

Package ‘renpow’

July 23, 2025

Type Package

Title Renewable Power Systems and the Environment

Version 0.1-1

Date 2018-05-09

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Description Supports calculations and visualization for renewable power systems and the environment. Analysis and graphical tools for DC and AC circuits and their use in electric power systems. Analysis and graphical tools for thermodynamic cycles and heat engines, supporting efficiency calculations in coal-fired power plants, gas-fired power plants. Calculations of carbon emissions and atmospheric CO2 dynamics. Analysis of power flow and demand for the grid, as well as power models for microgrids and off-grid systems. Provides resource and power generation for hydro power, wind power, and solar power.

License GPL (>= 2)

URL <https://www.r-project.org/>

LazyData true

NeedsCompilation no

Depends R (>= 2.10)

Repository CRAN

Date/Publication 2018-05-16 14:01:38 UTC

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renpow-package

Renewable Power Systems and the Environment

Description

Supports calculations and visualization for renewable power systems and the environment. Analysis and graphical tools for DC and AC circuits and their use in electric power systems. Analysis and graphical tools for thermodynamic cycles and heat engines, supporting efficiency calculations in coal-fired power plants, gas-fired power plants. Supports carbon emissions and atmospheric CO2 dynamics. Grid, microgrids, and off-grid. Hydro power, wind power, and solar power.

Details

The DESCRIPTION file:

```

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Type:      Package
Title:     Renewable Power Systems and the Environment
Version:   0.1-1
Date:     2018-05-09
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Maintainer: Miguel F. Acevedo <acevedo@unt.edu>

```

Description: Supports calculations and visualization for renewable power systems and the environment. Analysis and graphi
 License: GPL (≥ 2)
 URL: <https://www.r-project.org/>
 LazyData: true

Index of help topics:

AC.DC.AC	AC-DC and DC-AC in the time domain
ACcircuits	AC in the time and frequency domain
ACharmonics	AC Harmonic Distortion
ACpower	AC power in the time and frequency domain
ASTMG173	Dataset: ASTM G173-03 standard
AirCvCpTK	Dataset: Specific heat of air vs temperature
CO2data	Dataset: CO2 monthly and annualy
CpCvT	Dataset: Specific heat of air vs Temp
Cseq	Carbon Sequestration
DCcircuits	DC circuits and power calculations
ERCOT	Dataset: ERCOT demand for year 2010
GlobTempAnom	Dataset: Global Surface Temperature Anomaly
TEODP2017	Dataset: Example of wind speed at two heights
Tides	Datasets: Tidal Harmonic Components
WaveHsTp	Dataset: Wave Duration
generator	Three-phase generator
grid	Electrical Power Grid
hydrology	Hydro Power Hydrology functions
hydropower	Hydroelectric Power Functions
magnetic.circuits	Magnetic circuit calculations
panels.plots	Plot utilities
pow.work	Mechanical power and work
renpow-package	Renewable Power Systems and the Environment
solarpower	Solar Power Functions
tau.bd	Dataset: monthly tau and bd for a location
test100	Dataset: simple example for 100 data points
thermodynamics	Thermodynamic paths and cycles
tidalpower	Tidal Power Functions
transformer	Transformer Circuits
wavepower	Wave Power Functions
windpower	Wind Power calculations and statistics

Author(s)

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References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

AC power

*AC power in the time and frequency domain***Description**

Calculates and plots AC power in the domain and phasors. Includes complex number calculations.

Usage

```
inst.pow.calc(x, freq = 60, nc = 2)
inst.pow.plot(x, rms = FALSE, freq = 60, nc = 2)
inst.pow.leg(ang, lab, ym, w, units, pf)
complex.pow.calc(xc, dig = 2, res = TRUE)
complex.pow.plot(cp)
complex.pow.tri(cp)
pf.corr(P, V, pf, pfc, w = 377, dig = 2)
pf.corr.tri(xpfc)
```

Arguments

x	list of voltage and current phasors
freq	frequency in Hz
nc	number of cycles to calculate and/or plot
rms	logical to decide to plot the rms value
ang	angles for legend
lab	label for legend
ym	magnitude for legend
w	angular frequency for legend and for pf correction
units	units for legend
pf	power factor for legend of inst.pow.leg or to be corrected by pf.corr
xc	list with voltage, current, and phase angle
dig	number of digits to round complex power
res	logical to print results of complex power
cp	output of complex power; a list
P	real power for pf correction
V	voltage for pf correction
pfc	target power factor
xpfc	output of pf.corr; a list

Details

inst.pow.calc calculates time domain instantaneous power given current and voltage phasors. Its output is passed to inst.pow.plot. inst.pow.plot produces time domain plots given current and voltage phasors. It uses inst.pow.leg to display legend

Value

w	angular frequency in rad/s
vm	array of magnitude
ang	array of angle
pf	power factor
pavg	average power
t	time sequence
v.i	matrix with voltage and current as a function of time
p	instantaneous power or power as a function of time
units	units for complex power result
S	apparent power
theta	phase angle
P	real power
Q	reactive power
pf	power factor
prnt	string to print results
cp	complex power output of pf.corr
cpc	complex power after correction
y	Voltage,current, and corrected params

Note

Functions used in Chapter Chapter 8 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

- Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)
- Irwin, J.D. and R.M. Nelms. 2011. Basic Engineering Circuit Analysis. 11th edition. 2011: Wiley.

See Also

Power electronics functions [ac.plot.rect](#), [rectifier](#), [inverter](#)

Examples

```

# power resistor
vm=170; R=10
x <- list(c(vm,0),c(vm/R,0))
inst.pow.plot(x)

# power capacitor
w <- 377; v.s <- c(170,0)
C=1000*10^-6
# current response
i.res <- c(v.s[1]*(w*C),v.s[2]+90)
x <- list(v.s,i.res)
inst.pow.plot(x)

# calc complex power
V.s=c(170,10); Z.p=c(10,20)
I.p <- div.polar(V.s,Z.p)
V <- V.s[1]/sqrt(2); I <- I.p[1]/sqrt(2)
theta <- V.s[2]-I.p[2]
cp <- complex.pow.calc(list(V,I,theta))

# pf correction
P=5; V=240; I=40; pfc=0.9
pf <- P*1000/(V*I)
# call pf correction function
pfcorr <- pf.corr(P,V,pf,pfc)
# visualize
pf.corr.tri(pfcorr)

```

AC waves and plots *AC in the time and frequency domain*

Description

Calculates and plots AC sinusoidal waves in the time domain and phasors. Includes complex number calculations.

Usage

```

waves(x, f = 60, nc = 2)
ac.plot(v.t, v.lab = "v(t)", v.units = "V", y.lab = "v(t)[V]", rms = FALSE)
phasor.plot(v.p, v.lab = "V", v.units = "V", lty.p = NULL)
polar(rec)
recta(pol)
mult.polar(x1,x2)
div.polar(x1,x2)
horiz.lab(nw, ym, tmax, ymax, units, yrms, rms)
wave.legend(nw, ang, lab, ym, w, units)

```

```

phas.leg(np, mag, ang, lab, units, lty.p)
gridcir(rmax)
sinplot(xlab, ylab)
arc(mag, ang)
rot.fig(vp, v.lab="wt")
admit(Z.r)
vector.phasor(V, I)

```

Arguments

x	AC variable given as a list of arrays. Each array contains two entries: magnitude and phase
f	Frequency in Hz, default 60 Hz
nc	Number of cycles to calculate and plot, default 2 cycles
v.t	Values of AC variable at time intervals calculated using waves
v.lab	Label for variable in time domain plot or phasor plot; time domain would typically include (t) and phasor would be upper case; also specifies label for angle in rot.fig
v.units	Units for variable in time domain plot or phasor plot; time domain would typically include (t) and phasor would be upper case
y.lab	Label for y axis composed of variable label and units
rms	Logical for whether the RMS value is added to the plot
v.p	Phasors to plot
lty.p	set of line types for plot and type of line for legend
rec	argument to polar array of rectangular coord
pol	argument to rect: array of magnitude and angle
x1, x2	complex numbers to multiply or divide by mult.polar and div.polar
nw	number of waves to assign horizontal lines
ym	magnitude array
tmax	max x axis value
ymax	max y axis value
units	units for lines and for legend
yrms	rms value to be used in y axis
ang	angle of waves or phasors
lab	label for legend
w	angular frequency for legend
np	number of phasors for legend
mag	magnitude of waves or phasors
rmax	max extent of polar grid for gridcir
xlab	xaxis label for sinplot
ylab	yaxis label for sinplot

vp	voltage for rot fig
Z, r	impedance in rectangular form
V	Voltage
I	Current

Details

Waves is first used to calculate values for time and the variable. Then the object created by wave is used by ac.plot. Functions polar() and recta() allow polar and rect conversion specifying phasors as arrays. Function mult.polar and div.polar are used for multiplication and division of phasors. Function horiz.lab plots horizontal lines with labels for magnitude and rms. Used mostly by other renpow functions. Function wave.legend and phas.legend write out waves and phasors for legend. Used mostly by other renpow functions. Function gridcir draws a polar grid. Used mostly by other renpow functions. Function arc draws an arc from 0 degrees to a phasor line specified by mag and ang. Used mostly by other renpow functions. Function admit calculates admittance given the impedance in rectangular form. Function vector.phasor specifies voltage and current phasors for plotting.

Value

Function waves:

w	angular frequency
t	time values
nw	number of waves
ym	magnitude values
ang	ang
y	values
yrms	rms values

Note

Functions used in Chapter 5, 8, and 10 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <Acevedo@unt.edu>

References

- Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)
- Irwin, J.D. and R.M. Nelms. 2011. Basic Engineering Circuit Analysis. 11th edition. 2011: Wiley.

See Also

Power electronics functions [ac.plot.rect](#), [rectifier](#), [inverter](#)

Examples

```

# from Chapter 5
# one wave show phase angle
x <- list(c(170,30)); v.t <- waves(x); ac.plot(v.t)

# two waves different magnitude and phase
x <- list(c(170,0),c(160,30)); v.t <- waves(x);
v.lab <- c("v1(t)","v2(t)"); v.units <- rep("V",2)
ac.plot(v.t,v.lab,v.units)

# one phasor
v.p <- list(c(170,10)); phasor.plot(v.p)

# phasors phase difference
v.units <- rep("V",2)
v.lab <- c("V1","V2")
# V1 leads V2
v.p <- list(c(170,70),c(170,50))
phasor.plot(v.p,v.lab,v.units)

# rect to polar
polar(c(2,1))
# polar to rect
recta(c(2,45))
# multiplication
x <- polar(c(1,2))
y <- polar(c(2,3))
mult.polar(x,y)

# from Chapter 8
# nodal analysis
Y1 <- 1/(5+5i); Y2 <- 1/(5+5i); Y3 <- 1/(10+10i)
Y <- matrix(c(Y1+Y2,-Y2,-Y2,Y3+Y2),ncol=2,byrow=TRUE)
Is <- c(1+0i,0+0i)
Vn <- solve(Y,Is)
VpIp <- vector.phasor(Vn,Is)
phasor.plot(VpIp$VI, c("V1","V2","Is1","Is2"),
             c("V","V","A","A"),lty.p=c(2,2,1,1))

```

Description

Calculates and plots AC sinusoidal waves in the time domain and phasors.

Usage

```
rectifier(v.t, full = FALSE)
ac.plot.rect(V.t, v.lab = "v(t)", v.units = "V", y.lab = "v(t)[V]", rms = FALSE)
inverter(x)
```

Arguments

<code>v.t</code>	Values of AC variable at time intervals calculated using waves
<code>full</code>	Logical to use full wave rectifier
<code>V.t</code>	output of rectifier
<code>v.lab</code>	Label for variable in time domain plot or phasor plot; time domain would typically include (t) and phasor would be upper case
<code>v.units</code>	Units for variable in time domain plot or phasor plot; time domain would typically include (t) and phasor would be upper case
<code>y.lab</code>	Label for y axis composed of variable label and units
<code>rms</code>	Logical for whether the RMS value is addedd to the plot
<code>x</code>	list(f,vin,nc): frequency, input voltage, number of cycles

Details

Calculations of basic power electronics devices

Value

<code>V.t</code>	output of rectifier list(w,t,nw,ym,ang,y,yrms,yavg)
<code>vtr</code>	Values of rectified AC variable at time intervals calculated using rectifier

Note

Used in Chapter 5 of Acevedo 2018

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Irwin, J.D. and R.M. Nelms. 2011. Basic Engineering Circuit Analysis. 11th edition. 2011: Wiley.

See Also

AC functions [ac.plot](#), [phasor.plot](#), [waves](#)

Examples

```
# rectified wave
v.AC <- list(c(170,0))
v.t <- waves(v.AC,nc=4)
V.t <- rectifier(v.t)
ac.plot.rect(V.t)

# inverter
x <- list(f=60,vin=170,nc=2)
inverter(x)
```

AirCvCpTK

*Dataset: Specific heat of air vs temperature***Description**

Specific heat of air vs absolute temperature

Usage

```
data("AirCvCpTK")
```

Format

Three columns text file with header

Details

Used to estimate coefficients of C_p and C_v vs T

Source

data from https://www.ohio.edu/mechanical/thermo/property_tables/air/air_Cp_Cv.html

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
AirCvCpTK
```

ASTMG

Dataset: ASTM G173-03 standard

Description

ASTM G173-03 standard

Usage

```
data("ASTMG173")
```

Format

list with location, lat-long-elev, and two columns for tau (b, d)

Details

Optical depth

Source

ASTM. ASTM G173 - 03(2012), 2017. Standard Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37 deg Tilted Surface. Accessed November 2017. Available from: <https://www.astm.org/Standards/G173.htm>

Gueymard, C.A., 2004. The sun's total and spectral irradiance for solar energy applications and solar radiation models. *Solar Energy* 76(4):423-453.

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
X <- ASTMG173
```

CO2*Dataset: CO2 monthly and annualy*

Description

Atmospheric CO2 monthly and annualy

Usage

```
data("CO2monthly")  
data("CO2annual")
```

Format

CO2 monthly is CO2 expressed as a mole fraction in dry air, micromol/mol, abbreviated as ppm a record has: year, month, decimal-date, average, interpolated, trend-season-corr, days For instance: 1958 3 1958.208 315.71 315.71 314.62 -1 CO2 annual has three values Year, Avg, Uncorrected

Details

CO2 monthly and annual

Source

NOAA. Trends in Atmospheric Carbon Dioxide. 2017. NOAA, Earth System Research Laboratory, Global Monitoring Division. Accessed June 2017. URL: <http://www.esrl.noaa.gov/gmd/ccgg/trends/>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
data(CO2monthly)
```

CpCvT*Dataset: Specific heat of air vs Temp*

Description

Specific heat of air vs Temp

Usage

```
data("CpCvT")
```

Format

Three columns text file with header

Details

Used to estimate coefficients of C_p and C_v vs T

Source

data from https://www.ohio.edu/mechanical/thermo/property_tables/air/air_Cp_Cv.html

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
X <- CpCvT
```

DC circuits

DC circuits and power calculations

Description

Calculates and plots DC V-I response as well as transient response

Usage

```
resistor(V,R)
ivplane(x, x0 = FALSE, y0 = FALSE)
diode(V)
vsource(Voc,Rs)
isource(Isc,Rp)
PVcell(x.PVcell)
PVcell.plot(y.PVcell)
eff.pow(x.eff.pow)
transient(ys, tau, ylabel, ylabel)
fuel.cell(x.fcell)
```

Arguments

V	Voltage
R	Resistance
x	Result of function resistor, diode, vsource, or isource
x0	Logical argument to plot2axis

y0	Logical argument to plot2axis
Voc	Open circuit voltage
Rs	Series resistance
Isc	Short circuit current
Rp	Parallel resistance
x.PVcell	list(I0.A, Isc.A, Area, Rs, Rp, Light)
y.PVcell	output of PVcell
x.eff.pow	list(Rth,Voc)
ys	Source for transient calculation
tau	Time constant
ylabel	y axis label for transient plots
yslabel	Source label for transient plots
x.fcell	list(area.cm2,Rload.ohm)

Details

Object x contains all the calculated values which can be passed to function ivplane to plot the graphs.

Value

V	Voltage
I	Current
P	Power
txt	labels
Light	Light levels from PVcell

Note

Functions used in Chapter 3 and Chapter 5 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

- Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)
- Irwin, J.D. and R.M. Nelms. 2011. Basic Engineering Circuit Analysis. 11th edition. 2011: Wiley.

Examples

```

# from Chapter 3
# resistors
V <- seq(-0.2,1,0.01) # volts
x <- resistor(V,R=1)
ivplane(x)

# diode
V <- seq(-0.1,0.6,0.01) # volts
x <- diode(V)
ivplane(x)

# voltage source
x <- vsource(Voc=24,Rs=1)
ivplane(x)
# current source
x <- isource(Isc=20,Rp=1)
ivplane(x)

# PV cell
x <- list(I0.A=1, Isc.A=40, Area=100, Rs=0.05, Rp=1, Light=1)
# units: I0.A pA/cm2 Isc.A mA/cm2 Area cm2 Rs ohm Rp ohm
X <- PVcell(x)
ivplane(X,x0=TRUE,y0=TRUE)

# efficiency of power transfer
x <- list(Rth=1,Voc=24)
eff.pow(x)

# from Chapter 5
# RC circuit transient
R=0.2;C=1 # Mohm and uF
transient(ys=12,tau=R*C,ylabel="Vc(t) [V]",ylabel="Vs [V]")

# RL circuit transient
R=20;L=1; # kohm and mH
transient(ys=12/R,tau=L/R,ylabel="iL(t) [A]",ylabel="Vs/R [V]")

# Chapter 6 fuel cells
x <- list(area.cm2=15,Rload.ohm=NA)
fuel.cell(x)
x <- list(area.cm2=15,Rload.ohm=0.5)
fuel.cell(x)

```

ERCOT

Dataset: ERCOT demand for year 2010

Description

ERCOT load year 2010 by region

Usage

```
data("ERCOT2010")  
data("ERCOT2010.01")
```

Format

Day and Hour, followed by demand for 8 regions, and demand total ERCOT Header: Hour_End
COAST EAST FAR_WEST NORTH NORTH_C SOUTHERN SOUTH_C WEST ERCOT Ex-
ample of record: 1/1/2010 1:00 7775.679969 1238.21679 1237.781607 950.698047 12406.20808
2467.652377 5032.076127 1059.772842 32168.08584

Details

Example demand grid

Source

ERCOT. Hourly Load Data Archives. 2017. Accessed October 2017. Available from: <http://www.ercot.com/gridinfo/load/load>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with
R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
data(ERCOT2010.01)
```

GlobTempAnom

Dataset: Global Surface Temperature Anomaly

Description

Global Surface Annual Temp Anomaly

Usage

```
data("GlobTempAnom")
```

Format

Year, average, and Five-year Avg For instance: 1880 -0.20 -0.13

Details

Global Surface Temp

Source

NASA. Global Climate Change. Vital Signs of the Planet. 2017. Accessed June 2017. Available from: <http://climate.nasa.gov/vital-signs/global-temperature/>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
data(GlobTempAnom)
```

grid

Electrical Power Grid

Description

Electric power systems calculations including buses and loads

Usage

```
infinite.bus(x)
seg.ts(Xts,dh0,dhf,var)
series.plot(x.t)
daily.min.max(x.t.y, ylabel, inst.cap, inst.lab)
load.duration(x.t.y, inst.cap, inst.lab)
```

Arguments

x	parameters for infinite bus a list(V,X,E,delta):V Voltage, X Reactance, E array of electromotive force, delta array of angle delta
Xts	data frame with ts values
dh0	intial time stamp
dhf	final time stamp
var	variable number to select
x.t	time series to plot
x.t.y	load time series for daily.min.max plots and load-duration curve
ylabel	label for min max
inst.cap	array of installed capacities
inst.lab	array of labels for installed capacities

Details

`infinite.bus` uses a fixed `V` and `X`, and plots the effect of a set of `E` and angle `delta` daily.`min.max` draws a plot showing daily maximum and minimum along with horizontal lines for installed capacities.`load.duration` builds a load-duration curve and calculate CF for daily load data and a set of generation capacities

Value

Hours	number of hours for each class
energy	total energy under curve
possible	possible utilization for each class
utilization	actual utilization for each class
CF	capacity factor for each class

Note

Functions used in Chapter 11 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
x <- list(V=13.8,X=1,E=seq(14,16,1),delta=seq(6,30,1))
infinite.bus(x)

X <- ERCOT2010
x.t <- seg.ts(X,dh0="1/1/2010 1:00",dhf="1/1/2011 0:00",c(1:9))$x.t

# week day Monday Jan 04 2010
x.t.wd.wt <- seg.ts(X,dh0="1/4/2010 0:00",dhf="1/4/2010 23:00",c(1,5,7))$x.t.seg
series.plot(x.t.wd.wt)

# week Sunday Jan 24 to Saturday Jan 30 2010
x.t.wd.wt <- seg.ts(X,dh0="1/24/2010 0:00",dhf="1/30/2010 23:00",c(1,5,7))$x.t.seg
series.plot(x.t.wd.wt)

# NORTH_C
x.t.y <- x.t[,5]; ylabel <- colnames(x.t)[5]; inst.cap <- c(10000,8000,8000) #MW
inst.lab <- c("Baseload","Intermediate", "Peaking")
daily.min.max(x.t.y,ylabel,inst.cap,inst.lab)

x.t.y <- x.t[,5]
inst.cap <- c(10000,8000,8000) # MW
```

```
inst.lab <- c("Baseload","Intermediate", "Peaking")
load.duration(x.t.y, inst.cap,inst.lab)
```

harmonics	<i>AC Harmonic Distortion</i>
-----------	-------------------------------

Description

Calculates harmonic distortion

Usage

```
harmonic(x, harm.odd, lab.units)
```

Arguments

x	list of arrays c(mag,phase) with fundamental magnitude and phase
harm.odd	fraction of odd harmonics with respect to the fundamental
lab.units	label for units

Details

Function harmonic performs calculations and plots, including odd harmonics and THD.

Value

t	Time sequence
Itot	Total currents
Isum	Sum of currents in neutral
THD	Total Harmonic Distortion

Note

Functions used in Chapter 10 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

See Also

AC waves and plots [ac.plot](#), [phasor.plot](#), [waves](#) three-phase [generator](#)

Examples

```
# single phase harmonics
x <- list(c(10,0)); harm.odd <- list(c(0.2,0.1,0.05)); lab.units <- "I [A]"
y <- harmonic(x,harm.odd,lab.units)

# three-phase harmonics
x <- list(c(10,0),c(10,-120),c(10,120))
harm.odd <- list(c(0.2,0.1,0.05),c(0.2,0.1,0.05),c(0.2,0.1,0.05))
lab.units <- "I [A]"
y <- harmonic(x,harm.odd,lab.units)
```

Hydro Power	<i>Hydroelectric Power Functions</i>
-------------	--------------------------------------

Description

Basic calculations in hydroelectric power generation

Usage

```
P.hA(x)
P.Qh(x)
Pmax.Qh(x)
Pe.Pw(x)
Pmax.Qh.plot(x)
turbine.regions(type)
turbine.regions.all()
pipe.loss(pipe)
```

Arguments

x	a list with possible h, A, Q, nu, plab: head, cross-area, flow, efficiency,label
type	a turbine type from 'kaplan', 'francis', 'pelton', 'crossflow', 'slh'
pipe	a list Q, d, L, mat: flow, diameter, length, and material. Component mat is one of 'pvc', 'concrete', 'steel', 'galvanized', 'poly'

Details

Basic calculations of hydropower

Value

X	result of P.hA(x) is array with Head(m),Vel(m/s),Area(m2),Flow(m3/s), and Power(in kW or MW)
X	result of P.Qh(x) is array with Head(m),Flow(m3/s),and Power(in kW or MW)

X	result of Pmax.Qh(x) is array with Gross head (m),Net head (m),Flow(m3/s),and Power(in kW or MW)
X	result of Pe.Pw(x) is array with GrossHead(m),NetHead(m),Flow(m3/s),Press(kPa),Eff, PowWater9in kW or MW), and PowGen(in kW or MW)
X	result of pipe.loss(pipe) is array with Head loss(m), and Roughness

Note

Functions used in Chapter 12 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
# head 3 m and cross-sectional area of 2 m2
x <- list(h=3,A=2); P.hA(x)

x <- list(Q=1000,h=15); Pmax.Qh(x)

x <- list(Q=1000,h=15,nu=0.9); Pe.Pw(x)

x <- list(h=1,Q=100); P.Qh(x)

x <- list(Q=1000,h=15,plab="A"); Pmax.Qh.plot(x)
turbine.regions(type='francis')

x <- list(Q=0.01,d=0.075,L=200,mat='pvc')
hL <- pipe.loss(x)[1,1]
x <- list(h=30-hL,Q=0.01,nu=0.9)
P.Qh(x)
```

Hydro Power Hydrology *Hydro Power Hydrology functions*

Description

Hydrological calculations in hydroelectric power generation

Usage

```

area.vol(xav)
model.flow(mf)
flow.plot(flow, label)
flow.exc.plot(flow, exc, label)
exceed(flow)
annual.avg(mf, nyrs)

```

Arguments

xav	area.vol is a list(H,B,W,L) H pool elevation (m), B bottom elevation (m), W width (km), L tail length (km)
mf	list(base.flow,peak.flow,day.peak,length.season,variab,coef)
flow	flow time series resulting from model.flow
label	label for flow
exc	exceedance levels as a result of exceed
nyrs	number of years

Details

Basic hydrological calculations for hydropower

Value

X	list(y,proby, prob, Q, Prob.Qmean, prob.Q)
flow	flow time series from model.flow
Xtm	annual avg of flow time series from model.flow

Note

Functions used in Chapter 12 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```

x <- list(H=130,B=100,W=10,L=100)
area.vol(x)

x <- list(base.flow=20,peak.flow=100,day.peak=200,length.season=90,
          variab=c(0.01,2),coef=c(0.4,0.3,0.2,0.1))

```

```

flow <- model.flow(x)
flow.plot(flow,label="Simulated flow (m3/s)")
exc <- exceed(flow)
exc$prob.Q
flow.exc.plot(flow,exc,label="Simulated flow (m3/s)")

```

magnetic circuits *Magnetic circuit calculations*

Description

Calculates magnetic elements and circuits

Usage

```

reluctance(x)
inductor(x)
flux(x)

```

Arguments

x	argument to reluctance or to inductance. For reluctance it is a list of one or more arrays; for instance, one array c(mu,l,A) where mu is relative permeability, l is path length, and A is cross-area. For inductance it is a list(N,rel) where N is number of turns and rel is reluctance For flux it is a list(N,i,rel) where N is number of turns, i is current, and rel is reluctance
---	--

Details

Function reluctance calculates reluctance in MA-turn/Wb from mu relative permeability, l path length, and A cross-area. Function inductor calculates inductance in mH from number of turns N and reluctance Function flux calculates magnetic flux from number of turns, current, and reluctance

Value

rel	reluctance value from reluctance, inductor, or flux functions
prnt	printout of reluctance, inductance, or flux including value and units
L	inductance value from inductor or flux functions
mmf	magnetomotive force or mmf
flux	magnetic flux value

Note

Functions used in Chapters 5 and 10 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <Acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Irwin, J.D. and R.M. Nelms. 2011. Basic Engineering Circuit Analysis. 11th edition. 2011: Wiley.

Examples

```
# Chapter 5 simple inductor
mu=1000; l=1*10^-2; A=pi*(1*10^-3)^2
reluc <- reluctance(x=list(c(mu,l,A)))
reluc$prnt
ind <- inductor(x=list(N=159,rel=reluc$rel))
ind$prnt

# Chapter 10 air gaped inductor
mucore=1000; lcore=6*10^-2; Acore=1*10^-4
mugap=1; lgap=1*10^-3; Agap <- Acore
reluc <- reluctance(x=list(c(mucore,lcore,Acore),c(mugap,lgap,Agap)))
reluc$prnt

rel.eq <- reluc$rel[1]+reluc$rel[2]
ind <- inductor(x=list(N=100,rel=rel.eq))
ind$prnt

magckt <- flux(x=list(N=10,i=1,rel=rel.eq))
magckt$prnt

magckt <- flux(x=list(N=10,i=1,r=reluc$r[2]))
magckt$prnt
```

panels plots

Plot utilities

Description

Uses layout to plot several graphs on a page and plot on two vertical axis

Usage

```
panels(wd, ht, rows, cols, pty, int = "r")
plot2yaxis(x, x0 = FALSE, y0 = FALSE)
```

Arguments

wd	Width
ht	Height
rows	number of rows
cols	number of columns
pty	type
int	axis intersection
x	Variable x for horizontal axis and variables y1, y2 for vertical axes
x0	Logical to select axis limit
y0	Logical to select axis limit

Details

Function panels makes more efficient use of space than par(mfrow)

Note

Util functions used in most chapters of Acevedo (2018)

Author(s)

Miguel F. Acevedo <Acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
wd=6; ht=3
panels(wd,ht,1,1,pty="m")
t <- seq(0,60,0.1)
x <- pow.work(t,pow="const",p=2)
pow.work.plot(x)

wd=7; ht=3.5
panels(wd,ht,1,2,pty="m")
# diode
V <- seq(-0.1,0.05,0.01) # volts
x <- diode(V)
ivplane(x)
V <- seq(-0.1,0.6,0.01) # volts
x <- diode(V)
ivplane(x)
```

pow.work

Mechanical power and work

Description

Calculates and plots mechanical power and work.

Usage

```
pow.work(t, pow = "const", p)
pow.work.plot(x)
```

Arguments

t	Values of a time sequence for calculation of power
pow	Mode of power calculation, constant or linear
p	Value of power for constant or slope for linear
x	power object calculated from pow.work

Details

A call to pow.work requires three arguments: a time sequence, a type of power function such as constant or linear, and a value of power for the parameter of the function.

Value

The output of pow.work contains the values of power and work as a function of time. Then we call the plot function using its output as argument to the pow.work.plot function

t	time sequence
p.w	matrix containing with power and work

Note

Functions used in Chapter 1 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
t <- seq(0,60,0.1)
x <- pow.work(t,pow="const",p=2)
pow.work.plot(x)

x <- pow.work(t,pow="linear",p=0.025)
pow.work.plot(x)
```

sequestration	<i>Carbon Sequestration</i>
---------------	-----------------------------

Description

Simulates carbon sequestration

Usage

```
forest.seq(x, y)
```

Arguments

- x parameters for forest growth; a list(t,B0,Bmax,nu,r): t time sequence,B0 Biomass at time zero, Bmax Maximum Biomass (parameter of Richards equation), nu Coefficient exponent to adjust shape (parameter of Richards equation), r Growth rate (parameter of Richards equation)
- y Specifications of power plant emissions a list(kgCO2.kWh,P,C): kgCO2.kWh kg of CO2 per kWh produced, P Power produced, C carbon content

Details

forest.seq produces rates, area, and a plot of C forest sequestration dynamics

Value

- yr.max time in years to achieve biomass for max rate
- B.i required biomass in t/ha to sequester at max rate
- max.dCO2 max rate
- tCO2.emiss carbon emission sequestered
- area area required

Note

Functions used in Chapter 9 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
forest <- list(t=seq(0,100),B0=1,Bmax=150,nu=0.5,r=0.3)
plant <- list(kgCO2.kWh=0.4,P=10^9,C=1.0)
forest.seq(x=forest,y=plant)
```

Solar Power	<i>Solar Power Functions</i>
-------------	------------------------------

Description

Basic calculations in solar power generation including irradiance and sun path

Usage

```
I0.orbit(leap = FALSE, plot = TRUE)
days.mo(day, leap = FALSE)
declination(leap=FALSE,plot=TRUE)
sun.elev(xdec,lat,plot=TRUE)
read.tau(file)
beam.diffuse(dat,plot=TRUE)
I0.blackbody(T.sun, wl.nm, plot = TRUE)
spectral(X, label, wl.lim.nm, T.sun, plot.surf = FALSE)
useful.waste(I0.bb)
sun.path(lat, nday, plot = TRUE)
sun.diagram(lat)
collector(Ibd, sunpath, tilt, azi.c, fr, label = "")
month.prod(dat)
tilt.adj(lat, days, labels)
one.axis.tracking(dat, mode = "PNS")
two.axis.tracking(dat)
```

Arguments

leap	logical to use a leap year
plot	logical to plot
day	day of the year for a given day in the month
xdec	result from declination
lat	latitude
file	filename

T.sun	temp sun
wl.nm	wavelength in nm
X	data read from file
label	label for plot
wl.lim.nm	limits for wavelength
plot.surf	logical plot together with surface data
dat	data from file
I0.bb	output from I0.blackbody
nday	day number
Ibd	Irradiance: direct beam and diffuse
sunpath	elev and azimuth from the output of sun.path
tilt	collector tilt angle
azi.c	orientation of collector
fr	fraction reflected
days	days
labels	labels
mode	tracking mode

Details

Basic calculations of solar power

Value

I0	result of I0.orbit: values of daily ET solar irradinace
day.mo	result of day.month: day numbers beginning at day
dec	result of declination: ne equinox day and values of daily declination
elev	result of sun elev: ne equinox day, latitude, and and values of daily sun elev
tau	list(loc, lat.long.elev, tau)
Ibd	list(day21.mo,tau,air.mass,lat,Ib,Id,Id.Ib)
I0.bb	list lambda,I.sun.nm,I0
sunpath	list nday, hr.noon, azi, elev
Ic	list(Ib,Id,Ibc,Idc,Irc,Ic,I.h)

Note

Functions used in Chapter 14 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

See Also

DC circuits [PVcell](#), [PVcell.plot](#)

Examples

```
I0.orbit()
declination()

x <- declination(plot=FALSE)
sun.elev(x,lat=32.9)

tau <- tauGolden
# or alternatively
# tau <- read.tau(system.file("extdata","tauGolden.csv",package="renpow"))
Ibd <- beam.diffuse(tau)

I0.blackbody(T.sun=5800,w1.nm=seq(150,2500))
```

tau and bd

Dataset: monthly tau and bd for a location

Description

Optical depth for a location

Usage

```
data("tauGolden")
data("tauAtlanta")
```

Format

list with location, lat-long-elev, and two columns for tau (b, d)

Details

Optical depth

Source

ASHRAE. ASHRAE Climate Data Center. 2017. Accessed November 2017. Available from: <https://www.ashrae.org/resources-publications/bookstore/climate-data-center#std169>.

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
tau <- tauGolden$tau
```

TEO at DP 2017

Dataset: Example of wind speed at two heights

Description

Example summer 2017 TEO station at DP campus. Includes wind speed at two heights, air temp two heights, BP, RH, Wind dir

Usage

```
data("TEODP2017")
```

Format

Text file with header x specifying the variable name

Details

Example for wind speed height calibration

Source

<http://teo.unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
v1.v2 <- TEODP2017[,c(1,8,4)]
```

test100*Dataset: simple example for 100 data points*

Description

Hypothetical Example

Usage

```
data("test100")
```

Format

Text file with header x specifying the variable name and one field per line with no separator between fields

Details

Example for scanning files

Source

acevedo

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
x100 <- test100$x
```

thermo paths*Thermodynamic paths and cycles*

Description

Functions to calculate thermodynamic paths and cycles

Usage

```

cpcv.cal(datafile, plots = FALSE)
RefCoefAir
cp.cv(TC,ref=RefCoefAir)
fcp(TC)
fcpcv(TC)
fcv(TC)
fpv(V,p)
simpson(fun, a, b, pts = 100)
simpson.pv(nRT, a, b, pts = 100)
path.calc(x)
path.summary(y)
isochor(x)
isobar(x)
adiabat(x)
isotherm(x)
phase()
path.lines(x, plane = "Pv", shade.between = FALSE, lab.cycle = FALSE, shade.cycle = FALSE)
path.cycles(x, plane = "Pv", shade.cycle = FALSE)
path.cycles.summary(y)

```

Arguments

datafile	name of file for calibration
plots	Logical TRUE for plot
TC	Temp in deg C
ref	Ref and Coef argument to cp.cv; default is RefCoefAir
V	Volume
p	Pressure
fun	function to integrate
a	lower bound of interval
b	upper bound of interval
pts	number of points within the interval
nRT	gas law to calculate pV
x	argument specifying the states for any of isochor, isobar, adiabat, and isotherm path functions. These functions are used internally by path.calc. Argument x of path.calc specifies states for each one of isotherm, adiabat, isochor, isobar: V, P, n, T, M, S or to path.lines shade.under is a logical and part of the x argument specification; it is used by path.lines to shade area under the curve for a given path; default=FALSE or no shade. Argument x is also an argument to path.cycles as list of states in the cycle and cycle type; "carnot", "brayton", "otto", "diesel", "stirling", "box"
y	argument to path.summary or to path.cycles.summary: return from any path function as list(v,V,P,T,s,S,W,Q,cv,cp,gamma,WQtot,call,nM)

shade.between	logical used by path.lines to shade area between to paths; default=FALSE or no shade
lab.cycle	logical used by path.lines to label paths as a thermodynamic cycle; default=FALSE or no cycle
shade.cycle	logical used by path.lines and path.cycles to shade area within a thermodynamic cycle; default=FALSE or no shade
plane	Thermodynamic plane "Ts" or "Pv" to draw cycle. Default is Pv

Details

Function `cpcv.cal` calibrates heat capacities as a function of temperature from a datafile. Results for data file `AirCvCpTK.csv` (same as dataset `AirCvCpTK`) are stored in `RefCoefAir` for easy reference. The result of `cpcv.cal` for other files can be used for the argument `ref` of `cp.cv`. Function `cp.cv` calculates heat capacity at a given temperature. Simpson integrates a function and `simpson.pv` integrates pv work using gas law. Function `path.calc` arguments, `V` is an array with values of `V1` and `V2`, `P` is array of corresponding pressure values, `T` can be left unspecified and calculated from `P` and `V`. Argument `path` declares the type of process. argument `lab` are labels for the initial and final states of the path. Default values are one mole of dry air with $M = 28.97$. Other calculation modes such as providing `T` instead of `P`, to calculate temperature from pressure and volume. The call `y<-path.calc(x)` produces `y` that contains values of specific volume (m^3/kg), volume (liters), pressure (bar), temperature ($degC$), specific heat `W` and work `Q` in kJ/kg , heat capacities in kJ/kgK , and gamma. By default there are 1001 points calculated. Function `path.summary(y)` provides a view of the `path.calc` results. Function `path.lines(x)` uses `path.calc` and helps visualize a paths `x`; or a list of paths, e.g., `list(x1,x2)` where `x1` and `x2` are paths. These paths could be more than 2 and form a thermodynamic cycle. Function `path.cycles` calculates and plots a thermodynamic cycle Function `path.cycles.summary(y)` provides a view of the `path.cycles` results

Value

<code>TK.ref</code>	<code>T</code> ref in K
<code>cv.ref</code>	<code>cv</code> ref
<code>cpcv.ref</code>	<code>cp</code> to <code>cv</code> ratio ref
<code>cv.coef</code>	<code>cv</code> coefficients
<code>cpcv.coef</code>	<code>cp</code> to <code>cv</code> ratio coefficients
<code>cv</code>	<code>cv</code> per mole
<code>cp</code>	<code>cp</code> per mole
<code>cp.cv</code>	<code>cp</code> to <code>cv</code> ratio
<code>cv.kg</code>	<code>cv</code> per kg
<code>cp.kg</code>	<code>cp</code> per kg
<code>s</code>	integration result by Simpson method
<code>y</code>	return list from <code>path.calc</code> or <code>path.cycles</code> . Used by <code>path.summary</code> and by <code>path.lines</code> as well as by <code>path.cycles.summary</code>
<code>start.end</code>	start and end of path
<code>WQtot</code>	Total work and heat

pts	number of points calculated
call=y\$call	function called
nM	Number of moles

Note

Functions used in Chapter 4 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
# heat capacities at a given temperature, say 100C
cp.cv(TC=100)

# cv at the middle of a range of temperature
cp.cv(TC=(323+25)/2)$cv

# arguments: V(l), P(bar), T(C), n(mol), M(g/mol)
# default n=1,M=28.9
# example specify V and P
x <- list(V=c(24.78,NA),P=c(1,2),path='isochor',lab=c("1","2"))
y <- path.calc(x)
path.summary(y)

# specify volume and calculate pressure
x <- list(V=c(24.78,34.78),P=c(1,NA),path='isobar',lab=c("3","4"))
y <- path.calc(x)
path.summary(y)

# example specify V and T visualize the path
x <- list(V=c(10,30),T=c(30,NA),path='isotherm',lab=c("1","2"))
path.lines(x)

# visualize two paths
x1 <- list(V=c(24.78,NA),P=c(1,2),path='isochor',lab=c("1","2"))
x2 <- list(V=c(24.78,34.78),P=c(1,NA),path='isobar',lab=c("3","4"))
path.lines(list(x1,x2))

# visualize two paths and shade in between curves
x1 <- list(V=c(10,30),T=c(200,200),path='isotherm',lab=c("3","4"))
x2 <- list(V=c(10,30),T=c(30,30),path='isotherm',lab=c("1","2"))
x <- list(x1,x2)
path.lines(x,shade.between=TRUE)
```

```
# carnot cycle
x <- list(TH=200,TL=30,V1=20,V4=40,cty='carnot')
y <- path.cycles(x,shade.cycle=TRUE)
```

three-phase

Three-phase generator

Description

Calculates three-phase generator

Usage

generator(x)

Arguments

x parameters for generator: list(S3p, V1.rms, pf, lead.lag, Zs.r) where: S3p rated three-phase apparent power, V1.rms line voltage as rms, pf load power factor, lead.lag is -1 or +1, and Zs.r armature impedance in rectangular form

Details

Function generator produces E, Vp, and Il in polar form and a phasor diagram.

Value

E.p	electromotive force in polar form
Vp.p	Phase voltage generated in polar form
Il.p	Line current generated in polar form
ys	Source results

Note

Functions used in Chapter 10 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

See Also

AC functions [ac.plot](#), [phasor.plot](#), [waves](#)

Examples

```
x <- list(S3p = 15*10^6, V1.rms = 13.8*10^3, pf=0.85, lead.lag=-1, Zs.r = c(0.1,2))
generator(x)
```

```
x <- list(S3p = 15*10^6, V1.rms = 13.8*10^3, pf=0.85, lead.lag=1, Zs.r = c(0.1,2))
generator(x)
```

Tidal Data

Datasets: Tidal Harmonic Components

Description

Harmonic components for tides

Usage

```
data("ElevationTide")
data("VelocityTide")
data("EastportTide")
data("CutlerFarrisTide")
data("PortAransasTide")
data("AnchorageTide")
```

Format

Harmonic components

Details

Tidal calculations

Source

National Ocean Service. Currents, Tidal Currents 1. 2017. NOAA, National Oceanic and Atmospheric Administration, Accessed October 2017. Available from: https://oceanservice.noaa.gov/education/tutorial_currents/0

NOAA. Harmonic Constituents - Station Selection. 2017. NOAA. Accessed October 2017. Available from: <https://tidesandcurrents.noaa.gov/stations.html?type=Harmonic+Constituents>.

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
data(ElevationTide)
data(VelocityTide)
```

Tidal Power	<i>Tidal Power Functions</i>
-------------	------------------------------

Description

Calculations in tidal power generation

Usage

```
read.tide(file)
harmonics.tide(x, days, ylabel, plot)
power.barrage.cycle(xba)
find.peaks(tz, band)
tide.current.abs(tz, ylabel, plot)
tidal.power(tz, Aflow)
```

Arguments

file	filename for tide files in extdata
x	a tidal dataset read from file
days	number of days
ylabel	label for y axis of plot default for harmonics.tide is "Tide wrt MSL (m)" default for tide.current.abs is "Current abs (m/s)"
plot	logical to decide to plot default is TRUE
xba	list(a,Abasin,z,nu): a center of mass at half the tidal range, Abasin tidal basin area, z tidal cycle range, nu efficiency
tz	time and tide height in tidal signal produced by harmonics.tide or rectified by tide.current.abs
band	threshold band to find peaks
Aflow	cross section area for tidal power generation

Details

Basic calculations for tidal power

Value

X	list(t,z,x) tide time series
X	list(xp,tp,range)
X	list(pow.tide.MW,pow.gen.MW,gen.MWh)

Note

Functions used in Chapter 12 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
# using extdata
x <- read.tide(system.file("extdata", "AnchorageTide.csv", package = "renpow"))
harmonics.tide(x, days=29)

x <- read.tide(system.file("extdata", "VelocityTide.csv", package="renpow"))
y <- harmonics.tide(x, days=15, ylabel="Velocity m/s")
tide.current.abs(y, ylabel="Velocity (abs val) (m/s)", plot=TRUE)
y <- harmonics.tide(x, days=365, ylabel="Velocity m/s", plot=FALSE)
z <- tide.current.abs(y, ylabel="Current abs (m/s)", plot=TRUE)
tidal.power(z, Aflow=1)

x <- read.tide(system.file("extdata", "ElevationTide.csv", package="renpow"))
y <- harmonics.tide(x, days=29)
y <- harmonics.tide(x, days=365)
z <- find.peaks(y, band=c(0,1))
```

transformer

Transformer Circuits

Description

Calculates tranformer circuits

Usage

```
xformer.ckt(x, dig = 2)
```

Arguments

x	list(N,Vs.p,Zs.r,Zo.r,Zl.r): these are N turns ratio, Vs.p Voltage source in polar form, Zs.r Source impedance in rectangular form, Zo.r Output impedance in rectangular form, Zl.r Load impedance in rectangular form.
dig	number of digits for results

Details

xformer.ckt transformer circuit calculations using source, impedances, and load,

Value

ys	Source results
yx	Transformer results
y1	Load results
prnt	Results of transformer function for printout form

Note

Functions used in Chapter 10 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

See Also

AC functions [ac.plot](#), [phasor.plot](#), [waves](#)

Examples

```
x <- list(N=c(2,1),Vs.p=c(12,30),Zs.r=c(1,0),Zo.r=c(0,0),Zl.r=c(1,0))
xf <- xformer.ckt(x)
```

Wave Power	<i>Wave Power Functions</i>
------------	-----------------------------

Description

Calculations in wave power generation

Usage

```
generate.duration(file)
powflux.wave(Hs, Tp)
wave.contour(X,label,sum, sumlabel)
duration.wave(datafile, file=TRUE)
energy.wave(Pflux, D)
energy.gen(Ew, L, nu)
```

Arguments

datafile	either a data file name or a renpow dataset
file	a logical to decide between a data file or a dataset
Hs	height in HsTp matrix
Tp	duration in HsTp matrix
X	Object to plot as contour; can be Pflux, Ew, or Eg
Pflux	Power flux produced by powflux.wave function
Ew	Energy produced by energy.wave function
label	label for plot; the default is ""
sum	logical default TRUE
sumlabel	label for sum; the default is ""
D	duration produced by duration.wave function
L	length of structure or energy conversion device
nu	efficiency

Details

Basic calculations for wave power

Value

Eg	Energy produced by energy.gen function
----	--

Note

Functions used in Chapter 12 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
Pflux <- powflux.wave(Hs=seq(1,10),Tp=seq(5,20))
wave.contour(X=Pflux,label="Power flux (kW/m)")
D <- duration.wave(WaveHsTp,file=FALSE)
# alternatively using file in extdata
# D <- duration.wave(system.file("extdata","WaveHsTp.csv",package="renpow"))
wave.contour(X=D,label="Duration (hrs/yr)")

Ew <- energy.wave(Pflux,D)
```

```
wave.contour(X=Ew,label="Energy flux (MWh/yr/m)",sum=TRUE,sumlabel="(MWh/yr/m)")
Eg <- energy.gen(Ew,L=30,nu=0.4)
wave.contour(X=Eg,label="Energy produced (MWh/yr)",sum=TRUE,sumlabel="(MWh/yr)")
```

Waves Data

Dataset: Wave Duration

Description

Hypothetical wave duration

Usage

```
data("WaveHsTp")
```

Format

matrix Hs (rows) and Tp (columns)

Details

Hypothetical data for wave power calculations

Source

Hypothetical data

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
data(WaveHsTp)
```

Description

Basic calculations in wind power generation

Usage

```
pow.rho.v3.table(x)
pow.rho.v3(xw)
rho.pT.air(pT)
rho.zT.air(zT)
pow.v3.plot(x)
pow.wind(pw)
v.H(vh)
betz()
cal.vH(calvh)
weibull.plot(xmax,scale,shape)
cdf.plot(rv,xlab,ylab)
fit.wind(xd,vlabel)
pow.class(wc)
power.curve(pc)
prob.power.curve(pc,avg)
wind.energy(pc,Pow,avg)
```

Arguments

x	a list with possible list(rho= density, v=wind speed and A=cross-section area)
xw	list(rho=array of density values,v=array of wind speed values, A=cross-section area)
pT	a list(p,T,C,punit)
zT	list(z=1000, T.C=20, punit="bar", lapse=6)
pw	list with z, array T.C, array v, punit press unit,lapse,yleg,ylabel
vh	list with array alpha exponent , and array rough of roughness coeffs
calvh	list with list(v1.v2=v1.v2,H1=2,H2=10)
xmax	max x value for Weibull
scale	parameter
shape	parameter
rv	data var for cumulative distribution function
xlab	label x axis
ylab	label y axis
wc	wind speed for wind class chart

<code>xd</code>	wind data object from two anemometers
<code>vlabel</code>	label for graph
<code>pc</code>	a list <code>cutin</code> , <code>vrated</code> , <code>cutout</code> , <code>A</code> , <code>v</code>
<code>avg</code>	avg wind speed for <code>prop.power.curve</code> and <code>wind.energy</code>
<code>Pow</code>	result of power curve and used as argument to <code>wind.energy</code>

Details

Basic calculations of wind power

Value

<code>X1</code>	result of <code>pow.rho.v3.table</code> is <code>list(X,P)</code>
<code>X2</code>	result of <code>pow.rho.v3</code> is <code>list(rho=,v=,Pow=)</code>
<code>X3</code>	result of <code>rho.pT.air</code> is array with <code>c("Pressure(kPa)","Temp(C)","Density(kg/m3)")</code>
<code>X4</code>	result of <code>rho.zT.air</code> is <code>list(X,rho)</code>
<code>X5</code>	result of <code>v.H</code> is <code>v.v0.exp</code> and <code>v.v0.log</code>
<code>X6</code>	result of <code>cal.vH</code> alpha exponent, and array rough of roughness coeffs
<code>X7</code>	result of <code>pow.class</code> is <code>list(Pow.x,class.x)</code>
<code>X8</code>	result of <code>pow.curve</code> is <code>list(Pow, z,P.rated)</code>
<code>X9</code>	result of <code>prob.power.curve</code> is hours in various ranges <code>list(h.cutin,h.cutout,h.rated.nstop, h.run.below.rated)</code>
<code>X10</code>	result of <code>wind.energy</code> is <code>list(energy,unit,CF)</code>

Note

Functions used in Chapter 13 of Acevedo (2018)

Author(s)

Miguel F. Acevedo <acevedo@unt.edu>

References

Acevedo, M.F. 2018. Introduction to Renewable Electric Power Systems and the Environment with R. Boca Raton, FL: CRC Press. (ISBN 9781138197343)

Examples

```
x <- list(rho=1.225,v=10,A=1); pow.rho.v3.table(x)

x <- list(rho=c(0.9,1,1.1,1.225,1.3),v=seq(0,10),A=1)
X <- pow.rho.v3(x)

x <- list(v=X$v,y=X$rho,Pow=X$Pow,yleg="rho",ylabel="Density(kg/m3)")
pow.v3.plot(x)
```

```
x <- list(z=1000, T.C=10, punit="bar")
rho.zT.air(x)
x <- list(z=100, T.C=30, punit="bar")
rho.zT.air(x)

x <- list(z=1000, T.C=c(10,20,30), v=seq(0,30),punit="bar",
        lapse=6,yleg="T.C",ylabel="Temperature (C)")
pow.wind(x)

x <- list(alpha=c(0.1,0.25,0.4),rough=c(0.1,0.4,1.6))
v.H(x)
```

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