Piezoelectric material property commands

mpdel,all,matid
!*

To delete material property it was assigned by default method.

et,matid,226,1001
!

To change the mesh type from SOLID186 to SOLID226 with keytops : 1001 (DOFs = U_x, U_y, U_z and Vol (piezoelectric coupling)).

! PZT-4 z-polarized
! Stiffness
!
TB,ANEL,matid
TBDATA, 1, 1.3900E+11, 7.7837E+10, 7.4284E+10
TBDATA, 7, 1.3900E+11, 7.4284E+10,
TBDATA, 12, 1.1541E+11,
TBDATA, 16, 3.0581E+10,
TBDATA, 19, 2.5641E+10,
TBDATA, 21, 2.5641E+10,
!

To assign Stiffness matrix of PZT4 to the geometry.

! Piezo
!
TB,PIEZ,matid
TBDATA, 3, -5.2
TBDATA, 6, -5.2
TBDATA, 9, 15.1
TBDATA, 14, 12.7
TBDATA, 16, 12.7
!

To assign Piezoelectric matrix of PZT4 to the geometry.

! Permittivity
!
EMUNIT,EPZRO, 8.85E-12
MP,PERX,matid, 1475
MP,PERY,matid, 1475
MP,PERZ,matid, 1300
!

To assign Relative permittivity and permittivity constant of PZT4 to the geometry.

! Density
!
MP,DENS,matid, 7500

To assign density of PZT4 to the geometry.

Water material property commands

```
/PREP7
!
CMSEL,S,Water
ESEL,R,ENAME, , 186
*GET,iNum186, ELEM, 0, COUNT
*IF, iNum186, GT, 0, THEN
*GET,iMaxEType,ETYP,0, NUM,
MAX
ET,iMaxEType+1, 220, , , , 0
KEYOPT,iMaxEType+1, 1, 0
KEYOPT,iMaxEType+1, 2, 1
!
*GET,iMaxMat,MAT,0, NUM, MAX
MP,SONC,iMaxMat+1, 1533.5
MP,DENS,iMaxMat+1, 990.15
MP,VISC,iMaxMat+1, 0.0005958
MP,BVIS,iMaxMat+1, 0
MP,KXX,iMaxMat+1, 0
MP,C,iMaxMat+1, 0
MP,CVH,iMaxMat+1, 0
!
*GET, iMaxReal, ELEM,,RELM
R,iMaxReal+1, 2E-05, 101325
EMODIF,ALL,TYPE,iMaxEType+1
EMODIF,ALL,MAT,iMaxMat+1
EMODIF,ALL,REAL,iMaxReal+1
*ENDIF
!
/SOLU
ALLSEL,ALL
OUTRES,FGRAD,ALL
!
```

To selects a subset of water (acoustic) domain.

To change the mesh type from SOLID186 to FLUID220 with key options when KEYOPT (2) : 1 (DOFs = P)

To assign material property of water at each temperature to geometry of water.

To define the reference pressure and static pressure.

Controls the solution data of element nodal gradients written with every sub-step.

Stainless steel material property commands

```
CMSEL,S,SS
ESEL,R,ENAME, , 186
*GET,iNum186, ELEM, 0, COUNT
*IF, iNum186, GT, 0, THEN
*GET,iMaxEType,ETYP,0, NUM,
MAX
ET,iMaxEType+1, 220, , , , 0
KEYOPT,iMaxEType+1, 1, 0
KEYOPT,iMaxEType+1, 2, 0
KEYOPT,iMaxEType+1, 6, 1
!
*GET,iMaxMat,MAT,0, NUM, MAX
MP,SONC,iMaxMat+1, 5590
MP,DENS,iMaxMat+1, 7790
MP,VISC,iMaxMat+1, 0
MP,BVIS,iMaxMat+1, 0
MP,KXX,iMaxMat+1, 0
MP,C,iMaxMat+1, 0
MP,CVH,iMaxMat+1, 0
!
*GET, iMaxReal, ELEM,, RELM
R,iMaxReal+1, 2E-05, 101325
EMODIF,ALL,TYPE,iMaxEType+1
EMODIF,ALL,MAT,iMaxMat+1
EMODIF,ALL,REAL,iMaxReal+1
*ENDIF
```

To selects a subset of stainless steel (acoustic) domain.

To change the mesh type from SOLID186 to FLUID220 with key options when KEYOPT (2) : 0 (DOFs = U_x, U_y, U_z and P), KEYOPT (6) : 1 (incompressible domain)

To assign material property of stainless steel to geometry of stainless steel.

To define the reference pressure and static pressure.

Fluid solid interface and Infinite surface commands

CMSEL,S, FSI_
ESEL,S,ENAME, , 220
SF, ALL, FSI
ALLSEL, ALL

To selects a subset of FSI_ face.
To change the element field type to FLUID220.
To set the degree of freedoms on all node at the face
with U_x, U_y, U_z and P.

CMSEL,S, INF_
ESEL,S,ENAME, , 220
SF, ALL, INF
ALLSEL, ALL

To selects a subset of INF_ face.
To change the element field type to FLUID220.

To set Robin radiation boundary condition on Exterior face.

Voltage commands

```
fini
!*
/units, MKS
```
To define unit to MKS unit.

```
/prep7
cmsel, s, Bot_Piezo
cp, 1, volt, all
*get, nbot, node, , num, min
d, nbot, volt, 0
nsel, all
cmsel, all
!*
!
```
To set voltage on the subset of Bot_Piezo to 0.

```
cmsel, s, Top_Piezo
cp, 2, volt, all
*get, ntop, node, , num, min
!*
alls, all
!*
!*
```
To set voltage on the subset of Top_Piezo with below loop.

```
frq = 40000
vlt = 220
cyl = 30
npt = 800
!*
```
To set frequency (frq), voltage (vlt), cycle (cyl) and number of time point (npt) follow as table …

```
*dim, v_top, table, npt, 1, 1, time
*do, i, 1, npt, 1
  v_top (i, 0) = ( ( ( 1/frq ) *cyl ) /npt ) *i
  tloop = ( ( ( 1/frq ) *cyl ) /npt ) *i
  v_top (i, 1) = vlt *sin ( ( tloop / ( 1/frq ) ) *2 *3.141593 )
*enddo
```
To generate voltage signal by sin wave.

```
!*
d, ntop, volt, %v_top%
!
cmsel, s, Top_Piezo1
cp, 3, volt, all
*get, ntop, node, , num, min
!*
alls, all
!*
!*
```

```
frq2 = 28000
vlt = 220
cyl2 = 30
npt = 800
!*
```
To set frequency 2 (frq2), voltage (vlt), cycle (cyl2) and number of time point (npt) follow as table …

```
*dim, v_top2, table, npt, 1, 1, time
*do, i, 1, npt, 1
  v_top2 (i, 0) = ( ( ( 1/frq2 ) *cyl2 ) /npt ) *i
  tloop2 = ( ( ( 1/frq ) *cyl2 ) /npt ) *i
  v_top2 (i, 1) = vlt *sin ( ( tloop / ( 1/frq2 ) ) *2 *3.141593 )
*enddo
!*
d, ntop, volt, %v_top2%
!
fini
!*
/solu
tintp, , 0.25, 0.5, 0.5         ! Required for piezo
```
To set 1st and 2nd order transient integration parameter that required for piezoelectric analysis.