

# **MDIA5100**

±Xi ghfmi±hYfbg\]d

HYfa 'Hk c''##'&\$&%

# 7ci fgY'Cj Yfj ]Yk

## GHJZZ7cbHJWh8YHJ]`g

### 7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`] <b>m</b>	@cWUhjcb	D\cbY
9a a U <sup>.</sup> 5"'>UbY	Ya a U"^UbY4 i bgk "YXi "Ui	6m'Uddc]bha Ybh		

### GWXcc~7cbhJWh~abZcfa Uhlcb

GWXcc`cZh\Y'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$ 

# 7ci fgY 8YHJ] g

## 7 fYX]hDc]bhg \*

## Gi a a UfmcZh\Y'7ci fgY

H\Y']bhYfbg\]d'fYei ]fYg'U'rchU`'Wca a ]ha YbhcZ%\$\$!%) \$`\ci fg'cZk cf\_'k ]h\'U'\cghcf[ Ub]gUr]cb'UbX'WUb'VY hU\_Yb']b'Z]fghzgYWcbX'cf'h\]fX'hYfa z'cf'cj Yf'h\Y'gi a a Yf'dYf]cX"'±bhYfbg\]d'cddcfhi b]hJYg'UfY'UXj YfhJgYX'j ]U h\Y': 5GGSK @SG5A '±bhYfbg\]d

dU[Y. \htdg.##a ccX\Y"HY\Hi bgk "YXi "Ui #\text{ki fgY#]Yk "d\d3]X1'') \( \text{\lambda} \) "5 \\htdg.##a ccX\Y"HY\Hi bgk "YXi "Ui #\text{\lambda} \) fgY#]Yk "d\d3]X1'') \( \text{\lambda} \) "5 \\htdot \\htdg.\Hi \) bh\fbg\]d\"mci 'a Umi\]b\\Yb\\Mi\] bh\fbg\]d\"mci 'a Umi\]b\\\fbg\]d\"mci 'a Umi\]b\\\fbg\]d\"mci '\text{\lambda} \) bh\fbg\]d\"mci '\text{\lambda} \) bh\fbg\]d\"mci '\text{\lambda} \) bh\fbg\]b\\\mathrace{\lambda} \) bh\fbg\]b\\mathrace{\lambda} \) bh\fbg\]b\\mathrace{\lambda} \) bh\fbg\]b\\mathrace{\lambda} \) bh\fbg\]b\\mathrace{\lambda} \) \\\mathrace{\lambda} \) bh\fbg\]b\\mathrace{\lambda} \] bh\fbg\mathrace{\lam

: cf`a cfY`]bZcfa Uhjcbžj ]g]h\hhdg.#k k k "Ufhg"i bgk "YXi "Ui #gUa #ghi Xmli g#bhYfbg\]dg": cf`UbmYbei ]f]Ygž d`YUgY`Ya U]``h\Y`K #@T b]hUh<u>: 5GG!K #@4 i bgk "YXi "Ui</u>

Hc VY Y`][ ]V`Y Zcf'h\]g Wci fgYžmci a i gh\Uj Y U a ]b]a i a 'K 5A 'cZ\*) "

# 7ci fgY @YUfb]b[ 'Ci hWca Yg

% \Uj Y`[ U]bYX`YI dYf]YbWY`cZ]bXi glfmdfc\WfggYg`UbX`dfU\WfJ\Wfg & UbX`Y dfc[fUa `hc`fYU`!k cfX`\bhYI hg \\ '\Uj Y`Yb\Ub\WfX`h\Y]f`\WdU\\\\mZcf`]bXYdYbXYbhYb[U[Ya Ybhk]h\\]bXi glfmdfcj ]XYfq

HYUWX]b[ 'GhfUhY[]Yg'

# 5ggYgga Ybh

h\Υ	′.M¢!	fgY fY	ei]fYa	a Ybh	g" <sup>-5</sup> b'	GM[fl	uxy k ]	``bchl	JZZY Whim	ci f'k Y	'Uj YfU			YYh]b[ @'[fUXY

#### 5qqYqqa Ybh& K cf\_ 9j ]XYbW

**@Yb[h**\. `A ]b]a i a `cZ&) \$'k cfXg'fcf'fci [\'Yei ]j U'YbhZcf'bcb!hYl hVUgYX'gi Va ]gg]cbgŁ'Vi ha Uma U\_Y'i d a cfY'cZh\Y'%) \$\$'hc'&) \$\$'k cfXg'fYei ]fYX'Zcf'Vch\'Ugq][ ba Ybhg']b'h\]g'Wci fgY"

#### 8 YW] g.

Ghi XYbhgʻk ]``dfYgYbhiUʻgUa d`YʻcZzʻfYdcfhgʻcbzʻcf``]b\_gʻhcʻcf][ ]bU``k cf\_ʻi bXYfhU\_Yb#dfcXi WYXʻXi f]b[ 'UbX Zcfʻh\Y'di fdcgYgʻcZh\Y']bhYfbg\]d":H\]gʻa UmVYʻU`\c`]ghJWk f]hhYbʻXcW a YbhfY[ 'bYk gʻghcfmžW]YbhdfcZ]Y YhWtcfʻfYWcfXgʻcZfYgYUfWk ii bXYfhU\_YbʻhcʻdfYdUfYʻZcfʻUʻXcW a Ybh#/j Ybh#dfcWyggʻ]bʻh\Yʻ\cghcf[ Ub]nUh]cbž fYdcfh]b[ 'cbʻhUg\_gʻi bXYfhU\_YbžXYgWf]dh]cbʻcZk cf\_Zck i]bʻfY`Uh]cbʻhcʻU``Uf[ YfʻdfcWyggžcfʻg]a ]`Ufž]Yʻ]h g\ci `X`dfcj ]XYʻYj ]XYbWiʻcZdfUWf]WU``k cf\_ʻi bXYfhU\_YbʻXi f]b[ 'h\Y'd`UWia Ybh'ʻH\]gʻg\ci `X`VY`Uʻa ]b]a i a cZ&) \$`k cfXgʻVi ha Uma U\_Yʻi dʻa cfYʻcZh\YʻWta V]bYXʻhchU``cZ%) \$\$!&) \$\$`k cfXgʻZcfʻVch\`UggYgga Ybh Wta dcbYbhg"

; fUX]b[ 'k ]``VY`GUhjgZJWcfm# bgUhjgZJWcfmcb`mUbX'bc'Z fh\Yf'ZYYXVUW\_k ]``VY'dfcj ]XYX"

# FYgci fWfg

## DfYgWf]VYX F Ygci fWYg

D`YUgY`k cf\_'h\fci [\`h\Y`cbVcUfX]b[`\_]hmci fî`Z]bX`cb`A ccX`Y`VYZcfY`Wca a YbW]b[`mci f`]bhYfbg\]d"`C h\Yf\Y`dZ``fYgci fWYg`WUb`VY`Zci bX`cb`h\Y`Wci fgY`A ccX`Y`g]hY"`

## FYWca a YbXYX FYgci fWfg

### 7ci fgY 9j U'i Uhjcb UbX 8Yj Y'cda Ybh

K Y fYgdcbX hc ZYXVUW\_fYWY]j YX j ]U X]fYWhYa U] hc h Y 7 ci fgY 7 cbj Ybcf UbX h Y K ⊕ I b]hž UbX ]bZcfa Uh]cb dfcj ]XYX jb h Y gh XYbh UbX \cgh ZYXVUW\_Zcfa g"

KY'\cdY'mci 'Yb'cm'mci f']bhYfbg\]d°

# Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g Hi fb]h]b Gi Va ]gg]cb

-Zmci 'YbWci bhYf'U'dfcV`Ya 'k \Yb'UhhYa dh]b[ 'hc'gi Va ]hmci f'Ugg][ ba Ybhh\fci [ \'Hi fb]h]bž'd`YUgY hY`Yd\cbY'9I hYfbU``Gi ddcfhcb'-',)'''' %cf'Ya U]`'h\Ya 'cb'YI hYfbU`hY`hgi ddcfh4 i bgk "YXi "Ui '"'Gi ddcfh

# 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