

# **MUSC4103**

 $5\,Xj\;Ub\,W\!\!/X\,{}^{\cdot}G\,h\,\,X]Y\,g^{\cdot}]b\,{}^{\cdot}A\;i\;g]W\!\!<\,]ghc\,fm\,{}^{\cdot}Ub\,X\,{}^{\cdot}7\,i\;{}^{\cdot}h\;\,fY\,{}^{\cdot}\%$ 

HYfa 'C bY''##'&\$&%

# 7ci fgY'Cj Yfj ]Yk

# GHJZZ7cbHJWh8YHJ]`g

### 7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`] <b>m</b>	@cWUhjcb	D∖cbY
8cfcHmU: UV]Ub	X"ZUV]Ub4 i bgk "YXi "Ui	6m'Uddc]bha Ybh	K YVghYf"%\$'	-',) '*-)(

# GWXcc`7cbHJWh =bZcfa Uhlcb

GVXcc``cZhY`5fhg`UbX`AYX]U

Fcca " %&ž@YjY`" žFcVYfhK YVghYf'6i]X]b['f) %(Ł

D\cbY. f\$&Ł'-',) '(,) \*

9a U]`. 'gUa 4 i bgk "YXi "Ui

K YVg]hY. k k k "Ufhg"i bgk "YXi "Ui #gUa

 $\label{eq:hamiltonian} $$HY'GW.cc``cZh,Y'5ftg'UbX'AYX]U'k ci`X``]_Y'tc'FYgdYWM\cong \cong m5W_bck``YX[Y'th,Y'HfUX]tjcbU``7i gtcX]Ubg\cong hY'6YXY[U'``fPYbg]b[tcb'WJa di g\cong \cong \cong \cong mUbX'5fti/'8Yg][b'7Ua di gYg\cong \cong \con$ 

7 ci fgY 8YHJ]`g 7 fYX]hDc]bhg \*\* Webgi `HJHjeb'k]h\'H\Y'`YWhifYf"

; fci d'k cf\_#dfYgYbHJHjcbž&\$a ]bi H/gžj YfVU`ZYYXVUW\_žh fb]Hjb^ZYYXVUW\_

#### 5XX]h]cbU`XYhU]`g.

 $Ghi XYbhg'k]^*VY'a Uf\_YX']bX]j ]Xi U^*m''; fci d'k cf\_k]^*hU\_Y'hXY'Zcfa 'cZXYVUhY'''DchYbh]U^*XYVUhY'hcd]Wg'hc WkccgY'Zfca .$ 

%"? ge[UebWS] e Xad[feWX

&" A  $V = ge[U eZag V TWbWdAd_WW SUUadV[Y fa fZWZ[efad[US^bdSUf[UWe aXfZWf[_WaXUa_bae[ffa]]]]] Waxua_bae[ffa] Waxua_bae[ffa]$ 

' " ? ge[U eZag V SbbWS^fa fZW\_ SeeWe

("? ge[U [e W fWdfS] W fl `af Sdf

) " ? ge[U [e ` af ba /ff[US^Tgf bgdW/SWefZWf[Ufib MSegdW

 $\label{thm:limit} \begin{tabular}{ll} Hi & fb \end{tabular} $$ $H \ fb \end{tabular} $$ fo \end{tabular} $$ Hi & fb \end{tabular} $$ fo \end{tabular} $$ fo \end{tabular} $$ fo \end{tabular} $$ Hi & fb \end{tabular} $$ fo \en$ 

5ggYgga Ybh' . A U'cf dfc YWh

GhUfhXUhY. Bch5dd`]WUV`Y

**@Yb[h**\. '&) \$\$ k cfXg fbch]bWi X]b[ 'fYZYfYbW'g 'UbX'V]V`]c[ fUd\mŁ

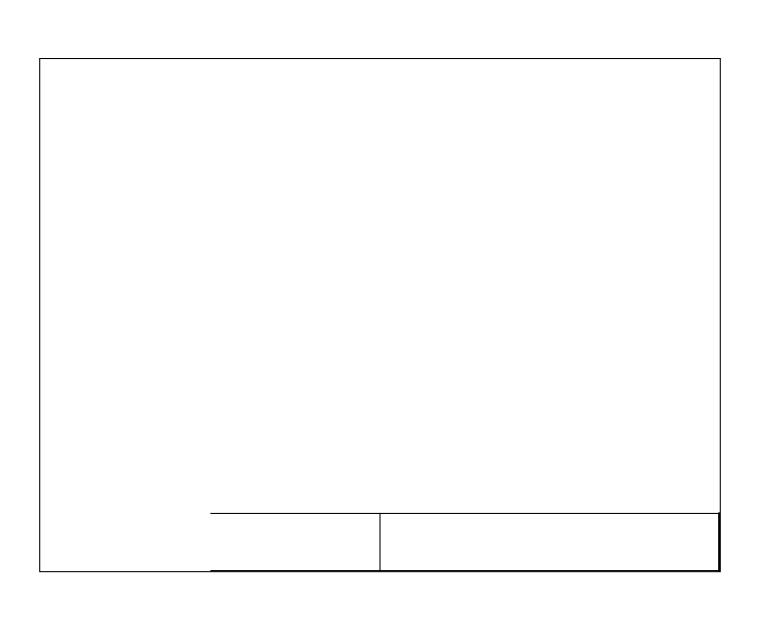
8YHJ]`q.

&) \$\$ k cfXgžZYYXVUW\_dfcj ]XYX Vmh fb]h]b"

#### 5XX]h]cbU`XYhJ]`g.

Ghi XYbhg`k]```VY`Ug\_YX`hc`Wf]h]WU``mYb[U[Y`k]h\`gYhfYUX]b[g`Wcad`YaYbhYX`VmfYUX]b[g`UbX`aig]WU` Yl Uad`Yg`cZh\Y]f`W\c]Wf"8YhU]`g`k]```VY`dfcj]XYX`VmkYY\_`&`cZhYfa"

 $\label{thm:limit} \begin{tabular}{ll} Hi & fb & fb & gYh &$ 



# FYgci fWyg

# DfYgWf]VYX F Ygci fWyg

A UbXUlrcfmfYUX]b[g'UfY'cf[Ub]gYX'Vmk YY\_'UbX'UfY'dfcj]XYX'cb'h\Y'Wti fgY'g'A ccX`Y'dU[Y'Ug'U'dXZ XcW'a Ybhz'cfa UXY'Uj U]'UV'Y'j]U'U'`]b\_"'5WWygg'hc'HUfi g\_]b'g': [efack aXI WefWt ? ge[U']g'fYWta a YbXYX/h\]g'HYI h']g'Uj U]'UV'Y'Zcf'ZfYY'Ug'Ub'9!Vcc\_jj]U'H\Y'I BGK '@]VfUfmk YVg]hY''' < UfX'Wtd]Yg'cZYUW\'j c'i a YUfY'U'qc'Uj U]'UV'Y'Zfca 'h\Y'`]VfUfm'

 $5 \ WW gg hc : UV] Ub fig 3 ? ge [Ua a Yk a XB W b Ad S ` UWk ] ``VY f Yei ] f YX Xi f] b [ h Y Z] f gh (k YY g" H ) g ] g Uj U] ` UV Y cd Yb ` UWW gg Z ca . ` h d g #k k k "cd Yb V cc _ di V ] g \ Yf g "W a #d f c Xi W# (* "$ 

5``]ghcZUi X]c'Yl Ua d`Yg'UfY'dfcj ]XYX'YUWX'k YY\_/U```k cf\_g'UfY'Uj U]`UV`Y'j ]U'Wca a YfWJU``ghfYUa ]b[ ž B Ul cg'cb`]bYžcf'Mci Hi VY''

# FYWca a YbXYX FYgci fWyg

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

H\Y`Wci fgY`\Ug`VYYb`fYj ]gYX`gYj YfU``fja Yg`Xi f]b[ 'f\Y`dUghZYk 'mYUfg'hc`UW\ca a cXUhY`h\Y`YI dYffjgY`cZ X]ZZYfYbhHYUW.]b[ 'gHJZ`UbX`fYgdcbX`hc`ghi XYbhZYYXVUW\_": YYXVUW\_`]g`\_YYb`mfYei YgHYX`hc`U``ck 'Z ff\Yf Z]bY!hi b]b[ 'UbX`]a dfcj Ya Ybhg`]b`Z hi fY`mYUfg": cfa U``a m9I dYf]YbWY`Yj U`i Uhjcbg`k ]``VY`i gYX`Uhh\Y`YbX cZgYa YgHYf`Vi highi XYbhg`UfY`YbWci fU[ YX`hc`dfcj ]XY`ZYYXVUW\_`h\fci [\ci hh\Y`gYa YgHYf`cb`Wci fgY WcbHYbhUbX`Ugg][ ba Ybhg`Ug`k Y``Ug`h\Y`dUW\b[ 'cZh\Y`Wci fgYžY]h\Yf`ZJWY`hc`ZJWY`cf`hc X"ZJV]Ub4 i bgk "YXi "Ui "'5```ZYYXVUW\_`k ]```VY`X]gW`ggYX`Ua cb[ 'a i g]WgHJZZUbX`h\Y``YWhi fYf`k ]```k cf\_ WcgY`mhc`a cb]hcf`ghi XYbhdfc[ fYgg`UbX``YUfb]b[ 'bYYXg"`7 ci fgY`WcbHYbhž'a cXY`cZXY`]j YfmUbX Ugg][ ba YbhgWXYXi `Y`a UmU```VY`UX^i gHYX`]b`Z hi fY`mYUfg`]Z]hWJb`VY`YghUv`]g\YX`h\Uhigi WX`W\Ub[ Yg`k ci `X ZcgHYf`XYYdYf``YUfb]b[ 'UbX`VYHHYfci hWca Y`Zcf`U```ghi XYbhg"

Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g Hlinf[b][h]b/Gjg]Ka ]gg]cb

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

D`U[]Uf]ga `]g`i g]b[ 'h\Y`k cfXg`cf`]XYUg`cZch\Yfg`UbX`dfYgYbh]b[ 'h\Ya `Ug`mci f`ck b"`±hWJb`hU\_Y`a Ubm Zcfa gžZfca `XY`]VYfUhY`W\YUh]b[ 'hc`UWW]XYbhJ``mWcdm]b[ 'Zfca `U`gci fWY`k ]h\ci hUW\_bck `YX[ Ya Ybh'

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

 $7 \text{ cdm}b[...i g]b[...h\Y.gUa Y.cf.j Yfmig]a] \Uf'k cfXg'hc'h\Y.cf][]bU''hYl h'cf']XYU'k]h\ci h'U\V_bck `YX[]b[...h\Y.cf][]bU''hYl h'cf']XYU'k]h'cf']$ 

- i bXYfgHUbX'mci f'f][\hg'UbX'fYgdcbg]V]`]h]Yg'Ug'U'gh XYbhUhI BGK
  VY'Uk UfY'cZd`U[]Uf]ga ž'Wcdmf][\hz'I BGK 'Gh XYbh7cXY'cZ7cbXi WhUbX'5VWWdhUV`Y'I gY'cZ IBGK =7 HF Ygci fWrg Dc`]Wh