work. This can be calculated according to

W=F * d

W= 7N * 3m

So, the work is W=21J.

P=W/t

P=21J/9s

The power of the person is 2.3W.

Thank You