4 Electrical Formulae and Constants

4.1 Basic

		Unit symbol
Series Resistors	$R_T = R_1 + R_2 + R_3 \dots$	Ω
Parallel Resistors	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \dots$	Ω 8
Potential Difference	$V = I\,R$	V
Power	$P = I\,V$ or $P = I^2 R$ or $P = \frac{V^2}{R}$	W
Energy (work done)	$W = P\,t$	J or kWh
Frequency	$f = \frac{1}{T}$	Hz

4.2 Electrostatics

Series Capacitors	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \dots$	F
Parallel Capacitors	$C_T = C_1 + C_2 + C_3 \dots$	F
Charge	$Q = I\,t$ or $Q = C\,V$	C
Capacitance	$C = \frac{A\,\varepsilon}{d} = \frac{A\,\varepsilon_0 \varepsilon_r}{d}$	F
Absolute Permittivity	$\varepsilon_0 \approx 8.854 \times 10^{-12}$	F/m

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4.3 Electromagnetism

Magnetomotive Force	$F = I\,N$	At or A
Magnetisation	$H = \frac{I\,N}{\ell}$	At/m or A/m
Reluctance	$S = \frac{l}{\mu\,A} = \frac{l}{\mu_o \mu_r A}$	At/Wb or A/Wb
Absolute Permeability	$\mu_0 = 4\pi \times 10^{-7}$	H/m

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4 Electrical Formulae and Constants

4.1 Basic

Unit symbol

Series Resistors R

T

=R

1

□R

2

□R

3

.... □

Parallel Resistors

1 R

T

=

R 1

1

□

R 1

2

□

R 1

3

.... □

8

Potential Difference V =I R V

Power P=I V or P=I 2R or P=

V R 2

W

Energy (work done) W =P t J or kWh

Frequency f =

T 1

Hz

- -

4.2 Electrostatics

Series Capacitors

1 C

T

=

C 1

1

□

C 1

2

□

C 1

3

....

F

Parallel Capacitors C

T

=C

1

□C

2

□C

3

.... F

Charge Q=I t or Q=C V C

Capacitance C=

$A\varepsilon d$

=

$A\varepsilon d$

$\varepsilon_0 \varepsilon_r$

F

Absolute Permittivity $\varepsilon_0 \approx 8.854\times10^{-12}$

F/m - - - - - -

- -

4.3 Electromagnetism

Magnetomotive Force F=I N At or A

Magnetisation H =

$I\,l$

N

At/m or A/m

Reluctance

S=

μ l

A

=

μ_o

l

At/Wb or A/Wb

Absolute Permeability □

0

□

r

A

$=4□\times10^{-7}$

H/m - - - - - - - - - -
- -

4.4 AC Circuits

			Unit Symbol
Force on a conductor	$F = B\, I\, \ell$		N
Electromotive Force	$E = B\, \ell\, v$		V
Instantaneous emf	$e = E \sin\theta$		V
Induced emf	$e = N \frac{d\,\Phi}{dt}$	$e = L \frac{di}{dt}$	V
RMS Voltage	$V_{rms} = \frac{1}{\sqrt{2}} \times V_{peak}$	$V_{rms} \approx 0.707\, V_{peak}$	V
Average Voltage	$V_{AV} = \frac{2}{\pi} \times V_{peak}$	$V_{AV} \approx 0.637\, V_{peak}$	V
Angular Velocity	$\omega = 2\pi f$		rad/s 17.7
Transformation Ratios	$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$		
Potential Difference	$V = I\, Z$		V
Power Factor	$\mathrm{pf} = \cos\phi$		
Capacitive Reactance	$X_C = \frac{1}{2\pi f C}$		Ω
Inductive Reactance	$X_L = 2\pi f L$		Ω
Admittance	$Y = \frac{1}{Z}$		S
True Power	$P = V\, I \cos\phi$		W
Reactive Power	$Q = V\, I \sin\phi$		VAr
Apparent Power	$S = V\, I^*$	$= P + jQ$	VA

Note: I^* is the complex conjugate of the phasor current. See 17

Thanks to Iain Smith, Aberdeen College

4.4 AC Circuits

Unit Symbol Force

on a conductor F=BIl N

Electromotive Force E=Blv V

Instantaneous emf e=E sin灼 V

Induced emf e=N

d dt

□

e=L

di dt

V

RMS Voltage V

rms

=

□2 1

×V

peak

V

rms

≈0.707V

peak

V

Average Voltage V

AV

=

□ 2

×V

peak

V

AV

≈0.637V

peak

V

Angular Velocity □=2□ f rad/s

17.7

Transformation Ratios

V

s V

p

N

s N

p

I

p I

s

Potential Difference V =I Z V

Power Factor pf =cos□

Capacitive Reactance X

C

=

=

=

2□ 1

f C

□

Inductive Reactance X

L

=2□ f L □

Admittance Y =

Z 1

S

True Power P=V I cos W

Reactive Power Q=V I sin VAr

Apparent Power S=V I* =P jQ VA

Note: I * is the complex conjugate of the phasor current. See

____ Thanks to Iain Smith, Aberdeen College