QUADRIC SURFACE
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Program Information: Written 8-11-1992 by Ravi Prasad, 3815-303 Lone Pine Road, West Bloomfield, MI 48323.

System Requirements: Texas Instruments TI-85 Graphing Calculator.
4.4K RAM Full Version. Any one module may be written in approximately 400 bytes.

Program Features:

- Graph in Cylindrical, Spherical, or Cartesian coordinates.
- Graph in left or right handed coordinate system.
- Enter equations in standard math format, including greek symbols.
- Variable formats include: $Z(X,Y)$, $r(\theta,Z)$ & $\rho(\theta,\phi)$
- All equations above may be entered as Z^2 or Z, ρ^2 or ρ, r^2 or r.
- Program automatically detects and adjusts for cylinders & planes if any variables are missing in the equation.
- Zoom In, Zoom Out, Zoom Sqr & Zoom Fit options included.
- Tilt X or Y axis at -135^o, -45^o, $+45^o$, -90^o or user input custom tilt.
- Rotate the image to get a better view of hard to see areas.
- Totally menu driven.
- View the graph with new options or zoom options without re-entering the equation over and over again.
- Accuracy and speed (resolution) controlled by setting appropriate axis size and increments.
- All angular values may be entered in radians or degrees.
- Standard (default) increment or custom increment for specified range values included.

EXECUTING THE PROGRAM

1) Type "GR3D" and press "ENTER" or simply press the "PRGM" key followed by the "F1" key and then selecting the appropriate menu function key designating the "GR3D" program.

2) If you wish to continue with the previous range settings from an earlier session, select "YES" at the "NEW CONFIGURATION" prompt. For a new session with new range settings, select "NO"

3) Press the "F1" key for a right handed coordinate setup or "F5" for a left handed coordinate setup.

4) If a right handed coordinate setup is selected (F1), you are prompted to select a tilt angle for the X axis. If a left handed coordinate setup is selected (F5), a tilt for the Y axis is to be selected. The tilt angle is customarily -135^{o} (zero degrees representing due east), although any tilt angle may be selected by the appropriate menu function keys. The CUSTM key lets you enter any desired tilt angle.

5) Select a scaling option. "SQR" is the standard scaling option which provides a one to one ratio for all axis. The "FIT" option is more time consuming but gives a best view (enlarged and stretched) of the graph to fit on the screen.

6) Select "YES" or "NO" by pressing the appropriate menu function keys at the option to display the coordinate axis. Note however, in the "FIT" option, the axis will be tilted with respect to the best fit view and may not appear to be accurate. The graph and axis displayed are however, accurately shown.

7) Select a working coordinate system at the "COORDINATE SYSTEM" prompt. Valid choices are "F1" for cartesian coordinates, "F3" for spherical coordinates, and "F5" for cylindrical coordinates.

8) Select the minimun and maximum values for the variables to be used in graphing the equation. The increment may be defaulted by entering zero for this option. By carefully incrementing the variables, speed and accuracy may be controlled. Incrementing a varible allows the program to successively choose new values for the variables and compute the values for the defined equation. The default increment results in a total of 20 traces to be plotted.

9) Enter the equation as you would normally write them.

Example: to enter $Z^2=X^2+Y^2$ ie: $Z = \pm \sqrt{}(X^2+Y^2)$

Type $Z=\sqrt{}(X^2+Y^2)$, press "ENTER" and then select "Z=+-" from the displayed menu.

Note: Selecting "Z=..." simply selects the equation $Z=\sqrt{}(X^2+Y^2)$

10) Select an image rotoation angle. By selecting a rotation angle other than zero means to spin the image by actually spinning the Z axis the angle desired. By rotating an image, you can examing parts of a graph that may not be visible in the tilt axis given. For example, a paraboloid opening on the positive X axis in a right handed coordinate system (X axis tilted at -135^o) rotated 90^o would now open on the positive Y axis. Enter zero for no rotation.

11) Select the XYZ axis size. The equation will not be plotted beyond the XYZ axis size unless a FIT graph was chosen.

12) After the equation is graphed, you may Zoom In, Zoom Out, perform a Zoom Fit or Zoom Sqr function. The "Menu" option always returns to the main menu shown at the end of graphing an equation. The "View" option simply eliminates the menu temporarily. Press ENTER, to return to the menu options. The "REcfg" option lets you re-plot the equation with new range values along with other appropriate settings. The "Graph" option will restart another graphing session. The "Exit" option terminates the graphing sesssion.

Note: At the end of a graphing session, any equation plotted remains in view and may be stored to memory for later retrieval by pressing the "GRAPH" key, followed by the "STPic" menu function key and an appropriate file name. Also, greek symbols may be incorporated into equations for cylindrical and spherical formats by pressing the "2nd" followed by the "CHAR" , followed in turn by the "GREEK" menu key. The program is case sensitive and thus requires the usage of "X Y Z" for variables versus "x y z" !

```
:Lbl BEGIN
:xt1=ΩX1:yt1=ΩY1
:xt2=ΩX2:yt2=ΩY2
:Radian:RectC:Param:RectGC:SimulG:GridOff:AxesOff:FnOff
:Ωσ=64/128:ΩNUCFG="NO":ClLCD:ClDrw:Ωϕϕϕ="STANDARD"
:1→xScl:1→yScl:Ωθ=Ωθθ*π/180
:ΩDASH="--------------------"
:ΩSTDINC=(abs ΩST+abs ΩED)/20
:ΩSTDINC0=(abs ΩST0+abs ΩED0)/20
:Disp "NEW    CONFIGURATION":Disp ΩDASH
:Outpt(4,3,"QUADRIC    SURFACE"):Outpt(5,10,"by")
:Outpt(6,6,"Ravi Prasad"):Output (7,7,"8-11-1992")
:Menu(1,"YES",NEW,5,"NO",OLD)
:Lbl OLD
:ΩCFG="OLD":Goto CRD
:Lbl NEW
:ΩCFG="NEW"
:Outpt(1,1,"COORDINATE    SYSTEM")
:Menu(5,"LEFT",LEFT,1,"RIGHT",RIGHT)
:Lbl LEFT
:ΩHND="LT"
:ΩX1=((X cos Ωθ) − (Y sin Ωθ))+(Ωσ * ((X sin  Ωθ) + (Y cos Ωθ))cos Ωϕ
:ΩY1=(Ωσ * ((X sin  Ωθ) + (Y cos Ωθ))sin Ωϕ + Z
:Goto TILT
:Lbl RIGHT
:ΩHND="RT"
:ΩX1=((X sin Ωθ) + (Y cos Ωθ))+(Ωσ * ((X cos  Ωθ) - (Y sin  Ωθ))cos Ωϕ
:ΩY1=(Ωσ * ((X cos  Ωθ) - (Y sin  Ωθ))sin Ωϕ + Z
:Lbl TILT
:ΩX2=ΩX1
:ΩY2=ΩY1-2Z
:If ΩHND=="LT"
:Then
:Outpt(1,1,"SELECT  A TILT FOR Y")
:Goto TLTANGL
:Else
:Outpt(1,1,"SELECT  A TILT FOR X")
:End
:Lbl TLTANGL
:Menu(1,"-135°",T1,2,"-45°",T2,3,"+45°",T3,4,"-90°",T4,5,"Custm",T5)
:Lbl T1
```

```
:Ωϕ=-135°:Goto SCL
:Lbl T2
:Ωϕ=-45°:Goto SCL
:Lbl T3
:Ωϕ=45°:Goto SCL
:Lbl T4
:Ωϕ=-90°Goto SCL
:Lbl T5
:Ωϕϕϕ="CUSTM"
:Lbl SCL
:Outpt(1,1,"SELECT A GRAPH SCALE")
:Menu(1,"SQR",S1,5,"FIT",S2)
:Lbl S1
:ΩSCL="SQR":Goto S3
:Lbl S2
:ΩSCL="FIT":Ωσ=1
:Lbl S3
:Outpt(1,1,"DRAW COORDINATE AXIS")
:Menu(1,"YES",AXISON,5,"NO",AXISOFF)
:Lbl AXISON
:ΩAXIS="ON":Goto CRD
:Lbl AXISOFF
:ΩAXIS="OFF"
:Lbl CRD
:If ΩNUCFG=="YES"
:Then
:If ΩHNDCRD=="CYL"
:Goto CYL
:If ΩHNDCRD=="SPH"
:Goto SPH
:If ΩHNDCRD=="XYZ"
:Goto XYZ
:End
:Outpt(1,1,"COORDINATE    SYSTEM")
:Menu(1,"CRTSN",XYZ,3,"SPHRCL",SPH,5,"CYLNDR",CYL)
:Lbl CYL
:If ΩCFG=="OLD"
:Goto CYLEQ
:ClLCD:ΩHNDCRD="CYL"
:Input "θ MIN:",ΩST
:Input "θ MAX:",ΩED
:Input "θ INC:",ΩINC
:Disp ""
```

```
:Input "Z MIN:",ΩST0
:Input "Z MAX:",ΩED0
:Input "Z INC:",ΩINC0
:If ΩINC==0
:ΩINC=ΩSTDINC
:If ΩINC0==0
:ΩINC0=ΩSTDINC0
:seq(Z,Z,ΩST0,ΩED0,ΩINC0)→Z
:ΩST→tMin:ΩED→tMax
:ΩINC→tStep
:If ΩNUCFG=="YES"
:Goto ROT
:Lbl CYLEQ
:ClLCD:Disp "Type (Z) in Capital  "
:Disp ΩDASH
:InpSt "r(θ,Z)=",r:St»Eq(r,r)
:Menu(1,"r=+-",R1,5,"r=...",R2)
:Lbl R1
:ΩX2=-ΩX1
:ΩY2=-ΩY1+2Z
:FnOn 2
:Lbl R2
:θ=t
:X=r(cos θ)
:Y=r(sin θ)
:FnOn 1
:Goto ROT
:Lbl SPH
:If ΩCFG=="OLD"
:Goto SPHEQ
:ClLCD:ΩHNDCRD="SPH"
:Input "θ MIN:",ΩST
:Input "θ MAX:",ΩED
:Input "θ INC:",ΩINC
:Disp ""
:Input "ϕ MIN:",ΩST0
:Input "ϕ MAX:",ΩED0
:Input "ϕ INC:",ΩINC0
:If ΩINC==0
:ΩINC=ΩSTDINC
:If ΩINC0==0
:ΩINC0=ΩSTDINC0
:seq(ϕ,ϕ,ΩST0,ΩED0,ΩINC0)→ϕ
```

```
:ΩST→tMin:ΩED→tMax
:ΩINC→tStep
:If ΩNUCFG=="YES"
:Goto ROT
:Lbl SPHEQ
:ClLCD:InpSt "ρ(θ,ϕ)=",ρ:St»Eq(ρ,ρ)
:Menu(1,"ρ=+-",RH1,5,"ρ=...",RH2)
:Lbl RH1
:ΩX2=-ΩX1
:ΩY2=-ΩY1
:FnOn 2
:Lbl RH2
:θ=t
:X=(sin ϕ)ρ(cos θ)
:Y=(sin ϕ)ρ(sin θ)
:Z=(cos ϕ)ρ
:FnOn 1
:Goto ROT
:Lbl XYZ
:If ΩCFG=="OLD"
:Goto XYZEQ
:Y=t:ClLCD:ΩHNDCRD="XYZ"
:Input "X MIN:",ΩST0
:Input "X MAX:",ΩED0
:Input "X INC:",ΩINC0
:Disp ""
:Input "Y MIN:",ΩST
:Input "Y MAX:",ΩED
:Input "Y INC:",ΩINC
:If ΩINC==0
:ΩINC=ΩSTDINC
:If ΩINC0==0
:ΩINC0=ΩSTDINC0
:seq(X,X,ΩST0,ΩED0,ΩINC0)→X
:ΩST→tMin:ΩED→tMax
:ΩINC→tStep
:If ΩNUCFG=="YES"
:Goto ROT
:Lbl XYZEQ
:ClLCD:Disp "Type (XY) in Capital"
:Disp ΩDASH
:InpSt "Z(X,Y)=",ΩZ
:St»Eq(ΩZ,Z)
```

```
:FnOn 1
:Menu(1,"Z=+-",A1,5,"Z=...",CYLINDER)
:Lbl A1
:FnOn 2
:Lbl CYLINDER
:For(r,1,lngth ΩZ)
:ρ=sub(ΩZ,r,1)
:If ρ=="X"
:Goto XFOUND
:End
:ΩINC=ΩRNG/64:ΩINC→tStep
:ΩINC0=(abs ΩST0+abs ΩED0)/10
:seq (X,X,ΩST0,ΩED0,ΩINC0)→X
:Lbl XFOUND
:For(r,1,lngth ΩZ)
:ρ=sub(ΩZ,r,1)
:If ρ=="Y"
:Goto ROT
:End
:ΩINC0=ΩRNG/64:seq(X,X,ΩST0,ΩED0,ΩINC0)→X
:ΩINC=ΩRNG*2:ΩINC→tStep
:Lbl ROT
:ClLCD
:If Ωϕϕϕ=="CUSTM"
:Then
:If ΩHND=="LT"
:Then
:Disp"SELECT  A TILT FOR Y"
:Else
:Disp"SELECT A  TILT FOR X"
:End
:Input "CUST TILT ANGL°:",Ωϕϕ:Ωϕϕϕ="STANDARD"
:Ωϕ=Ωϕϕ*π/180
:End
:Input "IMAGE ROTATION°:",Ωθθ
:Input "(XYZ) AXIS SIZE:",ΩRNG
:-ΩRNG→xMin:ΩRNG→xMax
:-ΩRNG→yMin:ΩRNG→yMax
:1→xScl:1→yScl
:Lbl PLTEQ
:If ΩSCL=="SQR"
:ZSqr
:If ΩSCL=="FIT"
```

```
:ZFit
:Lbl DONE
:If ΩAXIS=="OFF"
:Goto MNU
:ΩNUCFG="NO"
:ΩH=(abs xMin+abs xMax)/128
:ΩV=(abs yMin+abs yMax)/64
:ΩN=4
:ΩX=1E9*ΩRNG*cos Ωϕ
:ΩY=1E9*ΩRNG*sin Ωϕ
:Line(0,0,ΩX,ΩY)
:Line(0,0,xMax,0)
:Line(0,0,0,yMax)
:Line(3*ΩH,yMax,(3+ΩN)ΩH,yMax)
:Line(3*ΩH,yMax-(ΩN*ΩV),(3+ΩN)ΩH,yMax-(ΩN*ΩV))
:Line(3*ΩH,yMax-(ΩN*ΩV),(3+ΩN)ΩH,yMax)
:If ΩHND=="LT"
:Then
:Line(xMax-(ΩN*ΩH),3*ΩV,xMax,(ΩN+3)ΩV)
:Line(xMax-(ΩN*ΩH),(ΩN+3)ΩV,xMax,3*ΩV)
:Else
:Line(xMax-(ΩN*ΩH),3*ΩV,xMax,(ΩN+3)ΩV)
:Line(xMax-(ΩN*ΩH),(ΩN+3)ΩV,xMax-(.5ΩN*ΩH),(.5ΩN+3)ΩV)
:End
:Lbl MNU
:Menu(1,"Zoom",ZUM,2,"View",VU,3,"REcfg",NUCFG,4,"Exit",QT,5,"Graph",GRPH)
:Lbl ZUM
:Menu(1,"ZIn",ZI,2,"ZOut",ZO,3,"ZFit",ZF,4,"ZSqr",ZS,5,"Menu",MNU)
:Lbl ZI
:Ωσ=1:ZIn:Goto DONE
:Lbl ZO
:Ωσ=1:ZOut:Goto DONE
:Lbl ZF
:Ωσ=1
:ΩST→tMin:ΩED→tMax
:ΩINC→tStep:1→xScl:1→yScl
:-ΩRNG→xMin:ΩRNG→xMax
:-ΩRNG→yMin:ΩRNG→yMax
:ZFit:Goto DONE
:Lbl ZS
:Ωσ=64/128
:ΩST→tMin:ΩED→tMax
:ΩINC→tStep:1→xScl:1→yScl
```

```
:-ΩRNG→xMin:ΩRNG→xMax
:-ΩRNG→yMin:ΩRNG→yMax
:ZSqr:Goto DONE
:Lbl VU
:Pause :Goto MNU
:Lbl QT
:ClLCD:Stop
:Lbl GRPH
:Goto BEGIN
:Lbl NUCFG
:ΩNUCFG="YES":ClLCD:Goto NEW
```