

# **SOSS1000**

Dc`]WnUbX'GcWJYhm

HYfa "Hk c "# "&\$&\$

# 7 ci fgY Cj Yfj ]Yk

### GHJZZ:7cbHJWh:8YHJ]`g

#### 7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`]m	@cWUh]cb	D\cbY
8]UbU'DYfWXY	X]UbU"dYfW\Y4 i bgk "YXi "Ui	D`YUgY'Ya U]`'hc UffUb[Y'Ub Uddc]bha Ybh'		7 cbHJWhj]U HYUa g

### GWXcc`7cbHJWhi±bZcfa Uhjcb

GWXcc``cZGcWJU``GWJYbWYg

Fcca '%) -

A cfj Yb 6fck b 7 &\$

Ya U]`. 'gcgg4 i bgk "YXi "Ui

d\cbY. '\$&'-',) '% \$+

# 7ci fgY<sup>.</sup>8YW]`g

7fYX]hDc]bhg\*\*

Gi a a UfmcZ'h\Y'7ci fgY

Gi V^WhUfYUg. GcWJU`F YgYUfW. / 'Dc`]Wh

 $\label{eq:hamiltonian} $$H\ ]g'WcifgY'WUb'U'gc'VY'ghiX]YX']b'h\ Y'Zc``ck]b['gdYW]U']gUh]cbg.'7f]a]bc`c['m'UbX'GcW]U''Kcf_'$ 

#### fYUX]b[g"

&""HI HCF =5@G

Hi hcf]U`g`U`ck `ghi XYbhg`hc`X]gWi gg`h\YcfYh]WU``UddfcUW\Ygž`Ug\_'ei Ygh]cbgž´Z fh\Yf`]bhYffc[ UhY`WcbWi dhg UbX`]ggi Yg`Uf]g]b[ `Zfca `h\Y]f`]bXYdYbXYbhghi Xm''Hi hcf]U`g`U`gc`dfcj ]XY`ghi XYbhg`k ]h\`h\Y`cddcfhi b]hmhc Yb[ U[ Y`]b`dfcXi Whj Y`X]gWi gg]cb`k ]h\`h\Y]f`dYYfg`UbX`hc`dUfh]W]dUhY`]b`U`fUb[ Y`cZghfi Whi fYX``YUfb]b[ UWhjj ]h]Ygž`]bWi X]b[ `[ fci d#dU]f#]bX]j ]Xi U``UbU`mh]WU``k cf\_ž`Zcfa U``UbX`]bZcfa U``XYVUhYgžei ]nnYg`UbX`a ]b]! dfc`YWhg"

' "'-\$89D9B89BH'@95FB\$; '57H\$ \$H\$9G

±0XYdYbXYbh`YUfb]b[ 'UWfj ]h]Yg`a i gh'VY'Wca d`YhYX'YUW\`k YY\_"'H\Y``YUfb]b[ 'UWfj ]h]Yg`UfY`XYg][ bYX'hc Zcgh'f`]bXYdYbXYbhghi Xm'UbX`rc`U``ck 'Zcf`Yb[ U[ Ya Ybhik ]h\ 'X]ZYfYbhihUg\_g`h\UhWUbbch'VY`i bXYfhU\_Yb`]b`U hi hcf]U``Ybj ]fcba Ybhžgi W\ 'Ug`WcbXi Wfjb[ 'cb`]bY`fYgYUfW\ 'cf`k UhW\]b[ 'U'Z]`a "'Ghi XYbhg`k ]``'U'gc`i bXYfhU\_Y ZJY`Xk cf\_'VmcVgYfj ]b[ 'UbX`fYdcfh]b[ 'cb`fYU'!`]ZY'dc`]Wma U\_]b[ "'5Wfj ]h]Yg`UfY`k ]``'VY`YI d`U]bYX`UbX`k ]`` a cghmVY`ZJW]]hUhYX`Vmh\Y`I b]j Yfg]hm@YUfb]b[ 'A UbU[ Ya YbhGmghYa "'

### 5ggYgga Ybh

D`YUgY`gYY`A ccX`Y`Zcf`XYHJ]`YX`UggYgga Ybh]bZcfa Uh]cb"`

#### 5ggYgga Ybh'HUg\_g'

5ggYgga Ybh'HJg_	K Y][ \h	8i Y'8UHY	Gh XYbh@YUfb]b[ Ci hWca Ygʻ5ggYggYX
A ]bcf'9ggUm	' \$1	&*#\$*#&\$&\$`\$).\$\$`DA	%2
A U⁄cf <sup>·</sup> 9ggUm	) \$1	\$+#\$, #&\$&\$`\$).\$\$`DA	&ž(
: ]Y`Xk cf_'F Ydcfh'	&\$I	%( #\$, #&\$&\$`\$) .\$\$`DA	&Ž

#### 5ggYgga Ybh'8YhJ]`g

5ggYgga Ybh% A ]bcf 9ggUm

GHJfhXUhY. Bch5dd`]WUV`Y

**@Yb[h**\. %**%**\$\$ k cfXg

8YHJ]`g.

 $\label{lem:continuous} Ghi XYbhg gi Va ]hU g\cfhYggUmcZ%2&$$ k cfXg cb hY WcbhYbhcZhY ZfghgYhcZYWh fYg" H\g YggUm U`ck g`ghi XYbhg hc YI d`cfY hY ]ggi Yg ]b [ fYUhYf XYHJ]"$ 

Ghi XYbhg·k]```VY`dfcj]XYX`k]h\`kf]hhYb·ZYYXVUW\_'U`cb[g]XY`U`a Uf\_]b[`fi Vf]Wcb`h\Y]f`gi Va]hhYX`k cf\_" 5ggYgga Ybhg·k]```VY`a Uf\_YX`UbX`fYhi fbYX`k]h\]b`%\$`k cf\_]b[`XUmg"

Hi fb]h]b'gYh]b[.'H\]g'Ugg][ba Ybh]g'gi Va ]hhYX'h\fci [\'Hi fb]h]b'UbX'gh XYbhg'Xc'bchgYY'Hi fb]h]b g]a ]'Uf]hmfYdcfhg"

5ggYgga Ybh& A U/cf 9ggUm

GhUfhXUhY. Bch5dd`]WUV`Y

@Yb[h\.~&ž&\$\$

8 YW] g.

Ghi XYbhgi Va ]hU``cb[ 'YggUmcZ&ž&\$\$'k cfXg"'9ggUmei Ygh]cbg'k ]```VY`a UXY`Uj U]`UV`Y`]b`WUgg'UbX'cb`]bY" H\]g'YggUmU``ck g'ghi XYbhg'hc'Yl d`cfY`\_Ym]ggi Yg`]b`[ fYUhYf`XYhU]`"

Gh XYbhg k ]``VY`dfcj ]XYX`k ]h\ k f]hhYb ZYYXVUW\_U`cb[ g]XY`U`a Uf\_]b[ `fi Vf]Wcb h\Y]f`gi Va ]hhYX`k cf\_"

5ggYgga Ybhg'k]``'VY'a Uf\_YX'UbX'fYhi fbYX'k]h\]b'%\$'k cf\_]b['XUmg"

5ggYgga Ybh' .: ]Y`Xk cf\_F Ydcfh

GhUfh'XUhY.

@Yb[h\.\*\*\$\$\*kcfXg

8YHJ]`g.

Ghi XYbhgʻgi Va ]h'Uʻ\*\$\$ʻk cfXʻZ]YʻXk cf\_ʻfYdcfhʻʻH\]gʻ]gʻXcbYʻUZhYfʻk UhW\]b[ʻUʻʻcWUʻʻ[cj Yfba Ybha YYh]b[fY]h\Yf`]bʻdYfgcbʻcfʻcb`]bYŁžʻUbXʻUbUʻmg]b[ʻh\YʻdfcWYX]b[gʻʻH\YʻfYdcfhk]``Uʻ`ck ighi XYbhgʻhcʻUdd`mih\Y

# 5 hm/b XUbVW F Yei ]fYa Ybhg

 $\hbox{Ghi XYbhg'UfY'ghfcb[`mYbWc'i fU[YX'hc'UhhYbX'U```WUggYg'UbX'fYj]Yk'``YVWi fY'fYWcfX]b[g''] }$ 

# 7ci fgY GWX YXi `Y

J ]Yk 'WUgg'h] Y


### FYgci fWfg

#### DfYgWf]VYX F Ygci fWYg

5```fYUX]b[g'k]```VY'UjU]`UV`Y'X][]hU``mj]U'@Y[Ubhcž'k\]W\`WUb'VY'ZcibX`]b'AccX`Y"'

#### FYWca a YbXYX FYgci fWYg

5```fYUX]b[g'k]```VY'Uj U]`UV`Y'X][]hU``mj]U'@Y[Ubhcžk\]W\`WUb'VY'Zci bX']b'AccX`Y"'

#### 7ci fgY 9j U`i Uh]cb UbX 8Yj Y`cda Ybh

K Y i gY mci f ZYYXVUW\_hc i dXUhY ci f `YWh fY hcd]Wg UbX UggYgga Ybhg "

# 5 WUXYa ]W<cbYghmUbX D`U[]Uf]ga

D`U[]Uf]ga i]gii g]b[ih\Yik cfXgicfi]XYUgicZch\YfgiUbXidfYgYbh]b[ih\Ya iUgimci fick b"i=hWJbihU\_Yia Ubm Zcfa gžZfca iXYi]VYfUhYiWXYUh]b[ihciUWW]XYbhU`mWcdm]b[iZfca iUigci fWYik]h\ci hiUW\_bck iYX[Ya Ybh'

IBGK [fcidg'd'U[]Uf]ga ]bhc'h\Y'Zc``ck]b['WUhY[cf]Yg.



# 5 WUXYa]W + DZcfa Uh]cb

: cf'YggYbhJU`'ghi XYbhi]bZcfa UhJcb'fY`UhJb['hc.

- fYei Yghg Zcf Yl hYbg]cb/
- `UhY 'gi Va ]gg]cbg '[ i ]XY `]bYg/
- fYj ]Yk 'cZa Uf\_g/
- I BGK '< YU'h\ 'UbX'GUZYhm'dc']W]Yg/
- YI Ua ]bUh]cb dfcW/Xi fYg/
- •