# **! "#\$ ! "#\$%&#**:

! '' ! # **\$**%&''' ! ( ( ) & \* +% **\$** \* +,

& '()\*+, '-+!./!01234.5.62! 789%!: '1+!;)-3\*./+!<+\*''+! =->?'\*1>+2!./!".5'@.! ".5'@.A!B4>.!CDE9EFDDG9!

## H, )>5I!<u>3>-3>-J+)-KL+.5'@.J'@L</u>! 04.-'I!C%GFMD9F7G9G! N)0I!C%GFMD9F8CPG! !

79%GF(\*'1'-+!

!

! !

!"#\$%&' ()&' !"\*"+!+)
Q4>5@!&'?'5.(,'-+!
R>/'1()-!&'?'5.(,'-+!
S-/)-32!
#@.5'13'-3'!
T')5+4!01234.5.62!!
<+)+>1+>31!>-!01234.5.62!
U'1')\*34!V'+4.@1!
!
, -#'!&!#!&.")+/&00+)

\* "+" # \* \$%)&' ! " \* " + ! +)
S-/)-+!)-@!Q4>5@!H)+>-6!; '4)?>.\*!
<'5/FU'6L5)+>.-!>-!H)+>-6!
0)\*'-+FQ4>5@!N''@>-6!U'5)+>.-14>(!
Q.()\*'-+>-6!>-!N''@>-6!
#++>+L@'1!)W.L+!X'>64+!!
H3.5.6>3)5!>-/5L'-3'1!.-!34>5@!@'?'5.(,'-+!
V'+4.@.5.62!>-!\*'1')\*34!X>+4!34>5@\*'-!

V'+4.@.5.6>'1!	$VL_{5+>(5'!U'6^{*'}11>A!V'@>)+>!)-@!V.@'^{+}A!<+*L_{3+L})5!H^{+}!$
	V . @ '5>-6A!&2)@>3!# - )521>1A!_L)5>+)+>? ' !# - )521>1!
<./+X)*'!	<0<<&!#VB<&!U&!\$.5@L1F"4'!BW1'*?'*!]"&!H-@\$.+'!

)

### \* "+" # \* **\$**%) ! \* #& ' & ' ()+ / &0 0+)

 $\begin{array}{l} Q'*+>/>'@!Q.@'*!./!+4'!$L*1>-6!Q4>5@!#11'11, '-+!<)+'55>+'!''*)>->-6!`$Q#<"aFN''@>-6!<3)5'!\\ U'3'>?'@!N.*, )5!''*)>->-6!/.*!S-/)-+!#-+4*.(., '+*2!V')1L*', '-+) \end{array}$ 

- 3)\*)2,'
- !"#\$%

& ' ()\*+,-.%/0%,1-%2\*)3-45),0% '6%7 '8-.'%927:%, '%+; ;80%6 '4%,1-%!"!"%<=>2% =+8;1%?%A 'B-%CD\*) '4%E+FD8,0%?\*1+\*F-(-\*,%>B+4.5%&'()\*+,-.%+5% '\*-% '6%,1-% '\*80%4-;4-5-\*,+,)3-5%64'(%27%%

K

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## **2**\$, \$ ! **2** " **3** ' **1 2** ! \* + ,4'( - / . & " ! + & ) \* ,4' 5 ' ( **2**\$ , \$ \* + ! + & ) \* ,'

12!\*+,'

#### 1234546#789:5)

7979`<'(+aF	= - ? '*1 + 2! . / ! V + 34 + 6) - ! * + 5! - 1 + + L + '! . / ! T '. 5 + 4! U9% !`13 . * '@! @! (' - @> - 6! - 6! - 6! - 6! - 6! - 6! - 6! - 6
(*'1'-+!	/L-@>-6A! C ! ('*3'-+>5'aJ! "4'! &'?'5.(, '-+! ./! H)+>-6! ; '4)?>.*!>-! S-/)-32I!
	#11.3>)+>1!X>+4!; '4)?>.*A!&>'+A!)-@!Y*.X+4!+.!#6'!E!2')*1J!
	<b>\$ ;</b> <&=) <b>\$ 93</b> ) <b>\$ 93</b> ) <b>!</b> >3!`OS!RL , '-6a!
	!
79%GF(*'1'-+!	&'()*+, '-+!./!01234.5.62A!=->?'*1>+2!./!".5'@.A!\$)+>)5!\$-1+>+L+'!./!T')5+4A!
	U9DT&9GE9GMF9%#%!`13.*'@!)-@!/L-@'@A!%7 !('*3'-+>5'aJ!O*'@>3+.*1!./!O)*'-+1b!
	N''@>-6!;'4)?>.*1I!#!&2)@>3!0'*1('3+>?'J!
	?@9379A>B)&3:5C89D>8;@=)\$93)\$93)!>3)
	!
79%PF79%G!	Q' - +'*! / .*! TL, ) - !Y*.X+4! ) - @! &'?'5.(, '-+! = ->?'*1>+2!./!V>34>6) - !! )+>)5!

79%DF79%C!	$= ->? '*1>+2!./!: >131>-!B14 \setminus .14!<, )55!Y*)-+!!$ ?@9379A>B)&3:5C89D>8;@=)\$93)\$93)!>3) !
79%%F79%7!	$\label{eq:constraint} \begin{array}{l} "4'! = -??'*1>+2! ./! "'0)1! )+! &)55)1&!<34 \dots 5! ./! ; '4)?>.*)5! )-@! ;*)>-!<3>'-3'1! \\ &>11'*+)+>!B)&3:5C89D>8;@=)$93)$93)!>3) \end{array}$

" # \$ !C!

PJ **!>3I \$**LI) : )53e) \A!VJA!U. )34A!HJA!RL, '-6A!dJQJA! h!V>55'\*A!#J!RJ)`79%8aJ)R. -6>+L@>-)5!#11.3>)+>.-1!W'+X''-! H)+>-6!)-@!&\*>-\>-6!H-6)6', '-+!@L\*>-6!V')5+>, '!)-@!H)+>-6!>-!+4'!#W1'-3'!./!TL-6'\*!>-!R.X!S-3., '! ".@@5'\*1J!677\*#\$#\*5'89;5'7GFDCJ!

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- 8J !>3I |LI h |RL,  $-6A!dJ!QJ!^79\%8aJ! # 11.3>)+>.-1!W'+X''-!Q..5!)-@!T.+!HO'3L+>?'!NL-3+>.-1!)-@!Q4>5@*'-b1!$ H)+>-6!; '4)?>.\*1J!<math>I < //\*%#' = <#/\$#\$.%'>\*7./#-5'?5'7%F78J!!
- GJ Q4. XA!QJ! VJA! h !  $\cdot$  3I) \$J!`79%8aJ! "4'!U.5'!./!N)+!")5\!>-!H)+>-6!0)+4.5.62!)-@!&'(\*'11>?'!<2, (+., 1!), .-6!V.+4'\*F&)L64+'\*!&2)@1J!@. (*A'BC''&\*5'DE5'*DEFCDJ!
- %%J Q4.XA!QJ!VJA!UL45A!TJA!**!>3I)**\$LI!h !H55>1A!RJ!`79%PaJ!N')\*!./!N)+!)-@!U'1+\*)>-'@!H)+>-6I!\$'6)+>?'!;.@2!")5\! ;'+X''-!N',)5'!N\*>'-@1!)1!)!V.@'\*)+.\*J!!'"#\$%&'''%(')\*\$&+#',\$-./(\*/-J!
- %7J Q4.XA!QJ!VJA!T)\*+A!HJA!H55>1A!RJA! h ! **! >3I)**\$L)`79%PaJ!S-+'\*@'('-@'-3'!./!#++)34, '-+!<+25'1!)-@!U'5)+>.-14>(! \_L)5>+2!>-!0)\*'-+F#@.5'13'-+!&2)@1J!F.</%"2'.6'6(.2\*-3\*%3\*5'H85'PPF8E0!
- %DJ Y . 5@1+'>-A! V JA! **! >3I**) **\$** LI! h !Q4 . XA!QJ! V J!`79%P

- 7%J **!>3I**) **\$**LI) h !Q4. XA!QJ! V J!`79%CaJ! : '>64+!<+)+L1!) @!&' (\*'11>. -I! V . @ '\*)+>-6!U . 5'!./!N)+!")5\!W'+X''-! N', )5'!N\*>'-@1J!F.</%"2'.6'J\*"2#+'4-A3+.2.&A5'8.5'%D79F%D78J!
- 77J Q4. XA!QJ!VA!h!;L4\*, '1+'\*A!&JA!h!**!**>**3**I)**\$**L)`79%CaJ!S-+'\*('\*1.-)5!3. (>-6!1+25'1!)-@!3.L(5'1b!\*'5)+>.-14>(! ^L)5+2I!<>,>5)\*>+2!?'\*1L1!3., (5', '-+)\*>+2!42(.+4'1>1J!!</.7\*''%'F.</%''2'.G'K.3\$''2'4-A3+.2.&A5'EE5'%PMF %8EJ'! !
- 7DJ Q4.XA!QJ!VJA!h!**!>3**L)**\$**L)**`**79%DaJ!#++)34, '-+!)-@!Q., ,>+, '-+!>-!&2)@>3!N\*>'-@14>(1I!V'@>)+>-6!U.5'1!./! <)+>1/)3+>.-A!\_L)5>+2!./!#5+'\*-)+>?'1A!)-@!\$-?'1+, '-+!<>e'J!F.</%''2'.6'>\*2''#\$.%-+\$7-'>\*-\*''/3+5'E5'%F%%J!! !
- 7CJ **!>3I**) **\$**LI) h !T . 5LWA!<J!QJ!`79%7aJ! V )+ '\*- )5!N ' '@>-6!0\*)3+>3 '1! #11.3>)+ '@!X>+4!N . . @! **\$** ' . (4.W>)J!677\*#\$#\*5'I : 5' C8DFC8PJ! !
- $\begin{aligned} &7\text{MJ } !>3\text{I} \ \text{$\$$I$} \ h \ !\text{T } .5\text{LWA!} <J!\text{QJ!} \ 79\%aJ!\text{Q4} >5@*'-11!<'5/FU'6\text{L5} +>.-!>-!\text{H} )+>-6\text{I}! \# 11.3>) +>.-1!\text{X} +4!\text{S}-4>\text{W} +.*2!\text{Q}.-+*.5! \\ &)-@!\text{O})*'-+11!\text{N}''@>-6!; \ '4) ?>.*3!F. </\%''2'.6'4*(\$''\#/\$3'4-A3+.2.\&A5'9\text{H5}'\text{DC9FDCM0}') \end{aligned}$
- $\begin{aligned} & \text{7EJ T.} 5LW \texttt{A!} < \texttt{J!} \texttt{QJA! !} > \texttt{3I} \texttt{LI} \texttt{h} \texttt{O} \texttt{)} + \texttt{'5A!} < \texttt{J!} \texttt{RJ} \texttt{`79\% \texttt{AJ!N} \texttt{3}} + \texttt{`*1! \# 11. \texttt{3}} \texttt{)} + \texttt{`@!X} + \texttt{4!O} \texttt{``} + \texttt{+1!} \texttt{BW' 1} + \texttt{2!} < \texttt{+>6} \texttt{, }\texttt{)!} \texttt{)} \texttt{@!} \texttt{[.L-6!} \\ & \texttt{Q4>5} \texttt{@*'-11! : } \texttt{'>64+!} < \texttt{'``} + \texttt{2('1J!F.} < \texttt{/\%''2'.} \texttt{G'} \texttt{6772} \texttt{``(', *M*2.7C*\%\#''2'4-A3+.2. \&A5'9D5'\%\% \texttt{8F\%7EJ''} \end{aligned}$

#### M;@JC)93)?@;D@5CC)N2345@)@5:95E)>34)93)A@5A>@>89;30)

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- $\begin{array}{l} DJ & ")2A!QJ : JA!Q4>-A! \left[ J!<JA!R>, A!OJ! \left[ JA!Q4 . XA!QJ! VJA!$ **!>3I** $\right] Im(5W)4)*A! $JA! h!<4)*//A!mJ! VJ!`>-!(*'()*)+>.-aJ! \\ 0*'?)5'-3'!)-@!<'0!&>//'*'-3'1!>-!N)3+.*1!#11.3>)+'@!X>+4!&>1.*@'*'@!H)+>-6!), .-6!V)5)21>)!#@.5'13'-+II! \\ N>-@>-61!./!+4'!V)5)21>)-!B?'*X'>64+!)-@!&>1.*@'*'@!H)+>-6!<L*?'2!), .-6!'''-1!`VB&H<"aJ! \\ \end{array}$
- !

 $<sup>\</sup>begin{array}{l} CJ \quad \label{eq:constraint} CJ \quad \label{eq:constraint} SJ(1) \\ +SJ(1) \\ +SJ(2) \\ +SJ(2$ 

 $7J n # 1 + ) \texttt{A!} f J\texttt{A!} !> 3I) \texttt{II} \vee 3Q) / / '* 2\texttt{A!} T J\texttt{A!} RL, '- 6\texttt{A!} dJ! QJ\texttt{A!} h !0 '134\texttt{A!} \vee J! `79\% G\texttt{A!} \vee ) * 34\texttt{aJ!} U) (> \texttt{@!} \texttt{S} - /) - +! : '> 64 + !Y) > -I! = (> 6\texttt{A!} + \texttt{A!} \vee \texttt{J!} \vee \texttt{A!} \vee \texttt{A!} \vee \texttt{J!} \vee \texttt{A!} \vee$ 

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!

%%J !>3I) $L}`79%MA! V )*34aJ! "4'! V .@'*)+>-6!U .5'!./! V .+4'*1b! #@L5+! #++)34 , '-+!B*>'-+)+>.-!.-!Q.-+*.55>-6!

N''@>-6!0*)3+>3'1J!0)('*!<2, (.1>L, !(*'1'-+'@!)+!+4'!<.3>'+2!/.*!U'1')*34!>-!Q4>5@!&'?'5.(, '-+A!

04>5)@'5(4>)A!0 #J!!

!

%7J & 'WW .L+A!TJnA!O5L, WA!QJnA! f '51.A!<JnA! f )(*'5>)-A! V JnA! h !!>3I) $L!`79%CA! V )2a! #++)34 , '-+!<+25'1!)-@!Q4>5@!

N''@>-6!0*)3+>3'1!>-!0*'@>3+>-6!H, .+>.-)5!H)+>-6J!0.1+'*!(*'1'-+'@!)+!V>@X'1+'*-!01234.5.6>3)5!

#11.3>)+>.-A!Q4>3)6.A!SRJ!!

!

%DJ !>3I) $L]
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79J U. '51 'A!TJ!; JA! **! >3I) \$**[**I**!T>-\5'2A!<JA! h !T. 5LWA!<J!QJ!`79%%A!# (\*>5aJ! "4'!U.5'!./!0)\*'-+>-6!<+25'1!>-! \$-/5L'-3>-6!+4'!H//'3+>?'-'11!./!V.@'5>-6!H)+>-6!; '4)?>.\*1J!0.1+'\*!(\*'1'-+'@!)+!\$)+>.-)5!Q.-/'\*'-3'!/.\*! 0'@>)+\*>3!01234.5.62A!<)-!#-+.->.A!"]J!! !

!

- 7%J T.5LWA!<J!QJA!**!>3I**\$LJ&.5)-A!HJ!#JA!h!0)+'5A!<J!RJ!`79%%A!V)\*34aJ!0)\*'-+!)-@!Q4>5@!Q4)\*)3+'\*>1+>31! #11.3>)+'@!X>+4!0)\*'-+)5!N''@>-6!0\*)3+>3'1J!0)('\*!<2,(.1>L,!(\*'1'-+'@!)+!<.3>'+2!/.\*!U'1')\*34!>-!Q4>5@! &'?'5.(,'-+A!V.-+\*')5A!\_L'W'3A!Q)-)@)J! !
- !
- 77J 0)+'5A!<J!RJA! **!** >**3I**)**\$**LI!N)Z) 1A!dJA! h !T .5LWA!<J!QJ!`79%%A! # (\*>5aJ!Q4>5@\*'-b1!0'\*3'(+>.-1!./!<-)3\!N..@! T')5+4>-'11I!S1!>+!U'5)+'@!+.!R>\>-6!)-@!Q.-1L, (+>.-0!0.1+'\*!(\*'1'-+'@!)+!\$)+>.-)5!Q.-/'\*'-3'!/.\*!0'@>)+\*>3! 01234.5.62A!<)-!#-+.->.A!"]J!! !

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7DJ & .5) - A!HJ!#JA! **! >3I) \$**LJN)\*)6. A!NJA! "\*)L+'\*, )-A!<J!RJA!<34>-@5'\*A!QJ! f JA!V .>6'\*A!<JA!U'>+4A!HJ!VJA! h !T.5LWA!<J! QJ!`79%9A!#(\*>5aJ!V.+4'\*1b!; '5>'/1!)W.L+!"4'>\*!S-/)-+1b!; .@2!<4)('1I!#33L\*)32!)-@!#11.3>)+>.-1!X>+4! N''@>-6J!O.1+'\*!(\*'1'-+'@!)+!<.L+4X'1+'\*-!O1234.5.6>3)5!#11.3>)+>.-A!#@@>1.-A!"]J!! !

7CJ

D9J **!>3I \$ !**A!BX'-A!VJ!"JA!h!Q4.XA!QJ!VJ!`7998A!V)\*34aJ!"4'!U.5'!./!Q4>5@\*'-b1!<'5/FQ.-+\*.5!>-!V'@>)+>-6!+4'! U'5)+>.-14>(!; '+X''-!#66\*'11>.-!)-@!<34..5!#34>'?', '-+!>-!O\*'F#@.5'13'-3'J!O.1+'\*!(\*'1'-+'@!)+!+4'! <.3>'+2!/.\*!U'1')\*34!.-!#@.5'13'-3'A!Q4>3)6.A!\$RJ! !

!

D%J T .5LWA!<J!QJA! **!** >**3I**) \$**L**)!`7998A! V )\*34aJ!''4'!N>6L\*'!#\*\*)2! V '+4.@.5.62I! \$'X!\_L'1+>.-1!)W.L+!#33L\*)32!./! 0'\*3'(+>.-1!)-@!#++>+L@'1!)W.L+!: '>64+J!!0.1+'\*!(\*'1'-+'@!)+!+4'!<.3>'+2!/.\*!U'1')\*34!.-!#@.5'13'-3'A! Q4>3)6.A!SRJ!

!

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D7J T.5LWA!<J!QJA! **!** >**3**I) **\$**LI!U.W'\*+1A! fJ!VJA!<4)/>^L'A!"JA! fL('\*, )-A!"JA!0)+'5A!OJA!B5>?'>\*)A!&JA!\$>'@X>'3\>A! fJA! TL++.A!<JA! h!; 4)++A!#J!`799PA!#(\*>5aJ!H0), >-)+>.-!./!+4'!N>6L\*'!#\*\*)2!V'+4.@.5.62!/.\*!#11'11>-6!; .@2F <>e'!#++>+L@'1J!0.1+'\*!(\*'1'-+'@!)+!+4'!#--L)5!V''+>-6!./!+4'!<.L+4X'1+'\*-!01234.5.6>3)5!#11.3>)+>.-A!N.\*+! :.\*+4A!"]J!!

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&3:9854)Q;H5C897)>34)&385@3>89;3>B)\*5C5>@7R)?@5C538>89;3C)

%J **!>3I**)\$L)`79%GA!V)2aJ!Q4>5@4..@!BW'1>+2I!O)\*'-+)5!)-@!Q4>5@!N)3+.\*1!.-!Q4>5@\*'-b1!<'5/FU'6L5)+>.-!>-!

& '?'5.( , '-+!01234.5.62!`0<[QT!DG%a!= : !B14\.14! T')5+4!01234.5.62!`0<[QT!779a!= : !B14\.14!	N)55!79	<(*>-6!79%DA!N)55!79%7A!! N)55!79%DA!<(*>-6!79%DA! N)55!79%7!		
$S-/) -+! h!Q4>5@!\&'?'5.(, '-+!`0<[QT!DD%a!=: !B14\.14!Y'-'*)5!01234.5.62!`0<[QT!%97a!=: !B14\.14A!!<+)+>1+>31!/.*!01234.5.62!`0<[QT!7D%Pa!="!&)55)1!$	<(*>-6 N)55!79	<(*>-6!79%D! N)55!79%D! <l '*!79%9å!<l="" '*!<="" ,="" td=""></l>		
n3.?>@F%G!1', '1+'*!	!			
V>7R5B;@C)%;3;@C)!R5C9C)#4:9C5H538) T>55)*2!&'WW.L+! &'6*''!<+)+L1I!;J#J!! "4'1>1!">+5'I!N)3+.*1!#11.3>)+'@!X>+4!Q*)?>-6!)-@!H0+'*-)5!H)+>-6 U.5'1!./!<'5/FU'6L5)+>!)-@!U'1+*>3+>?'!N''@>-6!O*)3+>3'1J!!	! 5I! "4'!	79%DF79%C!		
<b>T &gt;C85</b> @WC) <b>! R5C9</b> C) <b>\$ ; HH98855</b> ) #5'O) - @*)! f .55! "4'1>1!">+5'I!"4'!U'5)+> 14>(!; '+X''-!; VSA!<'5/F#11'11, '-+!./!T] )-@!;*)>-!O*.3'11>-6!./!N@!\$, )6'1!	L-6'*A!	79%DF79%C!		
<b>?RQ</b> XC)Q9CC508>89;3)\$;HH98855)	,			
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	!	!!!!7979F(*'1'-+! !!!!7979F(*'1'-+		