Operator DEFI_FONC_ELEC

1 Drank

To define a function of time intervening in the computation of the forces of Laplace.

These forces are exerted on a principal driver (leaning on an Aster mesh) acting with one or more secondary drivers (not being based necessarily on Aster meshes); these drivers are traversed by flow intensities of short-circuit. The statement of the force of Laplace is composed of the product of a function of time due itself to the products of the flow intensities and of a function of space due to the relative position of the drivers.

Product a data structure of type `function`.

2 Syntax

```
F [function] = DEFI_FONC_ELEC (

    ◊FREQ=/          Fr,                              [R]
          /50. ,                                      [DEFAULT]
    ◊SIGNAL=/        “COMPLET”,
[DEFAULT]
          /  “CONTINU”,
    ♦/♦COUR=                 (_F (
                             ♦INTE_CC_1=I1          ,          [R]
                             ♦TAU_CC_1=          τ1 ,          [R]
                             ♦/PHI_CC_1=         ϕ1 ,          [R]
                               /INTC_CC_1        =IC1 ,        [R]
                             ♦  INTE_CC_2=I2        ,          [R]
                             ♦  TAU_CC_2=        τ2 ,       [R]
                             ♦  /PHI_CC_2      = ϕ2 ,       [R]
                               /INTC_CC_2        =IC2 ,        [R]
                             ◊  INST_CC_INIT=ti     ,          [R]
                             ♦  INST_CC_FIN=tf      ,          [R]
                          ),),
      /♦COUR_PRIN=           (_F (
                             ♦  INTE_CC_1=I1        ,          [R]
                             ♦  TAU_CC_1=        τ1 ,       [R]
                             ♦  /PHI_CC_1      = ϕ1 ,          [R]
                               /INTC_CC_1        =IC1 ,        [R]
                             ◊INTE_RENC_1=I1R       ,       [R]
                             ◊TAU_RENC_1=        τ1R ,      [R]
                             ◊PHI_RENC_1=        ϕ1R ,      [R]
                             ♦INST_CC_INIT=ti       ,          [R]
                             ♦INST_CC_FIN=tf        ,          [R]
                             ◊INST_RENC_INIT=/tiR          ,   [R]
                                                 /0 . ,
[DEFAULT]
                             ◊INST_RENC_FIN=/tfR           ,   [R]
                                                 /0 . ,
[DEFAULT]
                          ),),
         ♦COUR_SECO=         (_F (
                             ♦  INTE_CC_2=I2        ,          [R]
                             ♦  TAU_CC_2=        τ2 ,       [R]
                             ♦  /PHI_CC_2      = ϕ2 ,       [R]
                               /INTC_CC_2        =IC2 ,        [R]
                             ◊INTE_RENC_2=I2R       ,       [R]
                             ◊TAU_RENC_2=        τ2R ,      [R]
                             ◊PHI_RENC_2=        ϕ2R ,      [R]
                             ◊  DIST=/d                ,       [R]
                                                 /1 . ,
[DEFAULT]
                          ),),
    ◊INFO=/1          ,
[DEFAULT]
          /2 ,
    )
```

3 Operands

the treated data can be divided into two groups:

- those relating to only one secondary driver, generally in an unspecified **position** compared to the principal driver but with **several** time intervals. These intervals of time can be continuous between them (case of the same flow with characteristics different from one interval to another) or discontinuous (case of one or more resets at various levels of intensity key word factor COUR),
- those concerning one or more possibly parallel and/or infinite secondary drivers with an interval of time corresponding to the short-circuit and **possibly** a second interval of time corresponding to a reset (key keys factors COUR_PRIN and COUR_SECO).

One can notice that:

- in second group of data, characteristics of flows crossing drivers secondary are treated separately those of flows crossing driver principal (with key word COUR_SECO which one can repeat several times),
- all the cases treated by the second group of data can be treated by the first group. However in the case of flows crossing several secondary drivers, it is then necessary to repeat operator DEFI_FONC_ELEC with key word COUR as many times as there are secondary drivers (and the same for AFFE_CHAR_MECA and CALC_VECT_ELEM).

3.1 Operand FREQ

```
◊FREQ=/50          .,
       /fr ,
```

Frequency of flow in Hertz (50.0 per default).

3.2 Operand SIGNAL

```
◊SIGNAL    =
```

Specifies the mode of computation of the electric function of time:

/	"COMPLET"	all the terms of the electric function are taken into account,
/	"CONTINU"	one does not take into account the periodic terms of the electric function.

3.3 Key word COUR

```
♦/♦COUR = (_F (

♦INTE_CC_1 = effective
```
I1 intensity of the flow of short-circuit, crossing the principal driver (in Amps),

```
♦TAU_CC_1 =constante
```
$\tau 1$ of time of the flow of short-circuit, crossing the principal driver (in seconds),

```
♦/PHI_CC_1 =
```
$\phi 1$ phase shift (in degrees) of principal flow (flow of short-circuit),

```
/INTC_CC_1 = IC1
```
intensity of first peak of principal flow (in Amps), amounts giving a phase shift,

```
♦INTE_CC_2 = I2
```
effective intensity of the flow of short-circuit, crossing the secondary driver (in Amps),

```
♦TAU_CC_2 =constante
```
$\tau 2$ of time of the flow of short-circuit, crossing the secondary driver (in seconds),

```
♦/PHI_CC_2 =
```
$\phi 2$ phase shift (in degrees) of secondary flow (flow of short-circuit),

```
/INTC_CC_2 = IC2
```
intensity of first peak of secondary flow (in Amps), amounts giving a phase shift,

```
◊INST_CC_INIT = tiinstant
```
initial of a flow interval, by default, equal to final moment of the preceding interval (the intervals are then continuous),

```
♦INST_CC_FIN = tfinstant
```
final of a flow interval

```
), ),
```

3.4 Key word COUR_PRIN

```
/♦COUR_PRIN       =   (_F    (

      ♦INTE_CC_1     = I1            effective intensity of the flow of short-circuit,
                                     crossing the principal driver (in Amps),

      ♦TAU_CC_1  =  τ1               time-constant of the flow of short-circuit,
                                     crossing the principal driver (in seconds),

      ♦/PHI_CC_1          =  ϕ1      phase shift (in degrees) of principal flow
                                     (flow of short-circuit),

         /INTC_CC_1     = IC1        intensity of first peak of principal flow
                                     (in Amps), amounts giving a phase shift,

      ◊INTE_RENC_1   = effective     I1Rintensité of the flow of reset,
                                     crossing the principal driver (in Amps),

      ◊TAU_RENC_1    =  τ1R          time-constant of the flow of short-circuit,
                                     crossing the secondary driver (in seconds),

      ◊PHI_RENC_1    =déphasage ϕ1R  (in degrees) of the principal flow of
                                     reset,

      ♦INST_CC_INIT = tiinstant      initial flow of short-circuit,

      ♦INST_CC_FIN   = tfinstant     final flow of short-circuit,

      ◊INST_RENC_INIT   =  shooting,   initial time of the flow of reset,
                          /0. ,

      ◊INST_RENC_FIN    =  tfRinstant  final flow from reset,
                          /0. ,

                  ), ),
```

Note:

By defaults, t_{iR} and t_{fR} are null and there is no flow of reset.

3.5 Key word COUR_SECO

```
/♦COUR_SECO = (_F (
```

`♦INTE_CC_2 = effective` I2 intensity of the flow of short-circuit, crossing the secondary driver (in Amps),

`♦TAU_CC_2 =` $\tau 2$ time-constant of the flow of short-circuit, crossing the secondary driver (in seconds),

`♦/PHI_CC_2 =` $\phi 2$ phase shift (in degrees) of secondary flow (flow of short-circuit),

`/INTC_CC_2 = IC2` intensity of first peak of secondary flow (in Amps), amounts giving a phase shift,

`◊INTE_RENC_2 = effective` I2Rintensité of the flow of reset, crossing the secondary driver (in Amps),

`◊TAU_RENC_2 =` $\tau 2R$ time-constant of the flow of reset, crossing the secondary driver (in seconds),

`◊PHI_RENC_2 =` $\phi 2R$ phase shift (in degrees) of the secondary flow from reset,

`◊DIST = D,` distance (in meters) from an infinite secondary driver
`/1. ,` and parallel with the principal driver.

```
), ),
```

Note:

Not credit in the other cases and taken with 1 . by default to neutralize its action in the computation of the force of LAPLACE.

3.6 Operand INFO

`◊INFO` = Specifies the options of printing on the message file .

`1` = not from printing (option by default),

`2` = printing of the parameters plus the list of the first 10 values in the order ascending of the parameter.

4 Statement of the calculated function

4.1 Given of the first group

In the case of data of the first group, with N occurrences of the key word factor `COUR` corresponding to N intervals of time, the arguments entered to the kth occurrence of the key word factor are affected index (k) is:

$$I_1^{(k)}, \tau_1^{(k)}, \phi_1^{(k)}, I_2^{(k)}, \tau_2^{(k)}, \phi_2^{(k)}, t_1^{(k)}, t_f^{(k)}$$

4.1.1 Complete signal

the statement of the calculated function is:

$$F(t) = 4.10^{-7} I_1^{(k)} I_2^{(k)} \times \left[\cos(2\pi\, fr(t-t_r^{(k)}) + \phi_1^{(k)}) - \cos\phi_1^{(k)} e^{-\frac{t-t_r^{(k)}}{\tau_1^{(k)}}}\right] \times \left[\cos(2\pi\, fr(t-t_r^{(k)}) + \phi_2^{(k)}) - \cos\phi_2^{(k)} e^{-\frac{t-t_r^{(k)}}{\tau_2^{(k)}}}\right]$$

4.1.2 Continuous signal

$$F(t) = 4.10^{-7} I_1^{(k)} I_2^{(k)} \times \left[\frac{1}{2}\cdot\cos(\phi_2^{(k)} - \phi_1^{(k)}) + \cos\phi_1^{(k)} \times \cos\phi_2^{(k)} \times e^{-\left(\frac{1}{\tau_1^{(k)}} + \frac{1}{\tau_2^{(k)}}\right)(t-t_r^{(k)})}\right]$$

for $t \in \left[t_i^{(k)}, t_f^{(k)}\right], k=1,N$

with $t_r^{(k)}$ defined by:

$$\begin{array}{lcll} t_r^{(1)} & = & t_i^{(1)} & \\ t_r^{(k)} & = & t_r^{(k-1)} & \text{si} \quad t_i^{(k)} = t_f^{(k-1)}, \quad k=2,N \\ t_r^{(k)} & = & t_i^{(k)} & \text{si} \quad t_i^{(k)} > t_f^{(k-1)}, \quad k=2,N \end{array}$$

$F(t)=0$ if $t_i^{(k)} > t_f^{(k-1)}$ and $t \in \left[t_f^{(k-1)}, t_i^{(k)}\right], k=2,N$

or so $t > t_f^{(N)}$

4.2 Given of the second group

In the case of data of the second group, with an occurrence of the key word COUR_PRIN (a principal flow) and N occurrences of the key word factor COUR_SECO (N secondary flows), the arguments entered to $k^{ième}$ the occurrence of COUR_SECO are assigned to the index (k) is: $I_2^{(k)}, \tau_2^{(k)}, \Phi_2^{(k)}, d^{(k)}$ and possibly $I_{2R}^{(k)}, \tau_{2R}^{(k)}, \Phi_{2R}^{(k)}$.

4.2.1 Case or t belongs to the first flow complete Signal

4.2.1.1 interval

the statement of the calculated function becomes then: if $t \in [t_i, t_f]$

$$F(t) = 4.10^{-7} \times I_1 \cdot \left[\cos\left(2\pi \cdot fr \cdot (t - t_i) + \Phi_1\right) - \cos(\Phi_1) \cdot e^{-\frac{t - t_i}{\tau_1}} \right]$$
$$\times \sum_{k=1,N} \frac{I_2^{(k)}}{d^{(k)}} \left[\cos\left(2\pi \cdot fr \cdot (t - t_i) + \Phi_2^{(k)}\right) - \cos(\Phi_2^{(k)}) \cdot e^{-\frac{t - t_i}{\tau_2^{(k)}}} \right]$$

4.2.1.2 Continuous signal

$$F(t) = 4.10^{-7} \cdot I_1$$
$$\times \sum_{k=1,N} \frac{I_2^{(k)}}{d^{(k)}} \left[\frac{1}{2} \cos\left(\Phi_2^{(k)} - \Phi_1^{(k)}\right) + \cos(\Phi_1) \cdot \cos(\Phi_2^{(k)}) \cdot e^{-\left(\frac{1}{\tau_1} + \frac{1}{\tau_2^{(k)}}\right)(t - t_i)} \right]$$

4.2.2 Case where t belongs to the second flow interval (reset)

4.2.2.1 complete Signal

the statement of the calculated function becomes then: if $t \in [t_{iR}, t_{fR}]$

$$F(t) = 4.10^{-7} \cdot I_{1R} \left[\cos\left(2\pi f_r (t - t_{iR}) + \Phi_{1R}\right) - \cos(\Phi_{1R}) \cdot e^{-\frac{t - t_{iR}}{\tau_{1R}}} \right]$$
$$\left[\cos\left(2\pi f_r (t - t_{iR}) + \Phi_{2R}^{(k)}\right) - \cos(\Phi_{2R}^{(k)}) \cdot e^{-\frac{t - t_{iR}}{\tau_{2R}^{(k)}}} \right]$$

NB: one must have $t_{iR} > t_f$ and $t_{iR} \neq 0$

4.2.2.2 Continuous signal

$$F(t)=4.10^{-7}\cdot I_{1R}$$
$$\times\sum_{k=1,N}\frac{I_{2R}^{(k)}}{d^{(k)}}\left[\frac{1}{2}\cos\left(\Phi_{2R}^{(k)}-\Phi_{1R}^{(k)}\right)+\cos(\Phi_{1R})\cdot\cos(\Phi_{2R}^{(k)})\cdot e^{-\left(\frac{1}{\tau_{1R}}+\frac{1}{\tau_{2R}^{(k)}}\right)(t-t_{iR})}\right]$$

Moreover:
When there is reset: $F(t)=0$ if $t\in[t_f, t_{iR}]$ or if $t>t_{fR}$
When there is not reset: $F(t)=0$ if $t>t_f$

5 Examples of stream function

5.1 With data of the two Definition

groups of stream functions using as well the data of the first group as of the second group.

Case of two-phase short-circuit lasting 0.5 second with reset of 1.5 at 2 seconds of intensity $20\,kA$, phase null and intensity and time-constant 0.2 second before reset $15\,kA$ after reset.

- Data of the first group:

```
f1 =DEFI_FONC_ELEC       (
        COUR = (_F (INTE_CC_1=20.E3     ,       TAU_CC_1=            0.2,
                 PHI_CC_1=         0. ,      INTE_CC_2=          20.E3,
                 TAU_CC_2=         0.2,      PHI_CC_2=180       .,
                 INST_CC_INIT=     0. ,         INST_CC_FIN=  0.5,
              ),

              _F (INTE_CC_1=15.E3        ,       TAU_CC_1=            0.2,
                 PHI_CC_1=         0. ,      INTE_CC_2=          15.E3,
                 TAU_CC_2=         0.2,      PHI_CC_2=180       .,
                 INST_CC_INIT=     1.5,         INST_CC_FIN=  2.0,
              ),),
                       )
```

- Given of the second group:

```
f2 =DEFI_FONC_ELEC       (
COUR_PRIN = (_F (   INTE_CC_1=20.E3           ,       TAU_CC_1=
 0.2,
                 PHI_CC_1=            0. ,      INTE_RENC_1=15.E3      ,
                 TAU_RENC_1=          0.2,      PHI_RENC_1=      0. ,
                 INST_CC_INIT=        0. ,         INST_CC_FIN= 0.5,
                 INST_RENC_INIT=      1.5,         INST_RENC_FIN=   2.0,
              ),),
COUR_SECO = (_F (   INTE_CC_2=         20.E3,         TAU_CC_2=
  0.2,
                 PHI_CC_2=     180. ,           INTE_RENC_2=     15.E3,
                 TAU_RENC_2=      0.2,          PHI_RENC_2=180      .,
              ),),
                        )
```

5.2 With only of the data of the first Definition

group of stream functions strictly **using** the data of the first group.

Case of two-phase short-circuit during 1 second, phase null, 0.2 second and bearing time-constant of intensity of $20\,kA$ during 0.5 second, $15\,kA$ between 0.5 second and 0.7 second, of $10\,kA$ between 0.7 second and 1 second.

```
f1 =DEFI_FONC_ELEC       (
        COUR = (_F (INTE_CC_1=20.E3      ,       TAU_CC_1=            0.2,
                  PHI_CC_1=          0. ,      INTE_CC_2=          20.E3,
                  TAU_CC_2=          0.2,      PHI_CC_2=180       .,
                  INST_CC_INIT=      0. ,          INST_CC_FIN=   0.5,
               ),
              _F (INTE_CC_1=15.E3        ,       TAU_CC_1=        0.2,
                  PHI_CC_1=          0. ,      INTE_CC_2=      15.E3,
                  TAU_CC_2=          0.2,      PHI_CC_2=180    .,
                  INST_CC_FIN=       0.7,
               ),
              _F (INTE_CC_1=10.E3        ,       TAU_CC_1=        0.2,
                  PHI_CC_1=          0. ,      INTE_CC_2=      10.E3,
                  TAU_CC_2=          0.2,      PHI_CC_2=180    .,
                  INST_CC_FIN=       1.0,
              ),),
                         )
```

5.3 With preferentially of the data of the second Definition

group of stream functions preferentially **using** the data of the second group.

To express the interaction of two drivers with the studied phase, the use of data of the first group would result in defining two functions `F1` and `F2` (by two calls to `DEFI_FONC_ELEC`) and two loads `ch1` and `ch2`.

The data of the second group make it possible to be limited to only one function.

Case of three-phase short-circuit during 1 second of intensity 20 kA, phase 45 degrees, time-constant 0.2 second with phases parallel and infinite apart 2 meters.

```
f1 =DEFI_FONC_ELEC       (
       COUR_PRIN = (_F (   INTE_CC_1=20.E3         ,       TAU_CC_1=0.2
   ,
                       PHI_CC_1=45         .,         INST_CC_INIT=0  . ,
                       INST_CC_FIN=      1. ,
                       ),),
       COUR_SECO = (_F (   INTE_CC_2=       20.E3,       TAU_CC_2=0.2
,
                        PHI_CC_2=165    .,         DIST=2          .,
                   ),
                  _F ( INTE_CC_2=        20.E3,      TAU_CC_2=
0.2,
                             PHI_CC_2=- 75. ,                 DIST=-
2. ,
                   ),),
                        )
```

One will find examples of DEFI_FONC_ELEC in benchmarks SDNL101A, SDLL102A and SDLL102B.