



MECH4100

A YVX Ub]WU`8 Yg][b`&

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

GWXcc`cZA YVX Ub]WU`UbX`A Ubi ZUW f]b[`9b[]bYYf]b[`##`I BGK `9b[]bYYf]b[]

7ci fgY`Cj Yfj]Yk

GHJZ`7cbHJW`8YHJ]`g

7cbj Ybcfg

B Ua Y	9a U]	5j U]UV]`]m	@cW]h]cb	D\cbY
=fYbY`F YbUi X! 5ggYa Uh]`fYbUi XUggYa Uh4 i bgk "YXi "Ui	- Ua !) da žA cb!: f]	5]bgk cftλ 6i]X]b[`>%+ž F cca `&\$, 7	

@YW`i fYfg

B Ua Y	9a U]	5j U]UV]`]m	@cW]h]cb	D\cbY
8Ub]Y`9[(]bgk cftλ			

fZ *%&E- ' ,) '' %+- '-I BGK `Gh Xm5VfcUX`UbX`I BGK `9I WUb[Y`fZcf`]bVci bX`gh XYbhgk

fZ *%&E- ' ,) `(\$- +'-GWcc`C Z]W}t

†D`YUgY`bch`h`Uhi`h`Y`GWcc`C Z]W`k`j`bch_bck`k`Yb#Zmc`i`f`Wci`fgY`Wcbj`Ybcf`]g`cb`Wla`di`g`cf`Uj`U]UV`Y

9a U]`

[9b\[\]bYYf\]b\[`Gh XYbhGi ddcfhGYfj \]Wg`-`W ffYbhghi XYbhYbei \]f\]Yg](#)

•

7ci fgY'8YHJ]`g

7fYX]hDc]bqg`*`

Gi a a UfmicZ\hY'7ci fgY

h`h]g`Wci fgYžgh XYbqg`k`i`i` bXYfU_Y`U`a` U`f`XYg][b`dfc`YWhUg`U`h`Ua` ž`YbUV`]b[`h`Ya` `h`c`XYj`Y`cd`
W`c`b`W`d`h`U` `UbX`XYHJ]YX`gc`i` h`cbg`Z`c`f`Ub`Y`b[]b`Y`Y`f`b[`d`f`c`Y`W`ž`i` h`]n`b[`U`b`X`Y`I` h`b`X`]b[`h`Y`f`_`b`c`k` `Y`X[`Y` `U`b`X`
g`_]`g`U`V`e`i`]f`Y`X`h`f`c`i` [` \`c`i` h`h`Y` `X`Y[`f`Y`Y` `d`f`c[`f`U`a` a` Y` `H` \`g`]b`W`i` X`Y`g` `d`f`c` `Y`W`i`V`U`g`Y`X` `X`Y`g][b`d`f`c`W`g`g`ž`d`f`c` `Y`W`i`
a`U`b`U[`Y`a` `Y`b`ž` `X`Y`g][b`Z`c`f`a` `U`b`i` Z`J`W`i` f`]b[`ž`f`Y` `]U`V`]m`ž`U`Z`c`f`X`U`V`]m`ž`U`b`X` `g`i` g`h`U`]b`U`V`]m`i`

Z`J`W`i`Y`U`h`g`k`ž`g`h`c`f`Y`U`b`]h`W`i`V`U`g`Y`X` `Z`c`k`]W`h`U`f`]b[`U`b`X`]b`W`b`c`U`h`a`]b`]b[`h` `f`a` `Y` `c`j` Y`f`U` ` `U`W`j`]h`Y`g` `c`Z`h`Y` `h`Y`U`a` ž`U`g` %d` ` %g`
W`c`f`X`]b`U`h` `h`Y` `c`j` Y`f`U` ` `X`]f`Y`W`i`c`b` `c`Z`h`Y` `h`Y`U`a` ž`U`b`X` `f`Y`d`c`f`h`h`Y`]f`d`Y`f`Z`c`f`a` `U`b`W`i`h`f`c`i` [` \`d`f`c`h`m`d`Y`
a`U`b`i` Z`J`W`i` f`]b[`U`b`X` `h`Y`g`]b[`ž`k` f`]h`Y`b` `X`Y` ` %o` ` Y`

F Ygci fWg

F YWca a YbXYX'F Ygci fWg

Gi [[YghYX'fYUX]b['fU'ghUfh]b['dc]bhcb`mŁ

9I WY`YbhUXj]WzXYgW[dh]cbg'UbX'[i]XY`]bYgžVUgYX'cb'dfUW]WU`YI dYf]YbWY'UFY'[]j Yb`]b`? S] [Y'E f[d] Y
7` Y[Wē Vm5bXmF cggžk \]W'Wb'VY'cVhU]bYX'Ug'U'ZY'Xck b'cUX'Zca 'hY'Zc`ck]b[
dU[Y.

Gi Va]gg]cb'cZ5ggYgga YbhiHUg_g

5ggYgga Ybhgi Va]gg]cb'UbX'a Uf_]b['Wf]hYf]U

G\ci 'X'h\Y'Wci fgY'\Uj Y'Ubmbcb!Y'YVWfcb]WUggYgga Ybhgi Va]gg]cbž'h\YgY'g\ci 'X'\Uj Y'U'ghUbxUfX
GWkcc'Wcj Yf'g\YYH'

5`gi Va]gg]cbg'UfY'YI dYVWY'X'hc'VY'bYUhiUbX'WYUfmgYhici H'Mci f'fYgi 'hg'UfY'h\Y'd]bbUWY'cZU`mci f'\UfX
k cf_'UbX'g\ci 'X'VY'hYUhiX'k]h'Xi Y'fYgdYVW'DfYgYbh]b['fYgi 'hg'WYUfmi[]j Yg'h\Y'a Uf_Yf'h\Y'VYghWUbxWY
cZi bXYfgUbx]b['mci f'a Yh\cX/Yj Yb']Zh\Y'bi a Yf]WU'fYgi 'hg'UfY']bVc'fYVW'

A Uf_]b['[i]XY']bYg'Zcf'Ugg][ba Ybhgi Va]gg]cbg'k]`VY'dfcj]XYX'Uhih\Y'gUa Y'h]a Y'Ug'Ugg][ba YbhXYH]g
hc'Ugg]ghk]h'a YH]b['UggYggUV'Y'fYei]fYa Ybhg" Gi Va]gg]cbg'k]`VY'a Uf_YX'UWVc'fX]b['hc'h\Y'a Uf_]b[
[i]XY']bYg'dfcj]XYX"

@UHY'dc`]Wm

K cf_gi Va]hYX'`UHY'k]h\ci hUb'Uddfcj YX'YI hYbg]cb'Vmih\Y'Wci fgY'Wc'fX]bUhc'f'cf'XY'Y[UHYX'Ui h\cf]hm]g
gi VYVWihc'U'`UHY'dYbU'micZ&\$'dYfW'bhf&\$i 'E'cZh\Y'a U[]a i a 'a Uf_'dcgg]V'Y'Zcf'hUhiUggYgga Ybh]hYa ž
dYf'WU'YbXUf'XUm'

H\Y'`UHY'dYbU'mi]g'Udd'YX'dYf'WU'YbXUf'XUmf]bWi X]b['k YY_YbXg'UbX'di V]W\c`]XUmgE'hUhih\Y
UggYgga Ybh]g'c] YfXi Y'"H\YfY'g]bc'dfc!fUHU'cZh\Y'`UHY'dYbU'miZcf'gi Va]gg]cbg'a UXY'dUfhk Umih\ci ['\U
XUm'

K cf_gi Va]hYX'UZfY'h\Y'XYUX']bY'Zcf'UVgc'i hY'ZU]']g'bchUWVW'dhYX'UbX'U'a Uf_'cZnYfc'k]`VY'Uk UfXYX
Zcf'hUhiUggYgga Ybh]hYa "

: cf'gca Y'UggYgga Ybh]hYa gžU'`UHY'dYbU'mia UmibchVY'Uddfcdf]UHY'"H\YgY'UfY'WYUfmi]bX]WUhiX'']b'h\Y
Wci fgY'ci h]bYž'UbX'gi W'UggYgga Ybhg'fYVW'j Y'U'a Uf_'cZnYfc']ZbchWca d'YhYX'Vmih\Y'gdYVW]ZYX'XUHY"
9I Ua d'Yg']bWi XY.

% K YY_'micb']bY'hYghg'cf'UVcfUhc'fmik cf_'k cffh'U'ga U`dfc'dcf]cb'cZh\Y'gi VYVWia Uf_ž'cf
&" C b']bY'ei]nnYg'k \YfY'Ubgk Yfg'UfY'fY'YUgYX'hc'gfi XYbhg'cb'Wca d'Yh]cbž'cf
' " DfcZYgg]cbU'UggYgga YbhHUg_gžk \YfY'h\Y']bhYbh]cb]g'hc'WYUHY'Ub'Ui h\Ybh]WUggYgga Ybh'hU
\Ug'Ub'UVgc'i hY'gi Va]gg]cb'XUHYž'cf
(" DUgg# U]'UggYgga YbhHUg_g"

9I Ua]bUH]cbg

UggYgga YbhdYfZcfa UbWžmci 'UfY'Y'[]V'Y'hc'Udd'mZcf'GdYWU'7 cbg]XYfUhc'b'df]cf'hc'gi Va]h]b['Ub
UggYgga Ybhcf'g]h]b['Ub'YI Ua "

I BGK 'bck '\Ug'U': [\]h\]c'G\]h#Gi Va \]hfi_Yžk \\]](#)W'a YUbg'hUh]Zmci 'UfY'a dhUb'YI Ua 'cf'gi Va]hU'd]YW'cZ
UggYgga Ybhž'mci 'UfY'XYWUf]b['mci fgY'Z]hYbci ['\ 'hc'Xc'gc'UbX'WUbbch'UfY'Udd'mZcf'GdYWU'
7 cbg]XYfUhc'b"

: cf'XYfU]g'cZUdd'm]b['Zcf'GdYWU'7 cbg]XYfUhc'b'UbX'WcbX]h]cbg'Zcf'hY'Uk UfX'cZgi dd'Ya YbhUfm
UggYgga Ybhž'd'YUg'gYY'hY'jbZcfa Uhc]b'cb'I BGK 'g' [GdYWU'7 cbg\]XYfUhc'b'dU\]_Y"](#)

D'YUgY'bc'hY'hUhghi XYbhg'k]'bchVY'fYei]fYX'hc'dfcj]XY'UbmXcW a YbhUfmYj]XYbW'hc
gi ddcfhUVgYbW'g'Zca 'UbmWUggYg'a]ggYX'VYWU]i gY'cZ7CJ -8!%- 'di V']W\YU'h' a YUgi fYg'gi W'Ug
]gc'Uh]cb" I BGK 'k]'bchVY']bg]gh]b['cb'a YX]W'Wf]h]Z]W]hYg'Zca 'UbmcbY'XYa YX'hc'VY'U'dcg]h] Y'WUgYž
cf'k \Yb'hYm\Uj Y'fYVčj YfYX" 'Gi W'Wf]h]Z]W]hYg'UfY'X]Z]W'h'hc'cVh]b'UbX'di hUb'i bbYW'ggUfmgfU]b'cb
gh XYbhg'UbX'a YX]W'ghUZZ'

5dd']W]h]cbg'Zcf'gdYWU'Wcbg]XYfUhc'b'k]'VY'fYei]fYX'Zcf'UggYgga YbhUbX'dUf]h]W]dUhc'b'UVgYbW'g'—
Vi hbc'XcW a YbhUfmYj]XYbW'Zcf'7CJ -8 %-]'bYgg'cf']gc'Uh]cb'k]'VY'fYei]fYX"

5 WUXYa]W< cbYgmiUbX`D`U[]Uf]ga

I BGK `Ug`Ub`cb[c]b[`Wca a]ha Ybhlc`ZcghYf]b[`U`W`h`fY`cZ`YUfb]b[`]bZcfa YX`VmiUWUXYa]W]bhY[f]m`5`
I BGK `gh`XYbhg`Uj`Y`U`fYgdcbg]V`]hmlc`UX`YfY`hc`h`g`df]bW]d`Y`cZUWUXYa]W]bhY[f]m`D`U[]Uf]ga
i bXYfa]bYg`UWUXYa]W]bhY[f]m]UbX`]g`bchlc`YfUHX`Uhl`BGK`"B`SY[Sde_`SfG@E|`[e VWX` VW`Se ge[`Y`
fZWi`ad/e`ad[VWSe`aXafZW`S`V`bSee[`Y`fZW`_`aXSe`kagdai` `z`

D`U[]Uf]ga `]g`U`hmdY`cZ]bhY`YW`i`U`h`YZ`h`#`hW]b`hU`_`Y`a`UbmiZcfa`gZ`Zca`X`Y`]VYfUHX`W`X`Y`U`h]b[`hc`UWUXYbH`U`m`
W`d`m]b[`Zca`U`g`ci`fW`k`]h`ci`hUW`bck`YX[`Ya`Ybh`I`BGK` `Ug`dfcXi`W`X`U`k`YVg]h`k`]h`U`k`YU`h`cZ`
fYgci`fW`g`hc`gi`ddcfhgh`XYbhg`hc`i`bXYfgHUbX`UbX`Uj`c]X`d`U[]Uf]ga`z`j`]g]h`[gh`XYbh`i`bgk`"YXi`"Ui`#d`U\[\]Uf\]ga`"](#)
H`Y`@`Y`U`fb]b[`7`Y`bh`f`Y`U`gg]g`h`g`h`i`XYbhg`k`]h`i`bXYfgHUbX]b[`UWUXYa]W]bhY[f]m]UbX`ck`bchlc`d`U[]Uf]gY`
H`Y`mi`U`gc`lc`X`k`cf`g`cdg`UbX`W]b`Y`d`gh`XYbhg`cbY!`cb!`cbY`"

Mci`U`fY`U`gc`fYa`]bXYX`h`UhWUfYZ`h`a`Y`a`UbU[`Ya`Ybh]g`Ub`ja`dcffUbhdufhcZg`h`XmiUbX`cbY`cZ`h`Y`
]X`Y`bh]Z`Y`X`W]i`g`Y`g`cZ`d`U[]Uf]ga`]g`d`ccf`h`a`Y`a`UbU[`Ya`Ybh`G`h`XYbhg`g`l`ci`X`U`ck`gi`Z`W]Y`bh]h`a`Y`Z`c`f`
fY`g`Y`U`f`W`X`Z`X`f`U`Z]b[`UbX`h`Y`d`f`c`d`Y`f`f`Y`Z`f`Y`b`W]b[`cZ`g`ci`f`W`g`]b`d`f`Y`d`U`f]b[`U`U`g`g`Y`g`g`a`Y`bh]U`g`_`g`"

=Zd`U[]Uf]ga`]g`Z`ci`bX`]b`mci`f`k`cf`_`k`Y`b`mci`U`fY`]b`Z`f`g`h`m`Y`U`f`z`mci`f`Y`W`h`f`Y`f`k`]`c`Z`Y`f`mci`U`g`g]g`h`U`b`W`h`c`
]a`d`f`c`j`Y`mci`f`U`W`U`X`Y`a`]W`g`_]`g`"H`Y`ma`U`mi`U`g`_`mci`hc`cc`_`U`h`g`ca`Y`cb`]b`Y`f`Y`g`ci`f`W`g`z`U`h`Y`b`X`h`Y`@`Y`U`fb]b[
7`Y`bh`f`Y`Z`c`f`g`ca`Y`h`a`Y`g`f`Y`gi`Va`]h`mci`f`k`cf`_`k`]h`h`Y`d`f`c`V`Ya`Z]`Y`X`"<`c`k`Y`j`Y`f`a`c`f`Y`g`Y`f]ci`g`]b`g`h`U`b`W`g`]b`Z`f`g`h`
m`Y`U`f`z`gi`W`U`g`g`h`U`]b[`Ub`ch`Y`f`g`h`XY`bh`g`k`cf`_`cf`d`U`m]b[`g`ca`Y`cb`Y`hc`X`c`mci`f`k`cf`_`z`a`U`m`V`Y`]b`j`Y`g`h[`U`h`X`
i`b`X`Y`f`h`Y`G`h`XY`bh`A`]g`W`c`b`X`i`W`h`D`f`c`W`X`i`f`Y`g`"

F`Y`d`Y`U`h`X`d`U[]Uf]ga`f`Y`j`Y`b`]b`Z`f`g`h`m`Y`U`f`z`d`U[]Uf]ga`U`Z`Y`f`Z`f`g`h`m`Y`U`f`z`c`f`g`Y`f]ci`g`]b`g`h`U`b`W`g`z`a`U`m`U`gc`V`Y`
]b`j`Y`g`h[`U`h`X`i`b`X`Y`f`h`Y`G`h`XY`bh`A`]g`W`c`b`X`i`W`h`D`f`c`W`X`i`f`Y`g`"H`Y`d`Y`b`U`h`Y`g`i`b`X`Y`f`h`Y`d`f`c`W`X`i`f`Y`g`W`U`b`]b`W`i`X`Y`
U`f`Y`X`i`W`h`c`b`]b`a`U`f`_`g`z`Z]`]b[`U`W`c`i`f`g`Y`c`f`Z`c`f`h`Y`a`c`g`h`g`Y`f]ci`g`a`U`h`Y`f`g`f]`_`Y`d`U[]Uf]ga`]b`Ub`l`c`b`c`i`f`g`
h`Y`g]g`L`Y`j`Y`b`gi`g`d`Y`b`g]c`b`Z`ca`h`Y`i`b]`Y`f`g]m`H`Y`G`h`XY`bh`A`]g`W`c`b`X`i`W`h`D`f`c`W`X`i`f`Y`g`U`f`Y`U`j`U]`U`V`Y`Y`f`Y`.

[k`k`k`"\[`g`"i`bgk`"YXi`"Ui`#d`\]W`h`c`W`a`Ybhg`gh`XYbh`a`\]g`W`c`b`X`i`W`h`D`f`c`W`X`i`f`Y`g`"d`X`Z`](#)

5 WUXYa]W=Zcfa Uh]cb

7 fYX]hdc]bhg

7 ci fgY`WYX]hg`W`W`UH`X`]b`I`b]hg!C Z 7 fYX]hfl C 7 E`H`Y`bcfa U`k cf`cUX`YI dYWUh]cb`Zf`cbY`I C 7

- [AccXY](#)
- [@UV5WYgg](#)
- [7ca di hb\[: UW\]hYg](#)
-

5ddYbX]l . '9b[]bYYfg'5i ghfU`U'f95E'DfcZYgg]cbU`'9b[]bYYf'7ca dYhYbWm GHUbXUfX

Dfc[fUa 'hYbXYX'@YUfb]b['Ci hWta Yg	
? bck `YX[Y'UbX'g_]`VUgY	
D9%"%7 ca dfY\Ybg]j YzhYcfmVUgYX'i bXYfghUbX]b['cZhY'i bXYfd]bb]b['bUh fU`UbX d\mg]WU`gWYbWg'UbX'hY'Yb[]bYYf]b['Z bXUa YbH'g'Udd`]WUV'Y'hc'hY'Yb[]bYYf]b['X]gWd`]bY	
D9%"&'7 cbWdh U`i bXYfghUbX]b['cZhY'a UhYa Uh]Wg'z'bi a Yf]WU`UbU'mg]g'ghUhg]Wg'z'UbX Wta di h'f'UbX']bZ'fa Uh]cb'gWYbWg'k \]W' i bXYfd]b'hY'Yb[]bYYf]b['X]gWd`]bY	
D9%" " 'h!XYdh'i bXYfghUbX]b['cZgdYWU`]ghVcX]Yg'cZ_bck `YX[Y'k]h]b'hY'Yb[]bYYf]b[X]gWd`]bY	
D9%"('8]gWfba YbhcZ_bck `YX[Y'XYj Y`cda YbhUbX'fYgYUfW'X]fYW]cbg'k]h]b'hY Yb[]bYYf]b['X]gWd`]bY	
D9%") ? bck `YX[Y'cZYb[]bYYf]b['XYg][b'dfUW]W'UbX'WcbhYI h U`ZUW'c'fg]a dUW]b['hY Yb[]bYYf]b['X]gWd`]bY	
D9%"* 'i bXYfghUbX]b['cZhY'gWc'dYz'df]bWd`Yg'z'bcfa g'z'UW'c'i bhUV]]h]Yg'UbX'Vci bXg'cZ gi gh]bUV'Y'Yb[]bYYf]b['dfUW]W']b'hY'gdYW]ZWX]gWd`]bY	
9b[]bYYf]b['Udd`]WU]h]cb'UV`]]m	
D9%"%5dd`]WU]h]cb'cZYghUV`]g\YX'Yb[]bYYf]b['a Yh'cXg'hc'Wta d'YI'Yb[]bYYf]b['dfcV'Ya gc`]]b[
D9%"&'&: 'i YbhUdd`]WU]h]cb'cZYb[]bYYf]b['h'W]b]ei Yg'z'hc'g'UbX'fYgci fW'g	
D9%" " '5dd`]WU]h]cb'cZgmg]Ya Uh]WYb[]bYYf]b['gmb'hYg]g'UbX'XYg][b'dfcW'ggYg	
D9%"('5dd`]WU]h]cb'cZgmg]Ya Uh]WUdd'fcUW'Yg'hc'hY'WcbXi W'h]UbX'a UbU[Ya YbhcZYb[]bYYf]b['dfc'YW'g	
DfcZYgg]cbU`UbX'dYfgcbU`Uhf]Vi hYg	
D9' "%9h]WU`WcbXi W'h]UbX'dfcZYgg]cbU`UW'c'i bhUV]]m	
D9' "&'9ZYW]j Y'cfU`UbX'k f]hYb'Wta a i b]WU]h]cb`]b'dfcZYgg]cbU`UbX`UmXca U]bg	
D9' " '7fYUh]j Y'z]]bcj Uh]j Y'UbX'dfc!UW]j Y'XYa YUbcif	
D9' "('DfcZYgg]cbU`i gY'UbX'a UbU[Ya YbhcZ]bZ'fa Uh]cb	
D9' ") 'CfXYf'ma UbU[Ya YbhcZgY'z'UbX'dfcZYgg]cbU`WcbXi W'h	
D9' "*" '9ZYW]j Y'hYUa 'a Ya VYfg\]d'UbX'hYUa ``YUXYfg\]d	