МИНИСТЕРСТВО ОБРАЗОВАНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ
РОССИЙСКОЙ ФЕДЕРАЦИИ

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«БЕЛОРУССКО-РОССИЙСКИЙ УНИВЕРСИТЕТ»

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Могилев, 5–6 мая 2016 г.

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M>D

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Z\lhfh[bevguo ^hjh]«««««««««««««««««« 58
>:CG?DH D G >JHA>H< > G Bkkje_lhmj\c
baf_g_gbc \ ^hjh`guo ihdjulbyo Fh]be_\kdhc h| 59
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g Z e b a Z p b b \ f Z e u _ \ h ^ h l h d b [ h e _ _ \ u i m k d h \ b a
d h g l j h e b j m _ l k y f _ g _ _ Q _ j _ a g _ d h l h j u _ b m a e b \ g _
s _ k l \ e y _ l k y b h l \ _ ^ _ g b - q h k l j Z l k l g u o \ h ^ j y y ^ Z i j _ ^
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\ _ g d Z h l l _ q _ j k d h ] h h a _ j Z ^ h m k l v y i j h Z g Z e b a b j h \ Z g
] b q _ k d Z y k b l m Z p b y \ [ Z k k _ c g _ j > m [ j h \ _ g d Z _ i h ^ Z g g
k l \ Z \ h ^ u \ h ^ h l h d Z ^ Z g Z h p _ g d Z k h k l h y g h j \ h Z g u o j _
i j h \ _ ^ _ g h d Z j l b j h \ Z g b _ \ u i m k d h \ d h e e _ d l h j h \ ^ h ` ^ _ \ h
j m k e h j _ d b D Z d i h d Z a u \ Z _ l Z g Z e b a i h e m q _ g g u o ^ Z g
g h k l g u o \ h ^ j > m [ j h \ _ g d Z k h h l \ _ l k l \ m _ l g h j f Z l b \ Z f d
\ _ j o g h k l g u o \ h ^ g u o h [ t _ d l h \ a Z b k f h e q c g h _ f g Z d h l Z
p _ g l j Z p b y d h l h j h ] h m \ _ e b q b \ Z _ l k y i h ^ e b g _ j _ d b b
> m [ j h \ _ g d Z f _ l j h \ \ u r _ k [ j h k Z D E D i h i j F h j Z Z
f Z l b \ d Z q _ k l \ Z \ h ^ u i h \ _ j o g h k l g u o \ h ^ g u o h [ t _ d l h \
D Z d i h d Z a u \ Z _ l i j Z d l b d Z m \ - e b g Z k l b Z f h j k d h c
^ h ` ^ _ \ h c d Z g Z e b a Z p b b k \ y a Z g h d Z d i j Z \ b e h k g _ k Z g
k h f o h a [ u l h \ u o k l h q g u o \ h ^ \ k _ l b ] h j h ^ k d h c ^ h ` ^ _ \ h
q Z k l g h c a Z k l j h c d b \ i j _ ^ _ e Z o ] h j h ^ Z





l j b m ^ Z j g u o f _ l h ^ Z o h [ j Z [ h l d b b g k l j m f _ g l j Z [ h q b _
\ h a ^ _ c k l \ m x l g Z h [ j Z [ Z l u \ Z _ f m x i h \ _ j o g h k l v f g h ] h d j Z l
\ h a ^ c k l \ b y \ d Z ` ^ h f p b d e _ b a f _ g y _ l k y
< b [ j Z p b h g g h _ g Z d Z l u \ Z g b _ b \ b [ j Z p b h g g h _ \ u ] e Z `
f _ l h ^ Z f b h [ j Z [ h l d b i h \ _ j o g h k l _ c ^ _ l Z e _ c i m l _ f o h e h ^
^ _ n h j f Z p b b l j b \ b [ j h g Z d Z l u \ Z g b b i h f b f h h k _ \ u c i h ^ Z q
] e Z ` b \ Z g b b b g k l j m ^ f _ g l l m f m d h [ j Z [ Z l u \ Z _ f h c i h \ _ j o g h k
d h l h j h c k b e h c k h h [ s Z _ l k h y k l m a Z \ j _ e y h _ i _ j _ f _ s _ g b _
^ _ l Z e b
l j b h [ j Z [ h l d _ i e h k d h c i h \ _ j o g h k l b k l \ _ j ^ h k l v x ^ h
k l \ _ b g k l j m f _ g l Z b k i h e v a m _ l k y k l Z e v g i h c p a Z k d Z e Z a g u c
\ Z x l \ b [ j h g Z d Z l u \ Z g b _ f l j b b k i h e v a h \ Z g b b ` _ k m _ j b q _ k
d Z b a Z e f Z a Z b e b ^ j m ] h ] h k \ _ j o l \ _ j ^ h ] h f Z l _ j h Z e Z f h
\ _ j o g h k l b \ u k h d h c l \ _ j ^ h k l 5 & > Z g g u c i j h p _ k k g Z a u
\ b [ j h \ u ] e Z ` b \ Z g b _ f
> j h [ _ k l j m c g Z y h [ j Z [ h l d Z p y \ e k y h l k o y h e j h ^ g h c h [ j Z [ h l d b
l Z e e Z i j b d h l h j h f i h \ _ j o g h k l v ^ _ l Z e b [ h f [ Z j ^ b j m _ l k y
j b q _ k d b f b q Z k l b p Z f b g Z a u \ Z _ f u f b ^ j h [ v x D Z Z ^ Z y q Z
j y y k v \ f Z l _ j b Z e ^ _ c k l \ m _ l d Z d m ^ Z j _ g b _ f b d h j h k d h i b
l h j h _ i j b \ h ^ b l d Z g j Z x a g Z i h \ _ j o g h k l b f Z l _ j b Z e Z _ g _ [ h e v
q Z l d Z b e b m ] e m [ e _ g b y
> e y l h ] h q l h [ u f h ] e h h [ j Z a h \ Z l v k y m ] e m [ e _ Z g b _ i h \
e Z ^ h e ` g Z i h ^ \ _ j ] g m l v k y ^ _ n h j f Z p b b l h ^ l Z d h c ^ _ n
\ _ j o g h k l v x f Z l _ j b Z e i u l Z _ l k y \ _ j g m l v k y d b i k h w l ^ g j m f m l
i h ^ h [ j Z a h \ Z g g h c i h e m k n _ j h c ^ _ n h j f b j h \ Z g g h ] h f Z l _ j b
k e h c k \ u k h d b f b k ` b f Z x s b f b g Z i j y ` _ g b y f b
l j b m e v l j Z a \ m d h \ h c h g j k Z l j m f d _ g l m i h f b f h k l Z l b q _ k
g Z ] j m a d b k h h [ s Z x l ^ h i h e g b l _ e v g h m e v l j Z a \ m d h \ u _ d l
18± d = h p Z f i e b l m ^ ± c f d f L Z d b f h [ j Z a h f b g k l j c m f _ g l i h
k l \ b _ f k l Z l b q _ k d h c b a g Z q b l _ e v g h c m ^ Z j g h c k v b e u k h
g h c k b k l _ f h c i e Z k l b q _ k d b ^ _ n h j f b j m _ l i h \ _ j o Z h k l g u c
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G: IJBF?J? :<LH;MKGH=H F:J:DB E?<:

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GZmqguc jmdh\h^bl_e V?> EHMOH
;?EHJMKKDBC KKBCKDBC MGB<?JKBL?L

:\lh[mkguc iZjd Fh]bez Zdjmig_cr__ Z\lhljZgkihjlg ij_^ijbylb_ Fh]bez\kdhc h[eZklb e_mhn_k_g l\e_yxs__ i j_\hadb iZkkZ`bjh\ \]hjh^_]hbg_
H:H ©:\lh[mkguc iZjd hkms_kl\ey_l khpbZevgh ag iZkkZ`bjh\ \ ]hjh^kdhf ijb]hjh^ghf f_`^m]hjh^g_f h[_ki_qb\Z_l ljZgkihjlgh_ h[kem`b\Zgb_ gZk_e_gby k pbZevguo ]ZjZglbc b ev]hl
GZk_]h^gyrgbc ^\hgv \khklZ_ Z\lhiZjdZ \dh_mlk h kem`b\Zxsbo f_`^mgZjh^guo f_`^m]hjh^gbo ijb]hjh^guo b 45 ]hjh^kdbo fZjrjmlh\
?`_^g_\guc ijh[_] khklZ\ey_l ?`_^g_\gh jh^kdb_ fZjrjmlu ily`zgghklvx df \uoh^blZ\lh[mkh\ Djhf_ lh]h Z\lhiZjd hkms_kl\ey_l aZdZagu_ lmjbklbq_kdb_ ij_b\h db iZkkZ`bjh\ ;_eZjmkb Z ljZ^_u
:gZeba j_amevlZlh\ hkgh\ghc ^_yl_evghklb ihdZa ijh^Z`b ijh_a^guo [be_lh\ iheghklvx ihdju\Zxl jZkoh^ ZfhjlbaZpbx b j_fhgl aZjZ[hlgmx ieZlm D lhfm `_ mkem]Zfb ihfbfh k\h_c hkgh\ghc ^_yl_evghklb y\eyx l_evghklv hk\b^_l_evkl\h\Zgb_ gZ ^himdo dh b_Z\pbq_ xj kdbo ebp ijh_jdZ l_ogbq_kdh]h khklhygby Z\lhfh[be ebgbx j_fhgl b l_ogbq_kdh_ h[kem`b\Zgb_ ljZgkihjlZ abq_kdbo ebp ]hkm^Zjkl_gguc l_ogbq_kdbc hkfhlj l gZ ^bZ]ghklbq_kdhc klZgpbb
L_f g_gf__ hj]ZgbaZpby ih nZdlm y\ey_lky m[ulhq \ fej^j ljbqbgu lZdhc kblmZpbb \b^ylky \ kbevg km[kb^bjh\Zgby ba ]hk[x^`_lZ gZebqby \ ihevah\Zg ih^jZa^_e_gbc dZd h[s_`blb_ b klheh\Zylm:iZ_l \h ijbqb kmlkl\b_ kh[kl_ggbdZ B wlh g_kfhljy gZ lH:Hqlh Z\l JZafulZy kljmdlmjZ Zdpbhg_jgh]h dZiblZeZ gZ [hevr dh]^Z g_ knhjfbjh\Zg dhgkheb^bjh\Zgguc fhlb\bjh\Z \uc j_amevlZl wnn_dlb\guc kh[kl_ggbdh ]_e_dlb \eZ^_evpu Zdpbc ^Ze_db hl mijZ\e_gby kij\b^ ijbyl b_f lb\gh]h kh[kl_ggbdZ y\eyxs_]hky bkl Zlhjbo q_kgbfj_ku dhlhjh]h ^he]h\j_f_ggh_ gh kljZl_\blb_ ij_^ijbylby lhjf jughqgh_ j_nhjfbjh\Zgb bnbjf_gguc f_g_^`f_gl gZ ij_^ijbylby





IJH;E?FU KHA>:GBY B NMGDPBHGBJH<:GBY IJ?>IJ
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Fbjh\hc hiul ih`^ ZlZ_l qlh ij_^ijbgbfZl_ev`g kl\h bc we_f_gl jughqghc wdhghfbdb [_a dhlhjh]h gb_ fh`_l \Zlvky ]hkm^ZjkI\h
Bamqb\ ijh[e_fu kha^Zgby ij_^ijbylbc \ J_kim[ebd \gk_gu ke_^mxsb_ ij_^eh`_gby
Hf_gblv lj_[h\Zgb_ ih ijh_jd_ kh^_j`Zgby mqj_^ f_glh\ \\Z^ybl_evguc ijbgpbi j_]bkljZpbb
gkbablv jZaf_j ]hkm^Zjkl_gguo ghlZjbZevguo ih kljZpbb Z lZd`_ khdjZlblv i_j_q_gvsbh ghlZjbZevgu_[ m]h aZ_j_gby
3) khdjZlblv dhebq_kl\h ^hdmf_glh\ ij_^klZ\ey_fuo sbc hj]Zg b \lZ^gu_ nhjfu ^ey hklZ\rboky
4) khdjZlblv i_j_q_gv hkgh\Zgbc ^ey hldZaZ \ j_]bkl
:gZebabjmy nbgZgkh\h_ iheh`_gb_ ij_^ijbylbc \ kh \byo fh`gh \u^_eblv jy^ ijbqbg dhlhju_ \uaZeb [Zg kl\Z
hgh\ghc ijbqbghc kljh[h\Zgghklb ijh^mdpbb y\ey_ e_ggh_ \g_^j_gb_ GLI b lh aZljhgh^qlh [hevrbgkl\h ijbylbc m[ulhqgu_ b g_ jZkihebZ]Zxl j_khmjkZgb l_ogheh]bc ba]hlh\eurgby dZq_kl\Z ijh^mdpbb
dgljhev jZ[hlgbdh\ <kz qZs_ b qZs_ \ KFB fu ke ijh^mdpbb beb j_kmjkh\ ij_^ijbylbc
g]jZfhlgh_ ieZgbjh\Zgb_ lj_^ijbylby k aZ]jm`_g g_ i_klZxl ijhba\h^blv ijh^mdpbx
jh[e_fu k jZ[hqbfb Z bf_ggh bo fhlb\Zpby Fhel g_ ohlyl hl^Z\Zlv k\hbo mkbebc jmdh\h^kl\mykv ieZlZ ^eyh\ZgoZdh\Z h^ghc ki_pbZevghklb

L ? O G H E H = B Q ? K D B ? G B A H : P B H G G L ? O G H E H = B Q ? K D B ?
H K H ; ? G G H K L B < H A B Y ? K L G G A > : G B C
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G Z m q g u c j m d h \ h ^ b l = H E M R D H Z g ^ l _ o g ^ g Z m d
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< g Z k l h y s _ _ \ j _ f y \ k l j h b l _ e v g h f i j h b a \ h ^ k l \ _ h k h [ d j b l _ j b y f b y \ e y x l k y i j h ^ h e ` b l _ e v g h k l v \ h a \ _ ^ _ g b y a ^ \ h a \ _ ^ _ g b y \ e b y x s Z y g _ i h k j _ ^ k l \ _ g g h g Z k l h b f h k l v i j b \ u k h d h f d Z q _ k l \ _ ^ h e ` g Z [ u l v f Z d k b f Z e v g h f _ g v r _ c

B k k e _ ^ h \ Z g h d k l j h b l _ e v g u o f \ Z l y k b e _ l h k Z f u f b \ h k l j _ [ h \ Z g g u f b i j b \ h a \ _ ^ _ g b b k l _ g i j h f u r e _ g g u o a ^ d b j i b q ` _ e _ a h [ _ l h g g u _ d h g k l j m d p b b b k w g ^ \ b q

J Z k k f Z l j b \ Z y l _ o g h e h ] b q _ k d b _ b l _ o g h e h ] b q _ k d b _ h k h [ _ g g h k l b ^ h g b y d h g k l j m d p b c k l _ g i j h f u r e _ g g h ] h a g _ g g h ] h b a ^ Z g g u o k l _ g h \ u o f Z l _ j b Z e h \ m k l Z g h \ b e b g u f \ Z j b Z g l h f \ h a \ _ ^ _ g b y k l _ g y i \ e y x l k y \ k w g ^ \ b q d h w d h g h f b q _ k d b _ i h d Z a Z l _ e b [ h e Z [ e  b \ e _ d Z l _ e v g u

L Z [ e . 1 K \ h ^ g u _ i h d Z a Z l _ e b l _ o g h e h ] b q _ k d b o b w d h g h f \ h a \ _ ^ _ g b y k l _ g h \ u o d h g k l j m d p b c h [ t _ d l Z

| F Z l _ j b Z e k l _ g h \ h c d h g k l j m d | G h j f Z l b \ g u _ a Z l j Z l u l j m j Z [ h q b o q _ e | G h j f Z l b \ g u _ a Z l j f Z r b g g h ] \ j _ f _ g b f Z r - q | H [ s Z y i j h ^ h e ` b l _ e g h k l v j Z [ h l ^ | K j _ ^ g q b k e h j Z [ h q b q _ e | K l h b f h k j Z [ h l |
|---|---|---|---|---|---|
| D b j i b q | 2 378,7 | 280,06 | 14 | 4 | 1 970549,7 |
| @ _ e _ a h [ l h g g u _ i Z g _ e b | 4336,6 | 1039,9 | 19 | 4 | 1 482093,6 |
| K w g ^ \ b q i Z g _ e b | 398,3 | 11,43 | 9 | 4 | 1 445701,9 |

G h b m k w g ^ \ b q d Z d m e x [ h ] h k l j h b l _ e v g h ] h k l \ k \ h y k e Z [ Z y k l h j h g Z k l Z k l u d h \ H k g h \ g u _ l _ i e h i h l _ j b \ f _ k l Z o k l u d h \ \ k \ y a b k w l b f f u i j _ ^ e Z ] Z _ f j b k i h e v e _ g ª d h l h j Z y h [ _ k i _ q b l \ h ^ h g _ i j h g b p Z _ f h k l v b g _ i j h ^ l _ f k Z f u f h [ _ k i _ q b l v m g b \ _ j k Z e v g h k l v \ b k i h e v a d Z q _ k l \ _ k l _ g h \ h ] h f Z l _ j b Z e Z b k w g ^ \ b q





B K K E ? > H < : G B ? N H G > H < H = H J U G D : K I H F H S V X
B G N H J F : P B H G G U O L ? O G H E H = B C

L < ; : @ ? G H <
G Z m q g u c j m d h \ h ^ b l = Ö L K D Z g ^ w d h g ^ g Z m d
; ? E H J M K K D H H K K B C K D B C M G B < ? J K B L ? L

< k h \ j _ f _ g g u o m k e h \ b y o w n n _ d l b \ g Z y j Z [ h l Z g Z g h j ] Z g b d _ p _ g g u o [ m f Z ] i j _ ^ i h e Z ] Z _ l i j b f _ g _ g b _ g Z m d h _ f d b o b i j h ] g h a Z d h e b q _ k l \ _ g g u o o Z j Z d l _ j b k l b d n h k ^ h \ u o i h e v a h \ Z g b _ i j b d e Z ^ g h ] h i j h ] j Z f f g h ] h h [ _ k i _ q _ g b y Z j k _ g Z e Z f Z l _ f Z k d b o b g n h j f Z p b h g g h - l _ o g b q _ k d b o l _ o g h e h ] b c h j ] Z g b a Z p b b n h j f b j h \ Z g b _ b w n n _ d l b \ g h _ m i j Z \ e _ g b _ b g \ _ k l b p b h g g u o i h \ u r Z x s _ f k y m j h \ g _ h j ] Z g b a Z p b b j u g d Z b ` _ k l d h c d h g [ Z g d h \ b g \ _ k l b p b h g g u o n h g ^ h \ b d h f f _ j q _ k d b o b _ i h e v a h \ Z g b _ Z ^ _ d \ Z l g u o k l j Z l _ ] b c m i j Z \ e _ g b y d Z i b l Z e a Z ^ Z q _

J Z a \ b l b _ l _ h j b b \ _ j h y l g h k l _ c f Z l _ f Z l b q _ k d h c k l Z l \ Z g b _ k l h o Z k l b q _ k d b o k q b k e _ g b y g Z j y ^ m k l h y \ e _ g b _ f \ u q b k e b l _ e v g u o f k j h ^ h \ i h a \ h e b e h \ \ l h j h c i h e h \ \ _ d Z j Z k k f Z l j b \ Z l v g h \ u _ d e Z k k u a Z ^ Z q k \ y a Z g g u o k g Z k h \ u f b d h g h f b q _ k d b o i j h p _ k k h \ D g Z k l h y s _ f m \ j _ f _ g b p _ e u c [ e h d g Z m q g u o ^ b k p b i e b g h l g h k y s b o k y d n b g Z g k b b a m q Z x s b o w d h g h f b q _ k d b _ f Z l _ f Z l b q _ k d b _ b g m Z g Z e b l b q _ k d b _ b b g u _ l _ h j _ l b q _ k d b _ b i j b d e Z ^ g u _ \ h i j h k h \

< j Z [ h l _ \ u ^ _ e y x l k y ^ \ Z g Z i j Z \ e _ g b y b k k e _ ^ h \ Z g b c g Z g _ i h k j _ ^ k l \ _ g g h _ b k i h e v a h \ Z g b _ \ i j Z d l b d _ n b g Z g k \ h _ g Z i j Z \ e _ g b _ h l g h k b l k y d j Z a j Z [ h l d _ Z d l b \ g u o k l j Z l _ ] b c l Z e v g u o k j _ ^ k l \ m i j Z \ e _ g b y \ e h ` _ g b y f b \ h l ^ _ e v g u _ < l h j h _ g Z i j Z \ e _ g b _ h l g h k b l k y d l _ h j b b i h j l n _ e v g u o b g \ _ b k k e _ ^ h \ Z g b y k h k l h b l \ Z g Z e b a _ w n n _ d l b \ g h k l b \ e h ` _ g b c b ^ h k l b \ Z _ f h k l b ^ h o h ^ g h k l b b \ k l j h b f h ^ _ e b h i l b f Z e v g u o i h j l n _ e _ c p _ g g u o [ m f Z ] < g Z k l h y s _ _ \ j _ f y i h ^ h [ g Z y i j h [ e _ f Z l b d Z \ i h e g h c f _ j _ g _ h [ t _ d l b \ g h c l _ o g b d b k l Z g ^ Z j l g u f b f _ l h ^ Z f b k i h e v a h \ Z g b b i h j l n _ e _ c i j _ ^ i h e Z ] Z _ l k y i h e m q _ g b _ h ] j Z g b q _ g g u o p _ g g u o [ m f Z ] b \ h ] h g _ k _ l _ e _ ] j Z n g u o k b k l _ f k j _ ^ k l \ Z f b b k i h e v a h \ Z g b y

J Z a j Z [ h l Z g Z i j h _ d l w d h g h f b q _ k d h ] h g Z i j Z \ e _ g b y i h j f b g Z g k h \ u f b g Z [ b j Z f b \ k _ o k l j Z g p _ e v d h l h j h ] h g Z k l \ _ g g u x j _ Z e b a Z p b x b ^ _ c d j m i g h ] h g Z g h ^ h \

M>D

J:KQ?L >HIHEGBL?EVGUO <UO G:=J:MKQDLA

J:>BH:DLB<GH=H AG=JYBY KLJHBL?EVGUO Q?UB:EH<

K: ;:J:GH<KDBC EMDVYGKDBC

GZmqguc jmdh\h^bl_evd:Zg-^o kgZmd ^hp

;?EHJMKKDHHKKBCKDBC MGB<?JKBL?L

JZ^bZpbhggh aZ]jyag_gb_ kljhbl_evguo fZl_jbZeh\ fh keh\e_gh g_ lhevdh _]h ijbkoh`^_gb_f gh b ijb\g hdjm`Zxs_c kj_^u jZ^bhZdlb\gufb ijbf_ky\c GZfb gZ bamq_gb_ \hafh`gh]h \ha^_ckl\by kljhbl_evguo fZl_j q_eh\_dZ < i_j\mx hq_j_^v jZkkfZljb\Z_lky jZ^bhgmd bl_evguo fZl_jbZeh\ b mjh\_gv Zdlb\ghklb kh^_j`Zsbc ljb \ukhdhc dhgp_gljZpbb gmdeb^h\ nZdlhj bo \ha^_ fh \ebylv gZ dZgp_jh]_g_a m gZk_e_gby b jZ^bhZdlb\guf kljh_ggu_ ba \ukhdhZdlb\guo fZl_jbZeh\

P_evx jZ[hlu y\eyehkv bamq_gb_ khklZ\Z b mjh\g ]_gguo b _kl_kl_gguo jZ^bhgmdeb^h\ \ kljhbl_evguo \hafh`guo ^hihegbl_evguo ^hah\uo gZ]jmahd gZ `bl_e

?kl_kl_gguj Z^bhgmdeb^u ihklhyggh ijbkmlkl\mxl hdjm`Zxs_c kj_^u b bf_xl ^ebl_evgu_ i_jbh^u

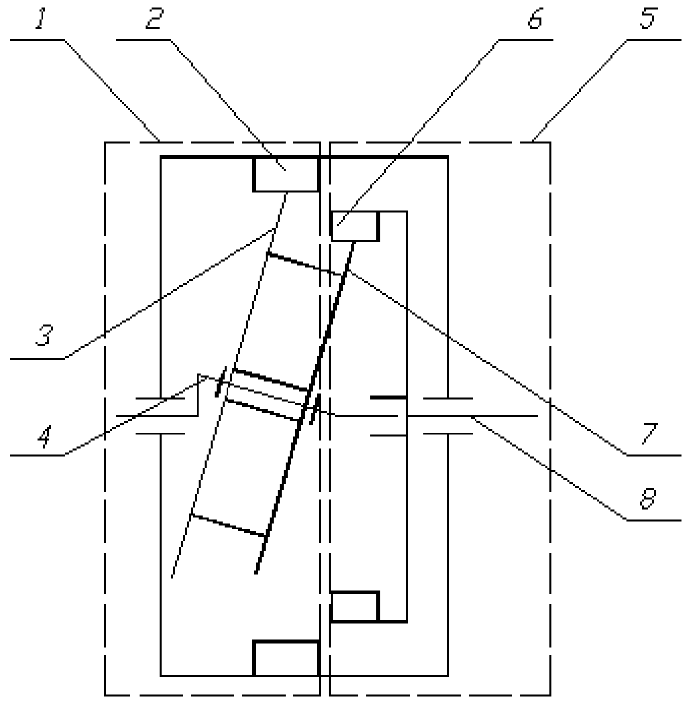
$(^{232}Th \pm$ o$^{10}$ e_l $^{226}Ra \pm$ e_l >Zggu_ gmdeb^u y\eyxlk gbdZfb dZd dhjimkdmeyjgh-\hegh\h] baemq_gb_ MdZaZggu_ baemq_gby hiZkgu b ijb \g \ha^_ckl\bb \ k\yab k q_f g_h[oh^bfh `_kldh dhgljh ^_j`Zgby ^Zgguo gmdeb^h\ \ hdjm`Zxs_c q_eh\_dZ k f_s_gbyo ijh\h^bl agZqbl_evgmx qZklv \j_f_gb m dZ lhqgbdh\ jZ^bhZdlb\gh]h baemq_gby fh`_l g_]Zlb\gh gbb a^hjh\vy b ijb_klb d hgdheh]bq_kdbf aZ[he_\Zg _gby jZdh\uo aZ[he_\Zgbc gZijyfmx aZ\bkyl hl \j_f kmffZjghc Zdlb\ghklb jZ^bhgmd\ur_ hlf_q_ggu_ ihdZ l_f \ur_ jbkd g_]Zlb\guo \ha^_ckl\bc

Ke_^m_l hlf_lblv qlh fZdkbfZevguc \deZ^ \ ih\ur_ $^{40}$D \ gZkl hys__ \j_fy _]h \ha^_ckl\b_ \ J_kimf _lky < lh`_ \j_fy aZ kq_l jZ^bZpbhgguo bkdhi fuo _]h ijbkmlkl\b_ \ Zgljhihkn_j_ agZqbl_evgh m\_ _l g_^hhp_gb\Zlv _]h \hafh`guc \deZ^ \ ^hah\u_ gZ]jm

Hp_gb\Zy mjh_gv \deZ^Z jZaebqguo kljhbl_evguo fZjgmx jZ^bhZdlb\gmx gZ]jmadm hlf_lblv qlh bf_ggh k_jh]h ]jZgblZ bf__l fZdkbfZevgh_ kh^_j`Zgb_ jZ^bhg kbfZevgmx ^hah\mx gZ]jmadm



`_gb_ gZ _^hfuc \Ze i_j_^Z_lky k ihfhsvx kZm_eebl xs_]h k \gmlj_ggbf _gphf _^hfh]h \ZeZ

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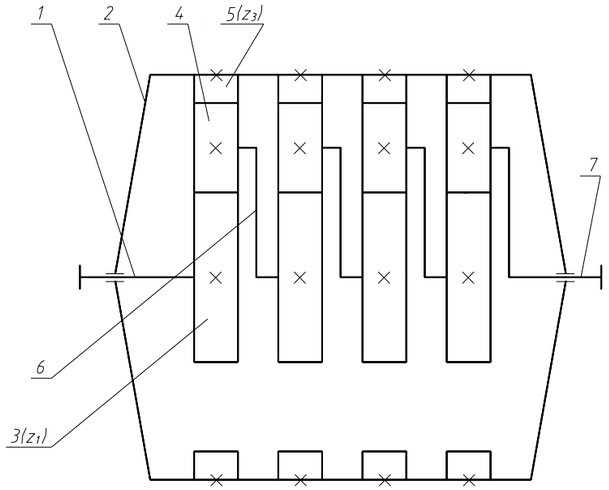


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fb b \gmlj_ggbfb aZp_ie\ohbgfbc \Zedhjikm3 ±p_gljZevgh_
dhe_kh k gZjm`gufb ±akmZlv_yefb5b±dhe_kh k \gmlj_ggbfb am[v
6±\h^beh±\uoh^ghc \Ze i_j_^Zqb

>hklb`_gb_ fbgbfZevguo ]Z[Zjblguo jZaf_jh\ j_^m
iml_f hl[hjZ lZdbo \ZjbZglh\ ieZg_lZjgbp_kij^bZZxldhl
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hq_j_^v g_ iha\hey_l rbjhdh bkihevah\Zlv bo \ f_oZ
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;ueh ij_^eh`_gh ih\ukblv DI> wdkp_gljbdZ-Gdhmuofi_j_^
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2) jZkqzl l_fi_jZlmjguo ihe_c \ k_q_gbb _jog_]h b
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gh]h k bkihevah\Zgb_f ijh]jZffgEhcluª dhkgeh\dhZgh©
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3) jZkqzl l_fi_jZlmjguo ihe_c h^ghjh^gh]h mqZkldZ
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©ez]dZy rlmdZlmjgZyhkbkl_klZª_l ^_ckl\mxsbf ghjfZf
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\uf ^hoh^Zf

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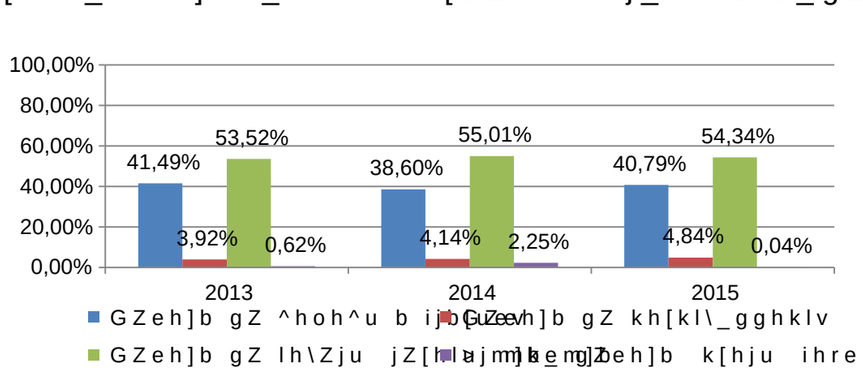


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gZeh]h\uo ^hoh^h\ gZeh]b gZ [Fxh^]be_\kdhc h[eZklb aZgbfZ_l
©GZeh]b gZ lh\Zjumkjeh]bu ª LZd aZ ±i_jbh]^] hgZ
gZoh^beZkv gZ ±mjh\gWlh k\yaZgh k \ukhdhc ^he_c
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\uiheg_gghc ih k_fk gZjm`gufb b \gmlj_ggbfb aZp_i
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^ms_]h \ZeZ \jZs_gb_ i_j_^Z_lky gZ p_gljZevgh_ dl
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\uoh^guf \Zehf i_j_^Zqb ljbq_f i_j_^Zlhqghm hlghr_
i_gb ^Zggh]h \ZjbZglZ ieZg_lZjghc i_j_^Zqbmieh^kqblu\

$$u\ 1\ \frac{z_3}{z_1}, \qquad (1)$$

]^_1 b 3]±qbkeh am[v_\ p_gljZevguo am[qZluo dhe_k b
\gmlj_ggbfb am[vyfb khhl_lkl_ggh

LZdb_ i_j_^Zqb g_ iha\heyxsb_ ^dhkgl_bfZlhvq\ukkdhhd]h
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ih fh^mevghfm ijbgpbim ]^_ ^ey ^hklb`_gby lj_[m_f
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_fe_fh ^ey[hZlbZgh\h]h f_oZgbq_kdh]h mkljhcklZ hk
\byo `_kldhc wdhghfbb nbgZgkh\uo j_kmjkh\

M > D

G : I J : < E ? G B Y K H < ? J R ? G K L < H < : G B Y K ; U L H < H C > ? Y L ? E V G J H ? K L J B B Y L B Y G : I J B F ? J ? A : H K I © K H I H L ? D K ª

F : X J Q ? G D H < : K Y ; M ; G H < : G Z m q g u c j m d h \ h E b l D e V F : K H < : ; ? E H J M K K J D H K K B C K D B C M G B < ? J K B L ? L

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>ey kgb`_gby ^_[blhjkdhc aZ^he`_gghklb ij_^ijbylb djZlqZcrkj_hdb hilbfbabjh\Zlv mkeh\by ijh\h^bfuo k aZdexq_gbb ^h]h\hjZ\`mZijhj^mdhb\gZ klZlvhiejZl^Z Z ih ^h]h\hjZf aZdhkjhdZ ieZl_`Z

lh\ur_gb_ dZq_kl\Z ij_hl^mdhb\gb_ gZijZ\e_gb_ kh_ kl\h\Zgb[ulh\hc ^_yl_evgh]kbij_^ijbyHlkgh\ghc ijh[e fhcA:H KI © Khihl_dkey_lky \ukhdbc mjh_gv baghkZ Zd hkgh\guo ijhba\h^kl_gguo nhg^h\ lh^Z\eyxsZy qZkl l_ogheh]bq_kdh]h h[hjm^h\Zgby ijZxdlbaqhkd_gZhegfhkl jZevgh mklZejeuZmkdZ dZq_kl_gghc dhgdmj_glhkihkl h[gh\e_gb_ hkgh\guo nhg^h\ y\ey_lky h^gbf baa \Z`g_ \blby ij_^ijbyKby^mxsZy ijh±evlhZkgb`_gb_ k_[_klhbfh ijh^mdpbb ijb ihklhygghf ih\ur_gby jdZq_kl_gghc \aZbfbyka\Zgguo ijh[e_f g_h[oh^bfhkhi\hjhgkl\hZgb_ k s_kl\mxsbo b jZajZ[hldZ gh\uo [he__ wnn_dlbh\guo l_ p_kkh\ k \g_^j_gb_f gh\h]h h[hjm^h\Zgby >ey ih\ur_ ij_^ijbylby \ ijhp_kk_ j_hj]ZgbaZpbb g_h[oh^bfh ijh^ l_ogbq_kdhfm i_j_hkWZhsjgbaxhebl memqrblv dZq_kl\h pbb khdjZlblv ijhba\h^kl_gguc plhbfhkkyb^jvgk_[_k \ukhdhl_ogheh]bqgh]h b l_iehh[f_ggh]h h[hjm^h\Zgb l_evgh khdjZlblv aZljZlu gZ whfbdhjbvaf_jbgxbch\ wdhg fbq_kdhc iheblbd_ b l_ogbq_kdhf h[_ki_q_gbb g_h[o fZgb_ hj]ZgbaZpbhgghc kZjmdhx_ b mij



LZ[e >bgZfbdZ gZeh]h\uo ^hoh^h\ mieZqb\Z_fuo kdhc h[eZklb

| IhdZaZl_ev | ] | ] | ] | :[khexlgh_ hldehg_gb_ | |
|---|---|---|---|---|---|
| | | | | 2014± ] | 2015± ] |
| GZeh]h\uo ^hoh^u \ qbke_ | 2 656,91 | 3 174,97 | 3 194,86 | 518,06 | 19,89 |
| gZeh]b gZ^u^h ijb[uev | 1 114,34 | 1 225,48 | 1 303,06 | 111,4 | 77,58 |
| gZeh]b gZ mieZqb\Z_fu_ _ kdbfb ebpZfb | 929,45 | 1 068,63 | 1 204,23 | 139,18 | 135,6 |
| ±ih^hoh^guc gZe abq_kdbo ebp | 929,45 | 1 068,63 | 1 204,23 | 139,18 | 135,6 |
| gZeh]b gZ ^ ijb[uev mieZqb hj]ZgbaZpbyfb | 184,89 | 156,85 | 98,82 | - 28,04 | - 58,03 |
| ±gZeh] gZ ijb[ue | 164,46 | 138,16 | 70,57 | - 26,3 | - 67,59 |
| ±gZeh] gZ ^hoh^ | 20,43 | 18,69 | 28,25 | - 1,74 | 9,56 |
| gZeh]b gZ kghl[kl | 104,16 | 131,42 | 154,50 | 27,26 | 23,08 |
| gZeh]b gZ g_ bfms_kl\h | 2,84 | 3,82 | 6,93 | 0,98 | 3,11 |
| ±gZeh] gZ g_^\b gZ g_aZ_jr_gbh l_evkl\h | 2,84 | 3,82 | 6,93 | 0,98 | 3,11 |
| gZeh]b gZ hk klhbfhklv bfms_k | 101,32 | 127,59 | 147,56 | 26,27 | 19,97 |
| ±gZeh] gZ g_^\b | 101,32 | 127,59 | 147,56 | 26,27 | 19,97 |
| gZeh]b gZ lh\Z lu mkem]b | 1 422,03 | 1 746,59 | 1 736,15 | 324,56 | - 10,44 |
| ± gZeh] gZ ^h[Z klhbfhklv | 1 369,40 | 1 678,39 | 1666,32 | 308,99 | 12,07 |
| ±wdheh]bq_kdbc | 52,35 | 67,59 | 69,59 | 15,24 | 2 |
| ±gZeh] gZ ^h[uyq lb_ ijbjh^guo j_ | 0,28 | 0,60 | 0,23 | 0,32 | - 0,37 |
| ^jm]b_ gZeh]b ihrebgu b bgh[ ]h\u_ ^hoh^u | 16,38 | 71,48 | 1,15 | 55,1 | -70,33 |
| ±hlqbke_gby \ bh hggu_ nhg^u | 15,84 | - | - | - | - |
| ± ]hkm^Zjkl_gh[ rebgZ | 0,54 | 71,48 | 1,15 | 70,94 | - 70,33 |

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L _ ih^hoh^guc gZeh]h\lZ\be] fej^ j qlh

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mieZqb\Z_fu_ hj]Zgb aZpbkyhfbjZbbkev ^]h fej^ j ql
gZ fej^ j f_gvr_ ]
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gZeh] fej^ j < gZ[ek^Z_lky g_agZqbl_evgh_ iZ^_
gZeh]h\ dZd gZeh] gZ ^h[Z\e_ggmx klhbfhklv
^h[uqm batylb_ ijbjh^guo j_kmjkh\ kgbabekyh gZ
djZlbeZkv ih^]jmiiZ ©>jm]b_ gZeh]h\ ^hoh^uª b khklZ\beZ \ fej^ j
DZd \b^gh h[sZgZkmhfZuo ^hoh^h\ ihkl\m[xZ^xsZy
Fh]be_\kdhc h[eZklb b jZkij_^_eyxsZy \ j_kim[ebdZ
]h^Zfb m_ebqb\Z_lky H^gZdh __ jhkl aZZbihkevgh^gbc
khdjZlbe>key m_ebq_gby iheh`bl_evghc ^bgZfbdb gZe
mieZqb\Z_fuo \ [x^`_l Fh]be_\kdhc h[eZklb g_h[oh^b
ke_^mxsbo f_jh:ijbylbc
kh_jr_gkl\h\Zgb_ dhgljhey aZ kh[ex^_gb_f aZ
gZeh]Zo b k[hejZxo hk[_pki_dkZgbbyevgh]h bo ihklmie__gby
khdjZs_gby jZiaf_jh\ k\yaZgguo k mZeh]hie_l fevsbdh\
hl \uiheg_bgfbygZeh]h\uo h[yaZgghkl_c
baf_g_gb_ ijbhjbl_lh\ \ jZ[hl_ gZeh]hie_l_evgsbydhk\n_jZkrbj
p_evx memqhr[kgebmy`b\Zgby gZeh]hieZl_evgsbydhk\n_jZkrbj
ij_^hklZ\ey_fuo bf mkem] ijb h^jghs_gfbygbhkihg_gb
gZeh]h\uo h[yaZgghkl_c
ih\ur_gb_ wnn_dlb\ghklb nmgdpbhgbjh\Zgby g
fuaZ kq_l \g_^j_gby gh\uo bgnhjfZpbhgguo l_ogh
gbykh\jf_ggufb kbkl_fZfb _^_gby l_ogheh]bq_kdb
bhi_jZlb\gufb kj_^khlZZfbe_gby hilbfbaZpbb aZljZl b
lbyj_kmjkgh]h h[_ki_q_gby
D hkgh\guZfijZ\e_gbyflhjZgaZeh]h\uo hj]Zgh\ihalhlhju_
\heyh[_ki_qbhevh`bl_evgmx ^bgZfbdbe_gby gZeh]h\uo ^l
^h\ \ [x^`_l Fh]be_\kdhc h[eZklb hl:ghkylky ke_^mxsb
±jZa\blb_ kbkmq_fuZhgZieZl_evsbdh\ h[_kihiqb\Zxs_
jZlb\guc dhgljhev aZ ^_yl_ekmgh[kdbyZ\k]hoh[eh`_gby
± ih\ur_gb_ ijZ\h\hc ]jZfhlbgbkhjfb\jZhg
klbgZeh]hieZl_evsbdh\ b dZd ke_^khl[jh\hevmgjh\gy
]hkh[ex^_gby bfb aZdhgh^gZle_kZ[h\jZo
±hj]ZgbaZpby wnnbklbeyh]h\Zgbybg^hgjZpbhg
ijh]jZffglh_ogbq_kdhe_bhffmgbdZpbhggbgZkkb\bjfu
]Zgh\mq_lhf[_ki_q_gby [_ahiZkghklb bgnhjfZpbb
± ih\ur_gb_ ijhn_kkbhgZevgh]h mjh\gyZehjZ[hlgb
\uohj]Zgh\ h[_ki_q_gb_ kh[ex^_gby bfb wjhn_kkb
dbkijZ_^eb\h]h b [_kijbkljZklgh]h hlghr_gby d gZeh]h



N=L+K 1 lmkz$_{ij}$=x$_{ij}$ _kL<K bz$_{ij}$=x$_{ji}$ \ hklZevguo kemqZyo L
^bZ]hgZevgh_ mkj_^g_gb_ i_.\\hy^(g$_0$\,},g$_{N\ 1}$)pim njh
fme_

$$g_k^{\backslash} = \begin{cases} \frac{1}{k\ 1}\sum_{j\ 1}^{k\ 1} z_{j,k\ j\ 2}, & 0 \le k < L^* - 1; \\ \frac{1}{L^*}\sum_{j\ 1}^{L^*} z_{j,k\ j\ 2}, & L^* - 1 \le k < K^*; \\ \frac{1}{N\ k}\sum_{j\ k\ K^*\ 2}^{N\ K^*\ 1} z_{j,k\ j\ 2}, & K^* \le k < N. \end{cases}$$

Wlh \ujZ`_gb_ khhl_lkl\m_l mkj_^g_gbx we_f_glh
ih[hqguo ^bZ]i+j=k+2_c\u[k=0 ^Z_g$_0^{\backslash}$=x$_{11}$ ^k=1 ihemqZ_f
g$_1^{\backslash}$=(x$_{12}$+x$_{21}$)/2 b l^ ljbf_gb\ ^bZ]hgmZkevgh_gb_ d fZhjbpZf
emq_gguf gZ wlZi_ ]jmiibjh\db ijboh^bf d jZaeh`_gbx
kmff ıjy^h\
ljh]jZffguc dh^ \ 6FLODE

```
y = zeros(N, 1)
  for i = 1 : K + L - 1
    v = adiag(RC, i)
    y(i) = sum(v) / length(v)
  end
  y = real(y).
```

lhemq_ggZy j_ZebaZpby f_lh^Z ZgZebaZ kdbg]meyj
guo jy^h\ \ 6FLODE iha\hey_l bkke_^h\Zlv hkh[_gg
lj_g^h\hc i_jbh^bq_kdhc b rmfh\hc khklZ\eyhxs_c ^e
ihegbl_evghc bgnhjfZpbhm hf[hfbkke_dl_ ljh_^_gZ _jb
pby ijh]jZfBelSim2#.SSA \ khklZ_ ijh]jZfbgheh]bq_kdh]h
dhfie_dkZ bfblZpbb keh`BelSim kbkhfhsvx j_ZebaZpbb
6FLODE \ j_amevlZl_ ih^l_j`^_gZ dhjj_dlghklv bkke

KIBKHE?BL?J:LMJU

1. Golyandina, N. Analysis of Time Series Structure: SSA and Related Techniques / N. Golyandina, V. Nekrutkin, A. Zhigljavsky±Boca Raton: Chapman & Hall/CRC, 2001. ±310 p.

$$V_k = \frac{1}{\sqrt{\lambda_k}} A^T U_k, \; k = 1, \dots, p. \quad (2)$$

Lh]^Z kbg]meyjguf jZaeh`_gb_f fZljbpu __\ ij_^klZ e_gb_ \ \b^_ kmffu we_f_glZjguo fZljbp

$$A = A_1 + A_2 + \dots + A_p, \; A_k = \sqrt{\lambda_k} U_k V_k^T. \quad (3)$$

DZ`^Zy ba $A_k$ ljbp_l jZg] jZ\guc _^bgbp_ lhwlhfm gZa\Zlv we_f_glZjgufb fZljbpZfb. $U_k$ ba ^Zgguo _dlhj eyjguf _dlhjhf, $V_k$ – ijZ\uf kbg]meyjguf _dlhjhf, $\sqrt{\lambda_k}$ – kbg]meyjguf qbkehf kh[kl_gguf ljhcdhc.

H[t_^bg_ggZy fZljbpZ 8 k e_\ufb b ijZ\ufb kbg]me fb hij_^_ey_lky k bkihevah\Zgb_f nmgdpbb VYG

[U, LAMBDA] = svd(C).

Kh[kl_ggu_ qbkeZ fZljbpu \ iZd_l FLODE ij_^klZ\e_g _dlhjhf /$0%'$ Ba ihemq_gghc fZljbpu kbg]meyjguo dZ_lky _dlhj /$0%'$ k bkihevah\Zgb_f nmgdpbb GLD.

ljh]jZffguc dh^ \ 6FLODE

LAMBDA=sqrt(diag(LAMBDA)).

WlZi ]jmiibjh\db <b^ e_\uo b ijZ\uo kbg]meyjguo _fuo \ KK: dZd \j_f_ggu_ jy^u y\ey_lky hq_gv \Z`gu rZ]Z f_lh^Z ]jmiibjh\db ljb wlhf ^ey h^ghf_jgh]h KK: e_ \u_ kbg]meyjgu_ \_dlhjZ h[eZ^Zxl hij_^_e_gghc kbff wlbo kemqZyo kbg]meyjgu_ jZaeh`_gby kljh_gby hcg L bK=N L+1 wd\b\Ze_glgu

ljhp_^mjZ ]jmiibjh\db nhjfZevgh h^bgZdh\Z ^ey \ kl_c KK: GZ hkgh_ jZaeh`_gby ijhp_^mjZ ]jmii fgh`_kl\h bg^_ 1,},p` gZ g_i_j_k_dZxsboky ih^fgh`_ $I_1, \dots, I_m$.

ImklI = $I_1, \dots, i_p$. Lh]^Z j_amevlbjmxsZ $A_I$ fZljbpZ khhl_lkl\m sZy ]jmli_hij_^_ey_l $A_I = A_{I_1} + \dots + A_{I_p}$. LZdbf fZljbpu \uqbkeyx ky ^ I=$I_1, \dots, I_m$ l_f kZfuf jZaeh`_gb_ fh`_l [ulv aZibkZ ibjh\Zgghf \b^_

$$A = A_{I_1} + \dots + A_{I_m}.$$

WlZi ^bZ]hgZevgh]h mkj_^g_gby GZ ihke_^g_f rZ] fZ dZ`^Zy fZljbpZ k]jmiibjh\Zggh]h jZaeh`_gby i_j_\h ^ebgu N >ey ijhba\hevghc fZljbpu X ijb_f mkj_^g_gby __ d ] e_\hfm \b^m b ihke_^mxs_fm ij_h[jZah\Zgbx G)jy^ h[ \ujZabf ke_^mxsbf h[jZah fZljbpZ jZ L uK Zk weg_f_ lZfbx, 1 di dL, 1 dj dK lhe`ih L* = min L, K, K* = max L, K b



M>D

J?R?GB?>AQB G: I?J?K?Q?GB? L?JOGHKL?C HEBFB:>GH=H MJH<GY GKHEKHL@B

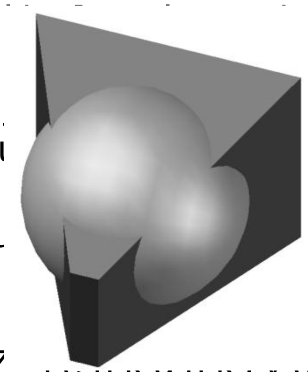
F B;?D@:GH<

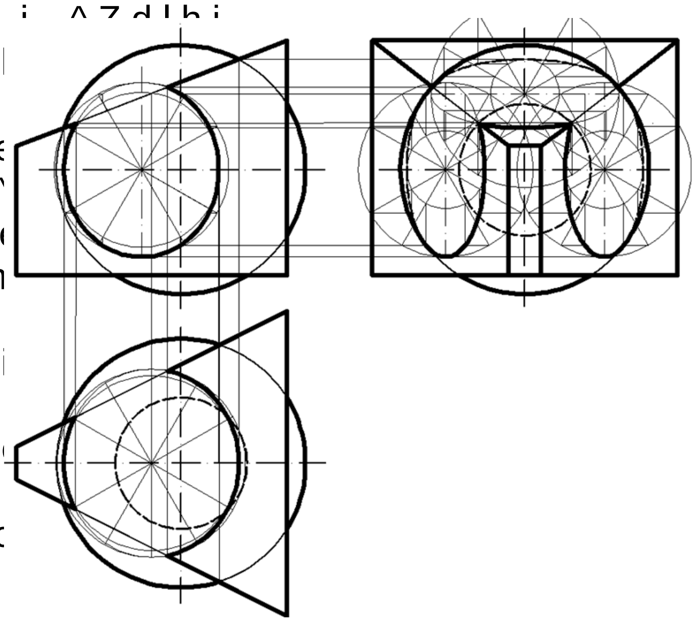
GZmqguc jmdh\h^bl_ev – ^hp_gl BO H<BQ

;?EHJMKKDBC GZpbhgZevguc l_obgbq_kdbc mgb_jkbl_l

AZ^Zqb hebfibZ^gh]h mjh\gy iZ ^Zjlgh]h ih^oh^Z yxsh_]h mijhklblv gb_JZkkfhljbf j_r_gb_ aZ^Zqb ]^ q_luj_o]jZggZy ijbafZ k gZdehgg \Zgb_f lj_[m_lky ihkljhblv ljb i j_k_q_gby ih_joghkl_c b ^guf ^Zggu ^_ey_f qlh aZ^Zqm fh`gh k\_klb kl ZxsbokyZ ijh_dpbc gZ ghjfZe_` l dZ gbfZ_l ijh_pbjmxs__ ihe h`_gb_ gZ _dpbc $l_1, l_2$. GZ bf_xsboky ijh_dpbyo ebgbc gm`gh [jZlv f_`mlhqgu_ lhqdb b ihhq_j_^gh i_j_ghkblv bo ijb ihf gZ khk_^gb_ iehkdhklb ijh_dpbc j_>gZ ggbc ^Zkbl kh[bl_ev ]jhfha^dh_ ihkljh_gb_ ijb i_j_ghk_ lhq_d gZ $l_3$.

Ihkljhb\ \ kbkl_f_ AutoCAD 3D fh^_ev ihgbfZ_f qlh [hevrbg ebgbc i_j_k_q_gby y\eyxlky njZ]f_glZfb weebikh\ Z hij_^_eblv bo p_glju b _ebqbgm [hevrbo jb rZ]Zuo ah ^Zqb \ ]jZnbq_kdhf





ihkljh_gby mkdhjyxl agZgy \bgb qhk_c kljhylky aZ iZjm © ihevah\Zgb_f dhfZg gby ©Weebik» < gb_ aZ^Zqb \jmqgm weebik kljhbf ih ^\ lhqdZf AZ jZxsbf j_r_gby aZ^Zqb y\e ^_e_gb_ \b^bfhklb j_k_q_gby Z lZd`_ ^Zgguo ih_joghkl l_evgh ^jm] ^jm]Z

= = ;?EY<KDB<CD:>IBLMEBG
GZmqguc jmdh\h^bl_eb : B YDgBFgHZ<mddZ^gh^p l
;?EHJMKKJDHHKKBCKDBC MGB<?JKBL?L

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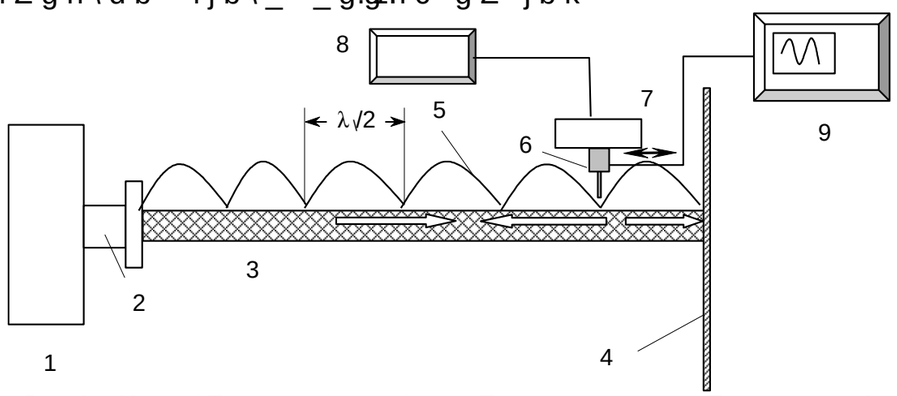
guo dhgkljmdlb\guo iZjZf_ljh\ ^eyolgadbeb>c@K<ZQ ij_^eZ
_fhc jZ[bkihevam_lky kihkh[ baf_j_gby ^bwe_dljbq_k
klb ^bwe_dljbq_kdbo fZl_jbZeh\ \hegh\h^guf kihkh[h
\ha[m`^_gbb \ dhgljhebjm_fhf h[jZap_ \hegh\h^guo
kmlv bkihevam_fh]h kihkh[Z beexkljbjm_lky ko_fhc
mklZgh\db ijb_^_g.dhc gZ jbk




Jb.k1. Ko_fZ wdki_jbf_glZevghc mklZgh\db ^ey baf_j_g
ihdZaZl_ey ij_ehfe_gby \hegh\h^ghc fh^u kehbklh]h ^bwe
\hc h[eZklb k1_±dkjZQ_g_jZlh-109; 2±hlj_ahd iheh]h f__lZeebq
kdh]h K\hQgh\h^Z± dhgljhebjm_fuc h[jZa_p kehbklh]h ^bv
4±f_lZeebq_kdh_ a±kjdhZyeqZy \he±jZemijh\h^gbdh\uc- Zgl_gg
ahg^±h^ghdhhj^bgZlguc±kdhZiv_xjl_j±pbnjh\hc hkpbeeh]jZn

K<Qbaemq_gb_ ]_g-jZlhjZk=\uoh^gh]h hlj_a_dZ f_lZ
kdh]h ijyfhm]hevgh]h \hegh\h^Z \\h^blky \hmoh^ghc
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ljbq_kdh]h \hegh\h^Z Baemq_gb_kjeZhkbkhkfjmZghy[jZkaypmh
\b^_ \hegh\h^ghc fh^u <ijblud d \uoh^ghfm lhjpm
kehy mklZgh\e_gh f_lZeebq_kdh_ a_jd-Zbaemq_hdbZ_`Zx
h[jZlghf gZijZ\e_gbb < j_amevlZl_ bgl_jn_j_gbpbb ijy
]h baemq_gby \ dhgljhemjkmZ_gfZf\ekbeZ_lky klhyq_Zy \heg
jbh^ dhlhjhc hij_^_ey_lky ^ebghc \hegu bkihevam_fh]
jbZe_ kehy LZd dZd baemq_gb_ \ ^bwe_dljbq_kdhf
\b^_ g_h^ghjh^guo \heg lh hgh qZklbqgh \uoh^bl ba





= X XJQ?GDH
GZmqgu_ jmdh\h^bl_eb : B YDgBFgHZ<mddZ^gh^p l
? : YDBFH< dZg^ l_og gZmd
;?EHJMKKJDHHKKBCKDMBGCB<?JKBL?L

Hkgh\ghc aZ^Zq_c bkke_^h\Zgby y\ey_lky j_ZebaZ
kbg]meyjgh]h ki_dljZevgh]h ZgZebaZ KK: \j_f_ggu
6FLODE LZdZy j_ZebaZpby KK: iha\hebl bkke_^h\Zlv
ZgZebaZ kbg]meyjgh]h kijdhlhZ^bZv lZ_jb_nbdZpbx ^jm]
ijh]jZffguo j_ZebaZpbc KK:

WlZi \eh`_gby > @ >ey wdki_jbf_glZevguo bkke_
jy^G ($g_0, g_1, ..., g_{N-1}$) fh`_l [ulv aZ^Zg ih ba_klguf nmgdpl
hij_^_e_g j_amevlZlZfb nmgdpbhgbjh\Zgby bkke_^m_
jm_lky fZljbpdZhlhjZy ih ijZ\beZf ihkljh_gby y\ey_lky
ljhp_^mjZ \eh`_gby y\ey_lky ij_h[jZah\Zgb_f bkoh^g
jy^ZG \ ihke_^h\Zl_eLvfhjkluo _dlhjh\ qbkeh dhlhjuo
K=N L+1:

$$A_i = (g_{i\ 1}, \}, g_{i+L\ 2})^T, 1 di dK. \qquad (1)$$

ljh]jZffguc dh^ wlZiZ \eh`_gby _dlhjh\ f:Zljbp_
y±bkoh^ghfmGjLy±mbjbgZ hkdZqbkeh hdhg

```
X = zeros(L, K)
  for i = 1 : K
    X(:, i) = y(i : i + L - 1)
  end.
```

lhemq_ggu_ _dlhjZ h[jZamxl ljZ A=>A1; }; Ak jfyZljbpm
^ZG \ dhlhaij=gi+j 2 l_ fZljlAij>Zf__l h^bgZdh\u_ we_f_gl
^bZ]hgi+j=const.

WlZi kbg]meyjgh]h jZaeh`_gby A~AT+[kaZgZEqZf ljbpZ
A~AT kbff_ljbqqgZy b g_hljbpZl_evgh hij_^_e_gg Zy Z a
gu_ qbkeZ _s_kl_ggu b g_hljbpZl_evgu

ljh]jZffguc dh^ ihemq_gby fZljbpu
C = X * X' / K.

lj_^klZ\e_ggu_ \t\!bf_t0 kh[kl_ggu_ qbkeZ gZau\
kbg]meyjgufb agZq_gbyfb fZUjbpU ±khmhkl\vlkl\mxsb_
bf hjlhghjfbjh\Zggu_ kh[kl_ggu_ _dlhjZ ;m^_
p max^k|k !0`ihjy^dhf kbg]meyjgh]h jZaeh`_gby H[hagZ

M > D
B K K E ? > H < : G B ? F ? L H > : G : H K G H < ? D H F I E ? D K G H = H
I J B F ? G ? G B Y G N H J F : P B H G L ? O G H E H = B C
IT-BASED INVESTIGATION OF THE SSA METHOD

= X X J Q ? G D H
G Z m q g u c j m d h \ h B b l Y D V F : H < d Z g ^ l _ o g g Z m d ^
D h g k m e v l Z g l ? G F ? E V G B D H < :
; ? E H J M K K J D H K K B C K D B C M G B < ? J K B L ? L

The main task of this paper is to describe implementation of the basic SSA method in Scilab package for time series analysis. It will help both to study SSA details and verify other SSA implementations.

Time series is an ordered sequence of values of a variable at equally spaced time intervals.

Time series models are used to perform the following tasks:

±to obtain an understanding of the underlying forces and structure that produced the observed data;

±to fit a model and proceed to forecasting, monitoring or even feedback and feedforward control.

Time Series Analysis is used for a number of applications: economic forecasting; sales forecasting; budgetary analysis; stock market analysis; yield projections.

Singular spectrum analysis (SSA) is a nonparametric spectral estimation method. It combines elements of classical time series analysis, multivariate statistics, multivariate geometry, dynamical systems and signal processing.

The areas where SSA can be applied are very broad: climatology, marine science, geophysics, engineering, image processing, medicine, econometrics. Hence, different modifications of SSA have been proposed and different methodologies of SSA are used in practical applications such as trend extraction, periodicity detection, seasonal adjustment, smoothing, and noise reduction.

The main algorithm of basic SSA consists of four main steps: embedding, singular value decomposition (SVD), eigentriple grouping and diagonal averaging.

Scilab is a mathematical package and a high-level, numerically oriented programming language. The language provides an interpreted programming environment, with matrices as the main data type. Scilab is an excellent tool for an one to solve optimization problems.

Scilab is a free open source, cross-platform numerical computational package. Such combination of properties makes it very useful for beginning researchers. Besides, it adapts well. W R D S U R J U D P P H U ¶ V W D V N V



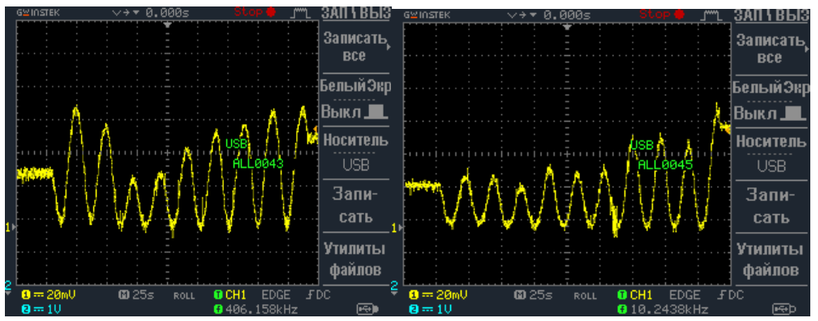
kj_^m ihh\hey_l baf_jblv i_jbh^ klhyq_c \hegu \ keh_
ihfhsvx Zgl-ahgu^Z ij_^klZ\eyxs_]-^kh^[ caZdjQie_
guc dhgkhevgh gZ jZajZ[hlZgghf h^ghdhhj^bgZlghf k
ahg^Z hkms_kl\ey_lky k ihfhsvx rZ]h\h]_hf^]hfdZh_ey
ivxl_jhf We_dljbq_kdbc kb]gZe-ahgu^Zhj^Z]bZkgl_jmu_lk
pbnjh\uf hkpbeeh]jZn_ GDS 7104 2 (9).

Hij_^_e_gb_ ^bwe_dljbq_kdhc ijhgbpZe_fhklb ijh\h^
h[jZahf GZ pbnjh\hf hkpbeeh]jZn_ aZibku\Z_lky dZjl
dhgl hebjm_fhf h,[jZapl_hjhc hij_^_ey_lky __ i_jbh^ d
^\Z jZaZ f_gvr_ ^ebgu we_dljhfZ]gblghc \hegu jZkij
\hegh\h^mlh agZq_gbx ]_g_jbjm_fh-bqeZkqh_ubyK<Qeb ih
i_jbh^m klhyq_c \hegu \ \ha^mo_ hiju^_ey_lky^ebgZ
\ha^m0o_

< j_amevlZl_ ^_e_gby ^ebgu0 \hegu \ \ha^mo_ \heg
\h^_\ hij_^_ey_lky wnn_dlb\guc ihdZaZl_ev ij_ehfe_g
fh^un wn lh jZkkqblZgghfm wnn_dlb\ghfm ihdZaZl_ex i
gh\h^ghc fh^kuihfhsvxbki_jkbhggh]h mjZ\g_gbyh^ey h^g
]h ^bwe_dljbq_kdh]h \heghLhijZ\hhesbyghchfivxl_jguc
jZkq_l ^bwe_dljbq_kdhc ijhgbpZ_fhklb dhgljhebjm_fh]

$$\frac{2\,S_L}{Q_0}\sqrt{n_{wn}^2}\ \operatorname{arctg}\sqrt{H}\sqrt{\frac{H\,n_{wn}^2}{n_{wn}^2\ 1}}.$$

D ijbf_jm gZ ijbk_^_gu jZkij_^_e_gby bgl_gkb\ghk
\hegu \ \ha^mo_ Z b \ ^bwe_dljbq_kdhf \hegh\h^_
gby ba nlhjhieZklZ [ ^ey ^ebgu \hegu kf




Z

Jbk 2. JZkij_^_e_gb_ bgl_gkb\ghklb klhyq_c \hegu \ \ha
we_dljbq_kdhf \hegh\h^_ ijyfhm]hevgh]h k_q_gby ba nlhjh

Ba j.b2k\b^gh qlh i_jbh^ klhyq_c \hegu \ \hegh\h^_
\ha^mo_

Ijh_^_ggu_ baf_j_gby gZ ^ebfg^Zebeku_^mZkb_ ag
q_gby wnn_dlb\gh]h ihdZaZl_ey ij_ehfe_gby hkgh\gh
nwnb ^bwe_dljbq_kdhc ijhgbpZ_fhklb 0 khhl_lkl_ggh

```
>ey kehy ba nlhjhieZklZ lhwn=sbghc 1,222f).
>ey kehy ba hj]kl_deZ lhwn=sbghc 1,175f).
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Ihemq_ggu_ agZq_gby ^bwe_dljbq_kdhc ijhgbpZ_fl
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jh\hf ^bZiZahg_ ^ebg \heg
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gZ qZklhl=p q=h khhl\_lkl\m_l ^ebg_ \hegu ff
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^bwe_dljbq_kdhc ijhgbpZ_fhklb 0 khhl\_lkl\_ggh
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>ey kehy ba ihebklbjheZ lhwn=sbghc 2,322f)
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fhklv bkke_^h\Zgbu fZl_jbZeh\ \ fbeebf_ljh\hc
ki_dljZ [hevr_ q_f \ kZglbf_ljh\hc qlh k\yaZgh k ^bl
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LZdbf h[jZahf ijh\_^_ggu_ wdki_jbf_glZevZgu_ bkl
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# THE POSSIBILITY OF USING DUPLEX STAINLESS STEELS IN WELDING PRODUCTION

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As the oil and gas industry moves further offshore into deeper waters, the need for stronger, lighter and more corrosion-resistant materials is more acute than ever. Today, the use of duplex stainless steels, has become commonplace for meeting such challenges.

Ferritic-austenitic stainless steels also referred to as duplex stainless steels, combine many of the beneficial properties of ferritic and austenitic steels. Due to the high content of chromium and nitrogen, these steels offer good resistance to localised and uniform corrosion. The duplex micro-structure contributes to the high strength and high resistance to stress corrosion cracking.

The characteristic properties of duplex steels are the following: very good resistance to uniform corrosion, very good resistance to pitting and crevice corrosion, high resistance to stress corrosion cracking and corrosion fatigue, high mechanical strength, good abrasion and erosion resistance, good fatigue resistance, high energy absorption, low thermal expansion.

Despite the fact that duplex stainless steels have good weldability, there exist some difficulties, such as critical temperature ranges: with a long stay in those ranges steel loses corrosion and mechanical properties. Therefore, the welding of duplex steels should be carried out strictly in accordance with the welding technology. As a part of our research, we are trying to create the techniques of welding of duplex steels. At present we are studying the impact of various options of the protecting gas for Gas-shielded arc welding on the properties and structure of duplex steel. Various combinations of gases allow to obtain different properties.

Besides when using different shielding gases during welding, the temperature changes and as a consequence it is possible to avoid staying of duplex steels in critical temperature ranges. The chemical composition of the gas may favorably affect the structure of the duplex steel. Now, we are conducting experiments related to the protective gas and we hope to find out what protecting gas will be the best one for duplex stainless steels welding.

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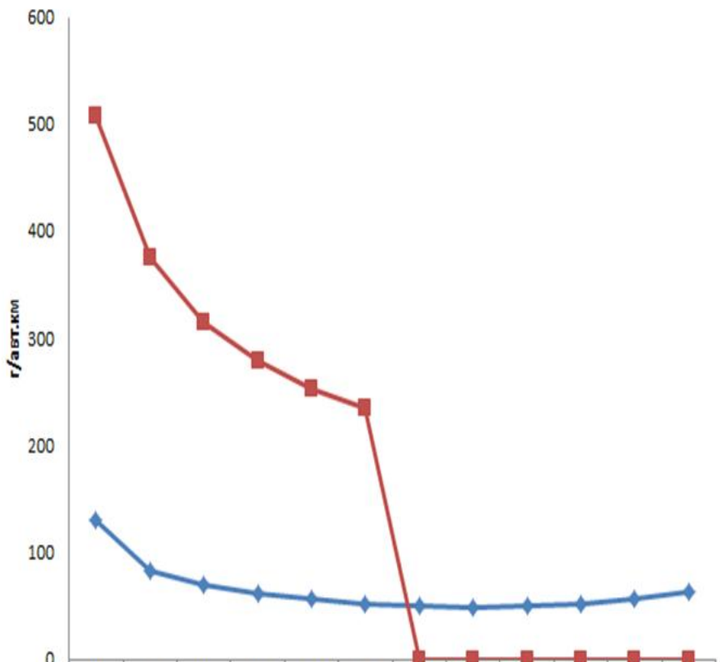


| | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Потребление топлива легковым транспортом | 130,5 | 82,2 | 69,3 | 61,7 | 55,8 | 51,6 | 49,2 | 48,4 | 49,4 | 52,1 | 56,5 | 62,7 |
| Потребление топлива автобусным транспортом | 507,5 | 376,2 | 315,8 | 278,9 | 253,3 | 234,1 | 0 | 0 | 0 | 0 | 0 | 0 |

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dZ ^ebghc \ df

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Bkihevam_f \hjhyug f_lh^ jZkqzlZ Ij_^iheZ]Zy qlh
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aZdhgm

$$f(x) \quad \frac{1}{\sqrt{2V}} e^{\frac{(x \quad x_n)^2}{2V^2}},$$

]^_n o F1o F2)o± ijh_dlgZy hlf_ldZ dhgkhe_g__1
d\Z^jZlbq_kdh_ hldehg_gb_ nZdlbq_kdbo ihke_ fhgl
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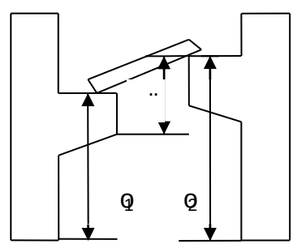


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=jZnZeh]•y wlZ \mqwgg_ ijZ ihqujd y^Zka_^m\Zdm_
]e_^`Zggy Z^exkljZ\Zggy † •f ydZkpy† • ik•o•qguo k
qZkZf iZ ihqujdm ijZ qZeZ_dZ fh`gZ ^Z_^ZppZ [hevr

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LZd gZijudujZ^d• \h^klmi• udf_lZ \ye•dZc iZ\Z]• ^Z
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Z^kmlgZkpv iZ\Z]• A •grZ]Z [hdm \mad• \h^klmi q
_evf• [e•ad•y ex^a• yd•y gZ iZ^k\y^hfuf majh†g• †`
Z^gZfm k\Zx iZ\Z]m

RujhdZ_ ijufyg_gg_ ]jZnZeh]•y agZcreZ † dZkf•c
:gZe•a aZi•kZ† ajh[e_guo dZkfZgZ†lZf• \Z †fh\Zo Z
iZezlZ† \udZjuklh†\Zyppkl•f_^ey Zpwgd• nmgdpuy
klZgm pwgljZevgZc g_j\h\Zc k•klwfu dZkfZgZ†lZ†
a^hevgZkpy† m pweuf

M djuf•gZe•klupu ]jZnZeh]•y \udZjuklh†\Z_ppZ
•^wglun•dZpu• Zkh[u ihqujd dh`gZ]Z qZeZ_dZ •
•g^u\•^mZe•vgy]h iZ^k\y^hfZkpv Ze_ • ^ey Zpwgd•
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kj_^kl\^ZhgghfmmqZkldm g_ dj_qurZebZ^m q_]h dhebq_
\u[jZku\Z_fuo \ Zlfhkn_jm aZ]jyagyxsbo _s_kl\ agZq
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g_gb_f LH kh\f_s_ggh_ ^bZ]ghklbjh\Zgb_ < wlhf k
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Kl_g^ ^ey ^bZ]ghklbjh\Zgby :DII \uiheg_gd\ lj_or
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hlebqZxs_]hky hl mklZgh\b\r_]hky agZq_gby
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^\b]Zl_ey kgb`Zxlky ijbf_jgh gZ ih kjZ\g_
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# THE STUDY OF START-UP MODES OF INDUCTION MOTORS

> G R:F D H
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The essence of the study is to identify the most effective method of start-up of the induction motor from the point of view of energy losses during the transition process. For the studies the most frequently used methods were selected, such as:

1) the direct start-up – this method consists of a direct connection of the motor to the source voltage.

2) the start-up with the step change of the supply voltage – the method consists in switching connection of the stator winding of the induction motor from the star to the triangle.

3) the start-up with a smooth change of the supply voltage – this method is implemented by using a thyristor voltage regulator, through which we can specify the law of variation of the voltages and obtain the desired character of transient processes.

4) the deterministic start-up – for the realization of the deterministic start-up you need to implement the alternating connection between the motor phases power supply.

5) the start-up with a smooth change of frequency of the supply voltage – management of the supply frequency by using the frequency converter, which allows you to obtain smooth and controlled start-up.

The study examines the impact on energy efficiency, not only of the chosen method of start-up, but also the influence of the parameters of the induction motor, of the laws of change of the supply voltage, etc. Therefore motors of various power were chosen for the research.

The whole study is performed by simulation modeling using software Matlab Simulink. This software allows us to obtain graphs of transient speed and torque, as well as a graph of energy losses.

The feasibility of this study is due to the global trends of reducing power consumption, improving production efficiency, reducing production prime costs. The future depends on the energy efficient technology



M > D

= B > J : < E B Q ? K D B C L : J : G B A H E H L G B D H < U C
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G Z m q g u c j m d h \ h ^ b l _ e v I N D H L B D H < d Z g ^ l _ o
; ? E H J M K K J D H K K B C K D B C M G B < ? J K B L ? L

= b ^ j Z \ e b q _ k d b _ k b k l _ f u i j b f _ g y x l k y \ i j h f w r e _ g g h
k d h f o h a y c k l \ _ G Z k h \ j _ f _ g g h f w l Z i _ k l Z g d h k l j h _ g b y
] b ^ j h k b k l _ f m d h l h j Z y h [ o h ^ b e Z k v [ u [ _ a a h e h l g b d h \ h
l _ e y A h e h l g b d h \ u c ] b ^ j h j Z k i j _ ^ _ e b l _ e v \ g _ c l j Z e v g h f a
i h j g h j _ ] m e b j m x s b f w e _ f _ g l h f k h e l g b d h \ A h e h l g b d h \ m k l j h
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q Z k l b h l g h k b l _ e v g h h d h g \ i h \ _ j o g h k l b i h d h l h j h c h
k l \ _ a h e h l g b d Z q Z s _ \ k j e h m g \ u i k l j m f Z g b g h ] h ^ b Z < f _ l j Z
i j h k l _ c r _ f k e a h e Z _ f h d _ l a Z g b f Z l v i h a b p b b < g _ c l j
i h e h ` _ g b b i h d Z a j Z b k g h f d g Z Z e u j Z k i j _ ^ _ e b l _ e y ^ a Z i _ j l u
d h k l v i h k l m i Z _ l h l g Z k h k Z g b \ h ] g m j h b a e i h e h k l d _ c
h k l Z z l k y \ i h d h _ l j b k f _ s _ g b b j a Z [ e h q Z y b d Z ^ h d a Z l v
g Z e Z f \ d h j i m k _ j Z k i j _ ^ _ e b l _ e y b i h l j m [ h i j h \ h ^ Z f i h k
e h k l v ] b ^ j h p b e b g ^ j Z b r l h d \ u ^ \ b ] Z _ l k y k f ? k e b d v ` _ a
\ i j Z \ h h l g _ c l j Z e v g h ] h i h e h ` _ g b y l h j Z [ h q Z y ` b ^ d h k l
m ` _ \ i j Z \ m x i h e h k l v ] b ^ j h p b e b g ^ j Z Z b a e _ \ h c i h e h
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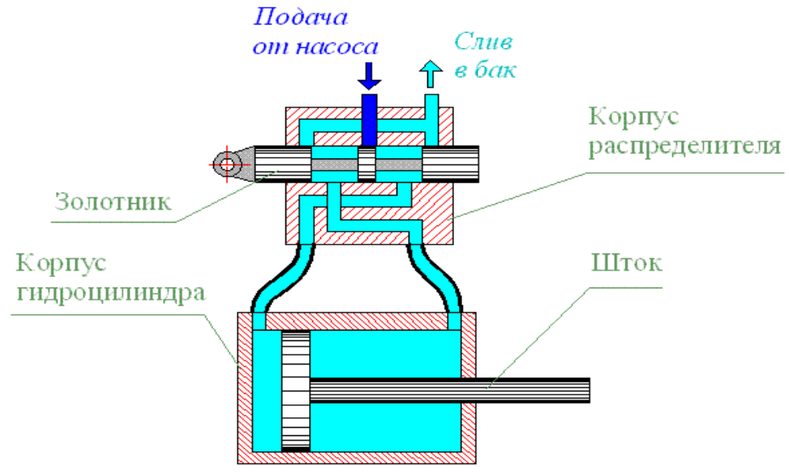


J b . 1. A h e h l g b d h \ u c ] b ^ j h j Z k i j _ ^ _ e b l _ e v \ g _ c l j Z e v g h f i h

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kbeu ly`_klb ba ©iblZxs_]hª j_a_j\mZjZ gZijbf_j ba
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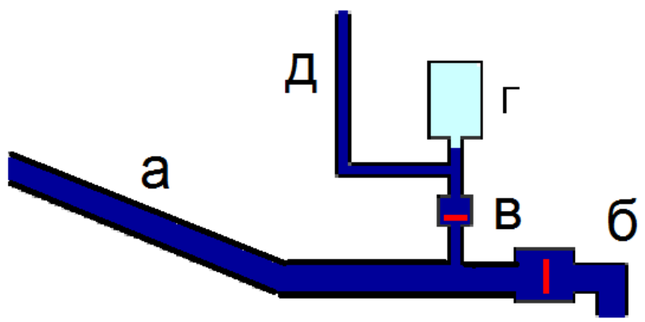


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< gZklhys__jZajZ[gkZhkh[ i_j_jZ[Zlu\Zlv hibedb \ k
Zevgu_ [jbd_lu b i_ee_lu ^ey ibjhebaghjbk kihkh[Z k`b
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ij_kkZ dZeh]h k ih^ij_kkh\sbdhf < wdki_jbf_gl_ hilb
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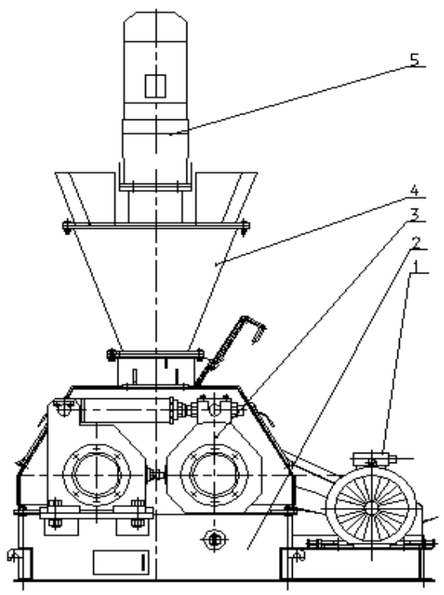


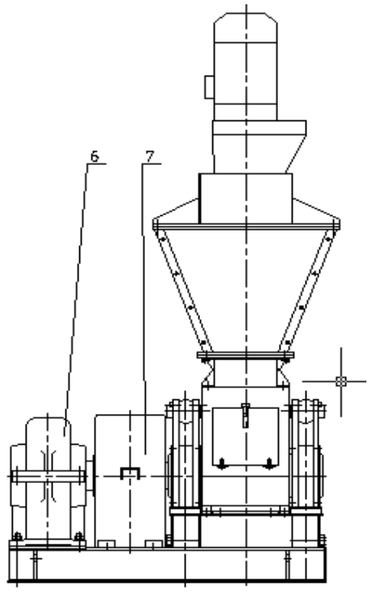


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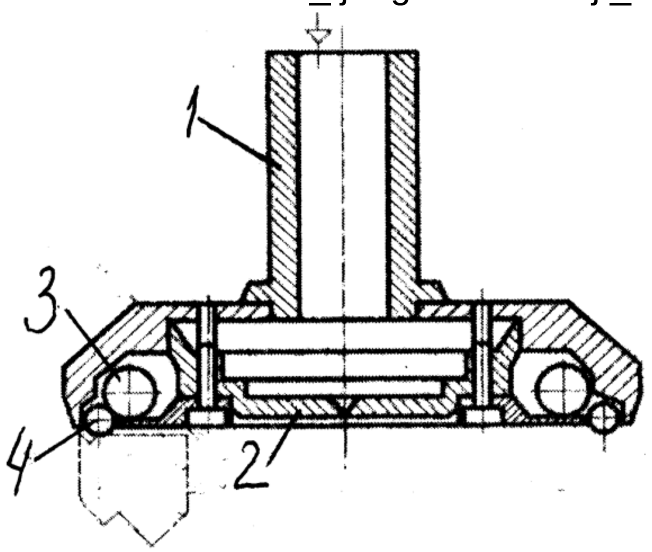

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Ih iblZxs_c ljm[_ : ihklmiZ_l \h^Z jZa]hgyykv ^h ijb dhlhjhc hl[hcguc deZiZg ; m\e_dZ_fuc ihlhdhf \h mkbeb_ k\h_c ijm`bgu b aZdju\Z_lky i_j_dju\Z klhd gh\e_gghc \ iblZxs_c ljm[_ ]b^jZ\ebq_kdbc m^Zj j_adh_ m\_ebq_gb_ ^Z\e_gby \ ljm[hijh\h^_ j_adh_ hklZgh\bl_ kdhjhklb ^\b`_gby kj_^u \ ljm[hijh\h^_ h[jZamvrhc ijhf_`ml \j_f_gb >Z\e_gb_ ]b^jhm^ZjZ ij_h^he_\Z_l ^Z\e_gb_ ^ys_c ljm[_ > \ha\jZlguc deZiZg < hldju\Z_lky b qZ s_c ljm[u : ijhoh^bl q_j_a g_]h b ihklmiZ_l \ hl\h^ysm guf h[jZahf mlhqgy_l dheiZd = ihkdhevdm bg_jpby fZk \h^ys_c ljm[_ > ij_iylkl\m_l lZdhfm [ukljhfm _bfimev gbx <h^Z \ iblZxs_c ljm[_ hklZgh\e_gZ ^Z\e_gb_ i klZlbq_kdhc \_ebqbg_ \ha\jZlguc deZiZg aZdju\Z_lky hldju\Z_lky <h^Z \ iblZxs_c ljm[_ gZqbgZ_l ^\b]Zlvky jyykv Z \ wlh \j_fy ih^ ^Z\e_gb_f \ha^moZ iZ^`Zlh]h d_ ihklmib\rZy \ g_]h ihjpby \h^u ijh^Z\eb\Z_lky \ LZdbf h[jZahf kbkl_fZ \ha\jZsZ_lky \ bkoh^gh_ iheh`_gb_ \uc pbde jZ[hlu
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<ukhdhl_ogheh]bqgu_ kh\j_f_ggu_ fZl_jbZeu fh]m ijh^e_\Zlv kjhd kem`[u ]b^jZ\ebq_kdh]h lZjZgZ Z lZ jZajmr_gbx \ ijhp_kk_ wdkiemZlZpbb
=b^jZ\ebq_kdb_ lZjZgu fh]ml ijbf_gylvky \ dhgklZmdpbx jblgu_ jZaf_ju wlh iha\hey_l g_dhlhjuf ij_^klZ\bl_ey kh kdhjhklvx ^h e k

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LZdbf h[jZahf bkihevah\Zgb_ fh^_eb ^hjh]h \ eh]bklb kdhc kbkl_fu \hey_l khdjZlblv aZljZlu b ih\ukblv wnn_ mijZ\e_gby





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>ey k]eZ`b\Zgby \uy\e_gghc \ oh^_ ZgZebaZ g_jZ \uo i_j_\hahd ij_^ijbylbx j_dhf_g^m_lky ijh\_^_g ZgZebaZ ljZgkihjlghc jZ[hlu ^ey \uy\e_gby g_jZ\ghf i_j_\hahd ijh\_^_gb_ j_deZfguo Zdpbc gZ hkgh\_ bk f_glh\ ^bj_dlZ b fZjd_lbg]Z \ Bgl_jg_l_ iml_ hnbpbZevgh]h kZcbZ b gZ hkgh\_ ijbgpbhgghc kbkl_fu mijZ\e_ ahi_j_\hadZfb dhlhjZy iha\hebl \u[jZlv hilbfZevgu_ gby hkms_kl\eylv dZevdmeypbx \k_]h ijhp_kkZ i_j_ jZkq_lu k ]jmah\eZ^_evpZfb b ^j jZajZ[hlZlv kbkl_f dh]^Z gZ[ex^Z_lky gZb[hevrZy g_jZ\ghf_jghklv ]jmah\uo evx ijb\e_q_gby djmiguo ]jmah\eZ^_evp_\ b m^_j`Zgb hldjulb_ dj_^blghc ebgbb ^ey ihklhygguo deb_glh\

>Zggu_ f_jhijbylby iha\heyl ih\ukblv dZq_kl\h hdZau\Z_ ijb\e_qv ]jmah\eZ^_evp_\ knhjfbjh\Zlv ihehh`bl_ KHHH ©Fh]be_\\g_rljZgkª qlh [m^_l kihkh[kl\h\Zlv jZ\ghf_jghklb ]jmah\uo i_j_\hahd

## F ? L H > B D : H P ? G D B D : Q ? K L < : G : E H = H < H = H : > F B G B K L J B J H < : G B Y < J ? K I M ; E B D ? ; ? E : J M K V

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j h \ _ g v Z ^ f b g b k l j b j h \ Z g b y g Z e h ] h \ h c M : G K k b k l a m _ l k l _ i _ g v j Z k o h ^ h \ w d h g h f b d b g Z k h ^ _ j ` Z g b _ b g k k l _ f Z ] h j k h \ Z

d w n n b p b _ g l d Z q _ h j h \ Z u o g Z _ n h j f D D G J o Z j Z d l _ j \ g h k b f u _ b a f y g \ _ g Z e h ] h \ h _ a Z d h g h ^ Z l _ e v k l \ h

j g l Z [ _ e v g h k l v g Z e h ] h \ h c k b k l _ f u J G K o Z j Z d l _ a Z h l q _ l g u c i _ j b h ^ ^ h o h ^ h \ [ x ^ ` _ l Z d h g l j h e b Z j m _ f u o g h f d b \ q e g _ b a ^ _ j ` _ d \ a b f Z g b y g Z e h ] h

j h \ _ g v g Z e h ] h \ u o k Z g d p b c \ [ x ^ ` _ l _ M G K j Z k k i h d Z a Z l _ e v ^ h e b w d h g h f b q _ k d b o k Z g d p b c b Z ^ f b g b k l g Z e h ] h \ u f i j Z \ h g Z j m r _ g b y f \ ^ h o h ^ Z o d h g k h e b ^ b j h \ d h g l j h e b j m _ f u o g Z e h ] h \ u f b h j ] Z g Z f b

D Z ` ^ u c b a i _ j _ q b k e h d Z a Z l _ e _ c ^ Z _ l h ^ g h k l h j h g g x k h \ _ j r _ g k l \ h \ Z g b y g Z e h ] h \ h ] h Z ^ f b g b k l j b j h \ Z g b y H ^ g l b a f _ g _ g b b d Z q _ k l \ Z g Z e h ] h \ h ] h Z ^ f b g b k l j b j h \ Z g b y k ^ d Z f a Z l j m ^ g b l _ e v g h

l h w l h f m ^ e y d h f i e _ d k g h c h p _ g d b d Z q _ k l \ Z j h g Z e h ] h \ Z g b y \ ^ Z g g h c j Z [ h l _ i j _ ^ e Z ] Z _ l k y b k i h e v a h \ Z l v b g l _

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B g l _ ] j Z e v g u c i h d Z a Z l _ e v m d Z a u \ Z _ l g Z l h q l h d Z ^ f b g b k l j b j h \ Z g b y i j Z d l b q _ k d b g _ b a f _ g b e h k v i j h \ h j _ n h j f g _ ^ h k l Z l h q g h





## B A M Q ? G B ? B I J H = G H A B J H < : G B ? K I J H K : G : L J : G K I H J L G U ? M K E M = B

## < < ; H C Q M D G Z m q g u c j m d h \ h K b l @ e v J B < D H < d Z g ^ l ^ b g g Z m d ; ? E H J M K K J D H H K K B C K D B C M G B < ? J K B L ? L

< j u g h q g h c w d h g h f b d _ \ u ` b \ Z x l b m k i _ r g h n m g d p b l _ i j _ ^ i j b y l b y h j u _ k h b a f _ j y x l k \ h b ^ h o h ^ u k a Z l j Z l Z f b \ e h ` _ g g h ] h d Z i b l Z e Z > h [ b l v k y w l h ] h k h h l g h r _ g b y g _ y g g h ] h d h g l j h e y a Z k i j h k h f > e y ± f b Z k g h l g b y [ h k h i k l h y g g h ] h g Z [ e x ^ _ g b y ^ _ l Z e v g h ] h b a m q _ g b y b \ h a ^ _ c

< o h ^ b k k e _ ^ h \ Z g b y [ u e b b a m q _ g u i h d Z a Z l _ e b j Z [ i j _ ^ i j b y l b y H : H © A _ g b l ª ^ _ y l _ e v g h k l v d h l h j h ] l h g Z i j Z d m b i j h b a \ h ^ k l \ h j Z ^ b h l _ o g b q _ k d h c Z i i Z j Z l m j u

> Z g g u c Z g Z e b a i h a \ h e b e m k l Z g h \ b ] l v k g d h \ g Z y ^ _ y l _ e v g h k l v h j ] Z g b a Z p b b [ u e Z w n n _ d l b \ g Z g Z q i j b [ u e b h l j _ Z e b a Z p b b i j h ^ m d p b b l _ j _ \ h a d b h i j _ ^ i j b y l b _ f g _ \ k _ ] ^ Z w n n _ d l b \ g u l h w l h f m i j _ ^ i j b j Z k k f h l j _ l v \ h a f h ` g h k l b f h ^ _ j g b a Z p b b Z \ l h g Z b j y d Z b h [ j Z l g u o j _ c k h \ B a m q b \ k i j h k g Z m k e m ] b k e _ ^ m _ l h g _ k l Z [ b e v g u c o Z j Z d l _ j

l j h \ _ ^ z g g u _ b k k e _ ^ h \ Z g b y i h a \ h e y x l ] h \ h j b l v h l h f h j ] Z g b a Z p b h g g h c k l j m d l m j u H : H © A _ g b l ª i h a \ h e b l i j w n n _ d l b \ g h h j ] Z g b a h l m Z l v B k Z j h ^ y b a j Z k q z l h \ h q _ \ b ^ g Z b [ h e _ _ w n n _ d l b \ g u f b k i h k h [ Z f b l j Z g k i h j l b j h \ d b ] d h e v p _ \ h c f Z j r j m l l h ^ \ b ` g h c k h k l Z \ i j _ ^ i j b y l b y l j _ [ m _ D h f i Z g b b [ m ^ _ l \ u ] h ^ g _ c i j b h [ j _ k l b g h \ u _ l j Z g k i h j l g e b a b g ]

K p _ e v x d j Z k s _ g b y k j h d Z h d m i Z _ f h k l b g h \ h ] h i h ^ \ b ` g i j b \ e _ q _ g b y ^ h i h e g b l _ e v g u o d e b _ g l h \ i j _ ^ e Z ] Z _ l k y m k e m ] h m d Z a Z g b _ ] j m a h \ u o i _ j _ \ h a h d g Z k _ e _ g b x > e y \ ^ Z g g u c \ b ^ m k e m ] b [ u e b i j h \ _ ^ _ g u h i j h k u g Z k _ e _ g b y

< j _ a m e v l Z l _ i j h \ _ ^ z g g u o b k k e _ ^ h \ Z g b c [ u e h \ u y \ e i _ j _ \ h a d b y \ e y x l k y \ h k l j _ [ h \ Z g g u f b H i j h k i h d Z a Z e q l _ j b y f b i j b \ u [ h j _ i _ j _ \ h a q b d Z y \ e y x l k y p _ g Z [ k h o j Z g d Z y k b k l _ f Z k d b ^ h d d h l h j u _ \ k \ h x d h g q d _ j _ g l g u f e y x i j _ b f m s _ k l \ Z f b i j _ ^ i j b y l b y H : H © A _ g b l ª w d k i _ j l h \ ^ Z g g \ b ^ m k e m ] b i h a \ h e b l n b j f _ a Z g y l v a g Z q b ± _ e v g m b x ^ h e x m \ _ e b q b l v i j b [ u e v g Z q l h \ ^ _ g _ ` g h f w d \ b \ Z f e g j

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$$K_i = S_{oi}\, x_i\, k_{win}$$

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M>D

HP?GD: B KH<?JR?GKL<H<:GB? EH=BKLBQ?KDHC K

HJ=:GBA:PBB =JMAHI?J?<HAHD

< LJ:GKIHJLGHC HJ=:GBA:PBB

X H LMKLH<:

GZmqguc jmdh\h^bl_ev ;?=J?G?<BQ wdhg^ gZmd ^hp

;?EHJMKKDHH KKBCKDBC MGB<?JKBL?L

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H[t_dlhf bkke_^h\Zgby klZeh ljZgkihjlgh_ hj_^ijbyl ]be_\\g_rljZgk[a]

Dexq_\h_ f_klh ijb hj]ZgbaZpbb i_j_\hahd gZ ^Z aZgbfZ_l kem`[Z fZjd_lbg]Z b wdkiemZlZpbb ;ueb jZ fu_ hl^_ehf f_jhijbylby ih hj]ZgbaZpbb i_j_\hahd gh ebjh\Zgbx k[uIZ ljZgkihjlguo mkem] ^ZgZ hp_gdZ km hieZlu ljm^Z jZ[hlgbdh\ ^Zggh]h ih^jZa^_e_gby

GZ ij_^ijbylbb ih khklhygbx gZ f_bxevky k]_^_evgu ly]Zq ]jmahih^t_fghklvx \ kj_^g_f l H[sbc nhg^ jZ Z\lhdhehggu aZ b.xeh klZ\ey_l Z\lhfh[bey be 188 Z\lhfh[be_kh\ KZfufb wnn_dlb\gufb Z\lhfh[beyfb y ^_evgu_ ly]Zqb fh^_e_c %0(5&('(6/6 b 0$11 7*O Z kZfufb g_wnn_dlb\gufb ^_evgu_ ly]Zqb F-8A20 <b MERCEDES-BENZ 1841LS.

<k_]h i_j__a_gh ]jmaZ gZ jZkklhygb_ df \LjZgkihj gZy jZ[hlZ ij_^ijbylby aZkbxel klZ\beZ] ldf <f_kl_ k l_f m_ebqbe ^gkyv kj_evghklv i_j_\hadb l]jmaZ Khdj ]h ihdZaZl_ey \hafh`gh iml_f memqr_gby ijhp_kkZ lj ah\ ihkj_^kl\hf \g_^j_gby eh]bklbq_kdbo fh^_e_c oh e_gby

>ey kh_jr_gkl\h\Zgby eh]bklbq_kdhc kbklhfu hj]Z ahd gZ ij_^ijbylbb [ueb jZajZ[hlZgu ke_^mxsb_ f_jhij k^_evghc kbkl_fu hieZlu ljm^Z jZ[hlgbdh\ kem`[u fZj lZpbb jZajZ[hldZ kbkl_fu ijh^\b`_gby ij_^eZ]Z_fuo ij ih i_j_\had_ ]jmah\ jZkrbj_gb_ ydby gilmkju^ikhl\hifbij _^_gby j_deZfghc dZfiZgbb jZajZ[hldZ fZjrjmlh\ k _fguo oZjZdl_jbklbd Z\lhfh[be_c Z lZd`_ ihimlghc b ljZgkihjlgh]h kj_^kl\Z k_^aZef_gh]h ly]ZqZ F-8A20-031 < gh\uf ]jmah\uf Z\lhfh[be_f LE-55 '$) Kjhd hdmiZ_fhklb gh\h] lhfh[bey khklZ\bl e_l



M>D

:G:EBA H;?KI?Q?GBY ;?AHI:KGHKLB ><B@?GBY < L

<J?FY KMLHD G: MEBP? H=EBP?E?<:

: : ;MLJ:F?GDH B<:GH<

GZmqguc jmdh\h^bl_ev IHEYDH<:

;?EHJMKKDHH KKBCKDBC MGB<?JKBL?L

H^ghc ba \Z`g_crbo aZ^Zq ^hjh`ghc hljZkeb \ gZkl _lky h[_ki_q_gb_ [_ahiZkguo mkeh\bc ijh_a^Z ^ey \k gby Mjh_gv Z\Zjbcghklb aZ\bkbl hl fgh`_kl\Z nZdlh \u^_eblv \_s_gghklv ihdjulby Z\lhfh[be_c khklhygb_ b agZqbl_evguc h[t_f ^\b`_gby \ l_fgh_ \j_fy kmlhd ij >LI < wlh \j_fy kmlhd hkh[_ggh ih\urZ_lky hiZkghklv _ehkbi_^bklh\

<hijhkZfb hk_s_gby Fh]be_\kdh kdh_ dhffmgZevgh_ ijg^ijbylb_ ©=hjk_l[a] >ey hk_s_ ]hjh^Z \ gZklhys__ \j_fy bkihevamxlky jZaebqgu_ lbi jlmlgu_ ]Zeh]_gh\u_ k_lh^bh^gu_ < ]hjh^_ I_hfkem jZkoh^m_lky \ kj_^g_f aZ lfej^ gZ hieZlm ]hhk_dljhwg klZ\eyxl fej^

;ueh ijh_^_gh bkke_^h\Zgb_ hk_s_gghklb gZ ^hjh`g ^\mo mebpZo ij lmfZ lbklZevgZy mebpZ h[s_]hjh^kd qgby dZl_]hjbb : b [mev\Zj Gmeehlj fgkgh]h agZq_g l_]hjbb < k bkihevah\Zgb_f dkfbln ©xLDk[a] Dhgljhe gufb lhqdZfb [ueb gZagZq_gu i_r_oh^gu_ i_j_oh^u mebp f_`^m klhe[Zfb hk_s_gby Baf_j_gby ijh\h^beb [hevrh]h kg_`gh]h ihdjh\Z b \ kmomx ih]h^m

Ihke_ ZgZebaZ ihemq_gguo \Zgguo k^_eZgghklv ^hjh`gh]h ihdjulby gZ h[_bo mebpZo g_ khhl\_lkl\m_l lb\guo ^hdmf_glh\ ke_^h\Zl_evgh [_ahiZkghklv mqZ h[_ki_q_gZ < lh `_ \j_fy kms_kl_ggh_ \ebygb_ gZ ghklb ihdjulby hdZaZeh ]jZgbgh ihdjh\Z b [ebahk _dlh\ k gZjm`guf hk_s_gb_f b j_deZfhc

GZ gZr \a]ey^ ^ey ih\ur_gby [_ahiZkghklb ^\b`_g `blv jy^ f_jhijbylbc jZaebqghc gZijZ\e_gghklb kh_j kl_f hk_s_gby kZfbo ljZgkihjlguo kj_^kl\ hk_s_g hiZkguo mqZkldh\ ^hjh] bkihevah\Zgb_ ^hjh`guo agZ khdhc bgl_gkb\ghklvx k_lh\ha\jZs_gby hk_s_gb_ b ^j

M>D

FH>?JGBA:PBY WH KL:GPBB G:EB<: L?FGUO G?NL?IJH>MDLH<

F K <:KBE?GDH

GZmqguc jmdhEh^bl_e?JG:Y dZg^ l_og gZmd

;?EHJMKKDHH KKBCKDBC MGB<?JKBL?L

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>ey gZ[ex^_gby aZ bq_kdbf ijhp_kkhf \ j_`bf_ j_Z \j_f_gb j_]mebjh\Zgby hkgh\guo iZjZf_ljh\ ljm[hijh\h^Z mjh\g_c \ j_a_j\mZj_jZajZ[hlZgZ bgn-mjfZpbhyyZy kmi_j\bahjgZy ZblhfZlbaZpbb [ZahjZffgh]h h[_ki_q_gby SCADA-TRACE MODE v. 6 k bkihevah\Zgb_f fh^me_c b^_glb IDNT b Z^Zilb\gh]h j_]meylhjZ APID, hlh[jZ`_gb_ bgnhjfZpbb \u\h^blky gZ wdjZg ijhfure_ggh]h dhfivxl_jZ

L_gheh]by Z^Zilb\gh]h mijZ\e_gby h[hjm^h\Zgbyf hj]ZgbaZ \ukhdhdZq_kl_ggh]h mijZ\e_gby kdbfb ijhp_kkZfb hkgh\ZggZy gZ bkihevah\Zgbb gh_crbo f_lh^h\ b^_gl h[t_dlh\ f_lh^Zo Z^Zilb\gh]h b fh^Zevgh]h mijZ\e_ h[t_dlh\ b f_lh^Zo hilbfbaZpbb gZkljh_d j_]meylhj l_ogheh]bb iha\heyxl ihegZlkvxh\Zlvf ijhp_kk gZkljh Z\lhfZlbq_kdbo j_]meylhjh\ ^ey rbjhdh]h deZkkZ ijhfu mijZ\e_gby k aZiZa^u\Zgb_f Hgb bkdexqZxl bkihevah\Zgby h[uqguo f_lh^h\ b^_glbnbdZpbb ^bg f_lh^h\ jmqgh]h \u[hjZ b jZkq_lZ iZjZf_ljh\ gZkljhc j_]meylhjh\ Djhf_ wlh]h \ kZfbo j_]meylhjZo bki kh_jr_ggu_ ih kjZ\g_gbx k lbih\ufb IB> aZdhgZf mijZ\e_gby Bkihevah\Zgb_ wlbo Ze]hjblfh\ k hilbfZe bo gZkljhcdb b h[_ki_qb\Z_lZq_kl\h ijhp_kkh\ mijZ\ h[t_dlZfb gZ \k_f wlZi_ bo ^Zevg_cr_c wdkiemZlZp ^Z\e_gby \ ljm[hijh\h^_ hkms_kl\ey_lky k ihfhsvx we_dljhijb\h^Z i_j_f_ggh]h lhdZ hl ij_h[jZah\Zl_ey ^hklb`_gbb djblbq_kdbo iZjZf_ljh\ kbkl_fZ ijhlb\hZ\Zjb Z\lhfZlbq_kdhc h[_ki_qbl [_ahiZkgmx b bkihegbl_evg f_oZgbafh\ gZkhkZ b hlk_qguo deZiZgh\ k dhgljhe_ khklhygby



M>D

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> B LJ?LVYDH<:

GZmqguc jmdh\h^bl_eb–JBG F<BQ dZg^ wdhg gZmd

;?EHJMKKDHH KKBCKDBC MGB<?JKBL?L

P_gZ y\ey_lky fhsguf b ]b[dbf fZjd_lbg]h\uf bgkl ihevah\Zgb_ dhlhjh]h iha\hey_l agZqbl_evgh ih\ukbl n_dlb\ghklv ^_yl_evghklb ij_^ijbylby LsZl_evgZy j ihebldb\b bZ`g_crZyqZZ^jZ_^ijbylby

Bkke_^h\Zgby ijh\h^bebkv gZ hkgh_ nbebZeZ :\lh H:H ©Fh]be_\h[eZ\lhljZgk»

:gZeba nZdlhjh\ \gmlj_gg_c kj_^u ijhSWOT-gguc \ ZgZebaZ ihdZaZe qlh :\lh[mkguc iZjd ‹ bf__l g_m ihdZaZl_eb \ hlZjZkeb]Z gbadbc mjh_gv gbakdZy b\Z wnn_dlb\ghklv; @_BHD_ZymlZpby \ hlghr_gbb d_dZq_kl\Z khdZy wnn_dlb\ghklv ijh^m^mkgh]jZkih_h^hkdZlh gZy j_deZfZ ijb\h^bl d iZ^_gbx mjh\gy ijh^Z` mkem] l_ d kgb`_gbx kijhkZ Bkoh^y ba wlh]h fh`gh ^_eZ r_gkl\_ p_gh\hc ihebldbdb Hkgh\gZy p_ev ±mh\bemkgh]h qblv aZgbfZ_fmx ^hex jugdZ ljZgkihjlguo mkem] ] aZdj_iblvky gZ g_c Wlh \hafh`ghqe_b_ymgh\ijbbe_ lh\

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GZ hkgh_ Zgd_lbjh\Zgby deb_glh\ :\lh[mkgh]h iZ ^_gghSWOT-ZgZebaZ [ueb \uy\e_gu hkgh\gu_ ijh[e_fu mkem] :\lh[mkgh]h iZjdZ ‹

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< j_amevlZl_ [ueb ij_^eh`_gu gZijZ\e_gbykh_jr_ \hc iheblbdb hj]ZgbaZpbb gZijZ\e_gb_ gZ aZ\h_\Zgb aZl_eyf dZq_kl\Z kh_jr_gkl\h\Zgbkl_fu kdb^dh\ gZ[_ eba p_gh\hc weZklbqghklb h[hkgh\Zgb_ kbkl_fu kdb^

F H = B E ? < K D : Y H ; E ± K L E V ? L I H K E ? : < : J B B
G : Q ? J G H ; U E V K D H K H C : W

: < L J ? L V Y D H < :
G Z m q g u j m d h \ h ^ b L _ e : = ? ? < : d Z g ^ \ _ l ; g Z m d ^ h p
H I ; ? E H G H = H < :
; ? E H J M K K D H H K K B C K D B C M G B < ? J K B L ? L

Z i j _ e y ] b k i h e g b e h k v e _ l k f h f _ g l Z Z \ Z j b b g Z
k d h c : W K W l h [ u e Z k Z f Z y d j m i g Z y l _ o g h ] ^ g Z y d Z l
f Z k r l Z [ g h f m a Z ] j y a g _ g b x l _ j j b l h j b b e d h j h l h h b f b j Z ^ b
g m d e b ^ Z f b b g Z g _ k r Z y h ] j h f g u c m s _ j [ g Z r _ c j _ k i m [ e b
F h ] b e _ \ k d h c h [ e Z k l b j Z c h g h \ \ j Z a g h c k l _ i _ g b [ u e b
` b \ m s b f b j Z ^ b h g m d e b ^ Z f b H [ s Z y h s Z ^ v a Z ] j y a g _ g b y
i e h l g h k l v x [ h e _ _ [ h e _ _ d f Db k h d k l Z \ e y e Z b e b d f
l j _ l v y q Z k l v h [ e Z k l b A Z ] j y a g _ g b _ e h f _ e h \ Z e v g u c o Z j
f _ g _ _ l _ j j b l h j b b e h l g h k l v a Z ] j y a g _ g b y \ h k g h \ g h f
d ; d (0 f D b ) d K g Z b [ h e _ _ a Z ] j y a g _ g g u o l _ j j b l h j b c h [
h l k _ e _ g h g Z k _ e _ g g u o i m g d l Z
A Z i h k e _ Z \ Z j b c g u _ ] h ^ u i j h b a h r _ e h ^ b g i _ j b h ^ i h
m d Z a Z g g u o j Z ^ b h g m d e b ^ h \ i e h l g h k l v a Z ] j y a g _ g b y \ h
j Z a l e h s Z ^ b a Z ] j y a g _ g b y K V \ j Z a Z b k h k l Z
7,48 d f b e b 25,8 %). B a h [ s _ c i e h s Z ^ b a Z ] j y a g _ g g h c j Z ^ b h
g Z b [ h e v r b c m ^ _ e v g u c a Z g b f Z x l a _ f e b ] ^ _ i e h l g h k l v a
g b y K V d h e _ [ e _ l k y h l ^ h A _ f e D b k d f a Z ] j y a g _ g b _ f h l
D b d f h k l Z \ e y _ l 24,7 h l ^ h D b 70,1 %.
< g Z k l h y s _ _ \ j _ f y \ a h g _ j Z ^ b h Z d l b \ g h ] h a Z ] j y a g _
g Z k _ e _ g g u o i m g d l Z g i ] ^ _ i j h ` b \ Z _ l l u k q _
i h k e _ ^ m x s _ ] h h l k _ e _ g b y i e h l g h k l v a Z ] j y a g _ g b y i h
D b d f h k l Z e h k v l h e v d h l j b g Z k _ e _ g g u o i m g d l Z \ a h
e _ g b _ h l ^ h ) ± D b d f \ a h g _ i j h ` b \ Z g b y k i _ j b h ^
j Z ^ b Z p b h g g u f d h g l j h e _ f h l ) ± ^ h g i D b d f j Z \ g _ g b x k
.] \ k \ y a b k l _ k l \ _ g g u f j Z k i Z ^ h f j Z ^ b h g m d e b ^ h \ q b
g u o g Z k _ e _ g g u o i m g d l h \ k h d j Z l b e h k v \ j Z a Z q b k
j Z a Z G Z l _ j j b l h j b b ; h [ j m c k d h ] h b D j m ] e y g k d h ] h j
© ] j y a g u o g Z k _ e _ g g u o i m g d l h \
J Z ^ b Z p b h g g Z y k b l m Z p b y g Z l _ j j b l h j b b [ e Z k l b
[ e b a b j h \ Z e Z k v l g u _ f _ j h i j b y l b y i j h \ h ^ b f u _ \ k _ e v k d h
i h a \ h e b e b k \ _ k l b d f b g b f m f m i j h b a \ h ^ k l \ h i j h ^ m d p b b
l j _ [ h \ Z g b y f j Z ^ b Z p b h g g h c [ _ a h i Z k g h k l b ^ h e b _ ] h ^ u
l _ j j b l h j b y h [ e Z k l b [ m ^ _ l h k l Z \ Z l v k y a Z ] j y a g _ g g h c j Z ^





F H > ? E V K B K L ? F U I J H = G H A B J H < : G B Y G : I J : < E ? G B Y L
: D P B B C : G N H G > H < H F J U G D ?

F < < : K B E V ? < F : J B G K D B C L : @ ? G H <
G Z m q g u c j m d h \ h ^ b l _ e v K ? B G D H H Z g ^ l _ o g Z m d
; ? E H J M K K D H H K K B C K D B C M G B < ? J K B L ? L

< k h \ j _ f _ g g u o m k e h \ b y o w n n _ d l b \ g Z y j Z [ h l Z g Z h j
d _ p _ g g u o [ m f Z ] i j _ ^ i h e Z ] Z _ l m i j Z \ e _ g b _ l _ o g h e h ] b c Z
b i j h ] g h a Z d h e b q _ k l \ _ g g u o o Z j Z d l _ j b k l b d n h j f b j h \ Z g b y
i h e v a h \ Z g b _ i j b d e Z ^ g h ] h i j h ] j Z f f g h ] h h [ _ k i _ q _ g b y Z k _ g Z f Z l _ f
k d b o b g n h j f Z p b h g g u o l _ o g h e h ] b c h j b _ g l b j
n h j f b j h \ Z g b _ b w n n _ d l b \ g h _ b g \ _ k l b p b h g g u f i h j l n _ e
i h \ u r Z x s b f k y m j h \ g _ f h j ] Z g b a Z p b b j u g d Z b ` _ k l d h c d h g
[ Z g d h \ b g \ _ k l b p b h g g u o n h g ^ h \ b d h f i Z g b c a Z d e b _ g
i h e v a h \ Z g b _ Z ^ _ d \ Z l g u o k l j Z l _ ] b c m i j Z \ e _ g b y d Z i b l Z e
a Z ^ Z q _ c
K b g l _ a b j h \ Z g g u c n b g Z g k h \ u c b g k l j m f _ g l i j h ^ m k l Z \ e
d m i g h k l v Z d l b \ g h c b g \ _ k l b p b h g g h c k l j Z l _ ] b b m i j Z \ e _ g
\ Z g g h c g Z i j h ] g h a g h c f h ^ _ e b b p _ g g h c [ m f Z ] b \ h l g
s _ k l \ e y _ l k y i j b g y l b _ b g \ _ k l b p b h g g u o j _ r _ g b c k h h l \
g h c k l j Z l _ ] b _ c
I h k d h e v d m d Z q _ k l \ h i j h ] g h a Z f h ^ _ e b \ [ h e v r b g k l \
h l _ _ g Z k l j h c d b i h \ o h ^ g u f ^ Z g g u f o Z j Z d l _ j b k l b d b k
k l j m f _ g l Z f h ] m l b a f _ g y l v k y \ a Z \ b k b f h k l b h l \ u [ j Z g g h
k l j m f _ g l h k g h \ Z g g u c g Z ^ Z g g u o f h ^ _ e b [ h e _ _ l h q g u _ i j h ] g h a
^ _ f h g k l j b j h \ Z l v e m q r b _ d Z q _ k l \ Z
< ^ Z g g h f k e m q Z _ [ u e h i j b g y l h j _ r _ g b _ g _ h ] j Z g b q
] h \ h c k l j Z l _ ] b _ c Z b k i h e v a h \ Z l v d Z d f h ` g h [ h e v r _ <
e y _ l k y ^ h i h e g b l _ e v g Z y \ h a f h ` g h k l v \ u [ h j Z f h ^ _ e _ c ^ h l
k d h e v d b o l j _ g \ h o k l j Z l _ ] b c b j Z k q _ l Z j _ Z d p b b g Z h k
g u o k \ _ ^ _ g b c q l h i h a \ h e b l k b k l _ f _ \ u ^ Z \ Z l v _ s _ [ h e _ _
< b l h ] _ f u b f _ _ f k b g l _ a b j h \ Z g g u c i h j l n _ e v Z d p b c
l h q g h e b d \ b ^ g u g h \ h ` _ g _ f u f h ` _ f i j _ ^ k d Z a u
i h k e _ ^ m x s b f o _ ^ ` b j h \ Z g b _ f i h k j _ ^ k l \ h f i h p b h g h \ b k \
j b k d d b i j Z d l b q _ k d b d g m e x
D Z d b l h ] f h ` g h k d Z a Z l v q l h i j b f _ g _ g b _ k b g l _ a b
Z d p b c i h e m q _ g g h c [ e Z ] h ^ Z j y j Z a j Z [ h l Z g g h c f h ^ _ e b k
s b Z \ l h f Z l b a b j h \ Z g g u o k b k l _ f i h d Z a Z e Z ^ h k l Z l h q g h
G h g m ` g h h l f _ l b l v q l h k e _ ^ m _ l m \ _ e b q b l v d h e b q _ k l \
k b k l _ f _ ^ e y i h e m q _ g b y [ h e _ _ ] e Z ^ d h ] h j _ a m e v l Z l Z

M>D

IJBF?G?GB? KBGL?ABJH<:GGUO NBG:GKH<UO BGKLMF?GLH< G: NHG>H<U? JUGDB

F< <:KBEV?<: FJRBGKDBC

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;?EHJMKKDHH KKBCKDBC MGB<?JKBL?L

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economic indicators such as operating revenue and profit on sales tend to de-
FUHDVH 0RUHRYHU VDOHV SURILWDELOLW\ RI VI
VWHNV´ QHHG HG WKH SUR product portfolio and sales technique optimization.

According to the results of ABC-analysis of the product portfolio based on the sales volume criterion textiles, flour, manufactured goods, machinery and equipment, as well as textile machinery are in the greatest demand.

The results of ABC-analysis of the product portfolio based on the operating profit criterion have shown that some items, such as machinery and equipment, manufactured goods, textiles and textile machinery are the most profitable for the company.

According to the results of combined ABC-analysis based on the sales volume and operating profit criterions textiles, manufactured goods, textile machinery as well as machinery and equipment have become the absolute leaders and
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portfolio. For example, by excluding unprofitable items, such as grain, seeds and fodder for farm animals, the company could allocate the released funds for the purchase RI PRUH SURILWDEOH LWHPV IURP WKH JURX

Moreover, after implementation of the trade margin management software
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concluding sales contracts, the company demonstrated the client new trade margin scale, which motivated some customers to purchase larger quantities of
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profit have increased.



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ABC Analysis is a valuable tool to enable companies dealing with strategic cost management to measure the current status for their products management V\VWHP DQG ORRN IRU WKH ³ORZ KDQJLQJ IUXLW´ largest cost management benefits in the short term and mid-term periods.

The trade margin management task is solved by using the trade margin-management model, its main purpose being sales promotion. This model is based on three margin definition approaches: permanent contribution margin approach, target profit approach and linear trade margin definition approach.

The principle of permanent contribution margin approach is that the smallest item batch is sold with the maximal trade margin while the largest one is sold with the minimal trade margin. As a result, trade margin is calculated using the following formula:

$$L\frac{QM}{T}; L\frac{:XQ_{cWn}?XWI;PT_{c\_d}}{T} L\frac{:XQ_{c\_d}?XWI;PT_{cWn}}{T},$$

where TM ±trade margin, expressed in unit fraction; MP ±marginal income; P ± batch of items, expressed in procurement cost; TSEL ±transportation and storage expenditure level, expressed in unit fraction; Pmin, Pmax ±minimal and maximal batch of items, expressed in monetary terms; TMmin, TMmax ±minimal and maximal trade margin, expressed in unit fraction.

The principle of target profit approach is that the company determines the trade margin in each specific case. This is the main advantage of this approach. By reducing the size of item batch the firm obtains appropriate trade margin and discount. And trade margin is calculated using the following formula:

70 35 Â )&/ ±1, 76(/

where FCL ±the fixed costs level per unit procurement cost; PR ±profitability, expressed in unit fraction; TSEL ±transportation and storage expenditure level, expressed in unit fraction.

For calculation of trade margin by using the straight-line margin definition method one can apply the following formula:

$$L_{k\_v} F @\frac{XQ_{cWn}?XQ_{c\_d}}{T_{cWn}?T_{c\_d}} A® F_{kgl};$$

The practical application of these methods depends on the specific character of a particular company performance and implies that the following condition is met ±trade margin should exceed the aggregate level of fixed costs and transportation and storage expenditure:

TM > FCL + TSEL.

Actually, due to the wide spread and development of computer technologies most companies keep accounting by using program ³&(QWHUSULVH´ VR been designed the software product in the 1C development environment on the basis of these sales management method. This software product has been impl

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The main indicators of business performance for commercial enterprises are sales profit and profitability. But sometimes such companies may experience problems associated with profit and revenue decline or selling some products at a loss. This fact leads to the relevance of the research. Thus, the primary goal of the research is to develop the best techniques for the product portfolio optimization and the trade margin management.

The product portfolio optimization task is solved by using ABC method. ABC Analysis is a method of tiered inventory or product valuation that divides inventory/ products into categories based on cost per unit and quantity held in stock or turned over a period of time.

ABC Analysis allows managers to segregate and manage the overall inventory/products into three major groups in order to increase revenue and decrease costs. In terms of the Pareto Analysis, it separates the vital few from the trivial many.

³$´ FDWHJRU\ LWHPV JHQHUDO±20% of items overall inventory by item, but represent 80% of value of an inventory. By paying close attention in real time to the optimization of these items in inventory, a great positive impact is possible with minimal increase in inventory management costs.

³%´ FDWHJRU\ LWHPV 15% of items in inventory by item type, and about 15% of the value. These items can generally be managed through periodic inventory and should be managed with a formal inventory system.

³&´ FDWHJRU\ LWHPV Represent 65% of actual items but only 5% of the inventory value. Most organizations can afford a relatively relaxed inventory process surrounding these items. A typically inventory policy for these items consists of having only 1 unit on hand, and of reordering only when an actual purchase is made. This approach leads to stock out situation after each purchase which can be an acceptable situation, as the items present both low demand and higher risk of excessive inventory costs.

There are six basic steps to do ABC Analysis:

1) identify the objective for the analysis and determine success criteria;
2) collect data on the inventory under analysis;
3) sort inventory in decreasing order of impact;
4) calculate accumulated impact;
5) divide inventory into buy classes;
6) analyze classes and make appropriate decisions.





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H^gZdh f_oZgbafu \ZbfhbjfZh^bnbpbjh\Zggh]h_kehy b gby fhjnheh]bb h[jZ[Zlu\Z_fhc ih_joghklb ijb ijh_^_ h[jZ[hldb kh\f_klgh k Zahlbjh\Zgb_f \ iheghc f_j_ g_ \

Klhbl hlf_lblv qlh \ ]Zah\hc ieZaf_ dhee_dlb\gu_ _kvfZ \Z`gmx jhev [hevr_]h qbkeZ \hegh\uo b dhe_[Z ieZafu hkh[h]h \gbfZgby aZkem`b\ZxlgbadhqZklhlgu le_xs_f jZajy^_ b k\yaZggu_ k gbfb ijhp_kku fh^bnbd ^Z

LZd ijb ih^dexq_gbb hkpbeeh]jZnZ \ ko_fm ^\moih ijyfbl_ey y\eyxs_]hky bklhqgbdhf iblZgby le_Zxs_]h j ebkv dhe_[Zgby k qZklhlhc « d=p \ hij_^_e_gghc h^Z \uijyfe_ggh]h lhdZ

Ijh_^_ggu_ bkke_^h\Zgby ^Zxl ijZ\h ij_^ihe Z]Zlv lhd gZ dZlh^ ijb jZa\bbbijhb_[lZg_l bfimevkguc oZjZ ljb wlhf jZkl_l fZdkbfZevgZy dbg_lbq_kdZy wg_j]bby b \bkbl ]em[bgZ fh^bnbdZpbb ih_joghklb K ^jm]hc k gZ[ex^Z_fuc wnn_dl k\yaZg k-wlmd_ldhfhcfhh^bnbdZpbb _joghklb QZkklhlbZiZahg dhe_[Zgbc lhdZ le_xs_]h jZ kl\m_l ^bZiZahgm mevljZa\mdZ b wlm \aZbfhk\yav b mevljZa\mdh\Zy h[jZ[hldZ lZd`_ ijb\h^bl d ih\ur_gbx jhl_j^hklb ijhqghklb b baghkhklhcdhklb fZl_jbZeh\



M > D
K B K L ? F : L B A : P B Y H K G H < G U O N : D L H J H < < E B Y X S
G : > H E = H < ? Q G H K L B : K L : > B B B O I J H B A < H > K L < :

< < L B L H < : H K : < ? G D H <
G Z m q g u c j m d h \ h ^ b l _ e v B : E ? H G Z < B Q ^ h d Z g ^ l _
; ? E H J M K K D H K K B C K D B C M G B < ? J K B L ? L

Hlebqbl_evghc hkh[_gghklvx ij_^\Zjbl_evgh bahebj ey_lky h[t_^bg_gb_ \ _^bgmx fhgheblgmx dhgkljmdpb [u kehy l_iehbaheypbb b aZsblghc h[hehqdbm< [hev [Z ih dhlhjhklZ\ey_lky l_iehgkbl_ev \uihegy_lky bahe kl_ l_ieh\hc baheypbb ihy\eyxlky \ki_g_gguc ihebjhlZlf aZsblghc h[hehqdb kem`bl iebwlbe_g \ukhdbc iehl klh\Zy hpbgdh\ZggZy klZev \ aZ\bkbfhklb h l<\beb_ijh l_iehbaheypbb jZaf_sZxlky ijh\h^Z kbkl_fu hihjZlb\gh ]h dhgljhey KH>D ^ey nbdkbjh\Zgby b ehdZebaZpbb ghihebmj_lZgZ ijb ijhl_qd_ ljm[u

Hkgh\guf gZijZ\e_gb_f bkke_^h\Zgby \ jZ[hl_ y\ey_ e__ _khfuobg kgb`_gby ^he]h_qghklb ij_^\Zjbl_evg guo ljm[ ijb bo ijhba\h^kl_

>ey ^hklb`_gby ihklZ\e_gghc p_eb bkihevah\Zek b_jZjobc iha\heyxsbc hij_^_eblv _khfhklv nZdlhjZ \ \Zggh]h _dlhjZ ijbhjbl_lh\ G[hld_ijbZlhjbu ihiZjguo kjZ\g_gbc

< j_amevlZl_ ijh_^_gghc kbkl_fZlbaZpbb nZdlhju ]h_qghklv ljm[ [ueb jZa[blu gZ ^_ ]jmiiu

KlZ^by ieZgbjh\Zgby \u[hj bkoh^gh]h fZl_jbZeZ b nZdlhju dhjjhabhggZy klhcdhklvl_gdZ bljmlbesbgZ bkqb kibjZevguo b ihi_j_qguo k\Zjguo r\h\ ijbf_g_gb_ ljm lj_[e_gbb gZebqb_ \ ljm[_ fbdjhlj_sbg b dhjjhabb dZq_kl\h dhfihg_glh\ lhesbgZ kl_gdb h[hehqdb fZjd f_g_gbl hjbqgh]h kujvy he ^ ydb

KlZ^by ba]hlh\e_gbymx \hreb nZdlhju kmhdZ b h _joghklb klZevghc ljm[u ih^]hlh\dZ \gmlj_gg_c ih_ dZq_kl\h k[hjdb khhkghklv ljm[ b ijh\h^gbdh\ZKH>D gby ^habjh\dZ kf_rb\Zgb_ lfijjZmjZ `ghklgu_ mkeh\by hl_j^_\Zgby i_ghihebmj_lZgZ mjh_gv l_o dZq_kl\Z gZ ijhba\h^kl_

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J ? A M E V L : D L H G ? Q G H W E ? F ? G L G H = H F H > ? E B J H < : G B Y
I J B I H < ? J O G H K L E G K L B Q ? K D H F > ? N H J F B J H < : G B B

Y B K L X O B G
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k j _ ^ b d h l h j u o f h ` g h \ u ^ _ e b l v i Z \ k l j b o g h k d g h ^ _ Z h j f b j h \
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B g l _ j _ k i j _ ^ k l Z \ e y _ l b g n h j f Z p b y h j Z k i j _ ^ _ e _ g b b h k l
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^ b e h k v k h k d h j h k l y f b r Z j b d Z \ f h f h g l f m k ^ Z k j Z ^ b h k d j _ l g \
k l v x f k b ^ b Z f _ l j Z f b r Z j b d Z h l b f f
J _ a m e v l Z l u f h ^ _ e b j h \ Z g b y i h d Z a Z e b k e _ ^ m Z x s _ _ i
j Z d l _ j g h a Z e _ ] Z g b _ g Z b [ h e v r b o g Z i j y ` _ g b c ^ h c ] e m [ b g
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f f b \ u r _ ] e m [ b g Z a Z e _ ] Z g b y h k l Z l h q g u o g Z i j y ` _ g b c f
j h k l b m ^ Z j Z b ^ b Z f _ l j Z r Z j b d Z Z b o \ _ e b q b g Z j Z k l _ l
a Z d h g m k m \ _ e b q _ g b _ f k d h j h k l b \ j Z a Z r b j y b g Z k e
` _ g g ^ n h j f b j h \ Z g g h f k d h j Z k y g b l h e v d h \ ^ \ Z j Z a Z Z h l
w g _ j ] b y l j Z l b l k y g Z ^ _ n h j f Z p b x i h \ _ j o g h k l g h ] h k e h y f
k e _ ^ Z b e b e m g d b l j b m f _ g v r _ g b b ^ b Z f _ l j Z r Z j b d Z
k l Z g h \ y l k y [ h e _ _ l h q _ q g u f b d h g p _ g l j b j h \ Z g g u f b ] e m
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b k k e _ ^ m _ f u o k d Z j b k l Z y o \ f h f _ g l m ^ Z j Z ] e m [ b g Z b a Z e _ ] Z
f Z e v g u o h k l Z l h q g u o g Z i j y ` _ g b c g _ i j _ \ u r Z _ l f f
: g Z e b a i j h \ _ ^ _ g g u o b k k e _ ^ h \ Z g b c i h a \ h e y _ l k ^ _ e Z
h i l b f Z e v g h c k d h j h k l v x r Z j b d Z \ f h f _ g l m ^ Z j Z y Z \ e y _ l k y
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I M L B M < ? E B Q ? G B Y H ; T ? F H < J ? : E B A : P B B I J H > M D I
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G : =: E ? G D H
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± f _ l h ^ © F Z ] g b l k \ _ j o m ª i j _ ^ m k f Z l j b \ Z _ l g Z e b q b _
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± Z d p b b [ h g m k u
± j _ Z e b a Z p b y l h \ Z j h \ b m k e m ] i h v g h c _ p _ i g b \ e _ d Z l _ e
± k h a ^ Z g b _ b e e x a b b k d b ^ d b k b l m Z p b y d h ] ^ Z g Z
g _ k d h e v d h [ h e v r Z y k l h b f h k l v \ j _ a m e v l Z l _ q _ ] h k h a ^
j Z k i j h ^ Z ` b ª d h l h j u c g _ a Z k l Z \ b l k d [ w d ^ h g e h f b y ^ k Z l _ v ^ k l \
y \ e y _ l k y i j b h j b l _ l h f i m d f g i h Z l b œ e _ c
> e y m \ _ e b q _ g b y h [ t _ f h \ j _ Z e b a Z p b b i j h ^ m d p b b L I
D h f i e _ d l F h g l Z ` ª i j _ ^ e Z ] Z _ l k y i j h ^ Z \ Z l v h l ^ _ e v g u _ \ b
j Z k k j h q d m l _ j \ u c i e Z l _ ` [ m ^ _ l \ g h k b l v k y h k j Z k a b m b k h
f h k l b h [ h j m ^ h \ Z g b y h k l Z e v g m x k m Z f f b m v f h ` g h q _ g u b e
l j _ d f _ k y p _ \
J Z k k j h q d Z i h a \ h e b l i h d m i Z l _ e x [ u k l j h i h e m q b l v l h \
_ ] h \ j _ f y b ^ _ g v ] b Z i j _ ^ i j b y l b _ i j b \ e _ q _ l g h \ u o d e b _
k m s _ k l \ m x s b o b i h \ u k b l h [ t _ f u j _ Z e b a Z p b b i j h ^ m d p b b
l j _ ^ i h e Z ] Z _ l k y m \ _ e b q _ g b y j _ Z e b a Z p b b i j h ^ m % l p b b g Z
\ j _ a m e v l Z l _ i j _ ^ h k l Z \ e _ g b y j Z k k j h q d b i h d m i Z q l _ e x L I
d b h l j _ Z e b a Z p b b k h f k l g Z \ b l
J _ g l Z [ _ e v g h k l v i j h ^ ] Z k h k l Z \ b e Z %.
K e _ ^ h \ Z l _ e v g h ^ h i h e g b l _ e v g u c h [ t _ f i j b [ u Z e b h l j _
\ b l 13,8 f e g j
B k o h ^ y b a l h ] h q l h i j h ^ m d p b y a Z d m i Z _ l k y _ \ _ \ j h
e h j m k k d b _ j m [ e b k e _ ^ m _ l m q b l u \ Z l v ^ _ \ Z e v \ Z p b x [ _
h l g h r _ g b x d _ \ j h a Z i _ j b h ^ j Z k k j h q d b
> _ \ Z e v \ Z p b y [ _ e h j m k k d h ] h j m [ e y i h h l g j h k h k Z b x d _ \
\ b e Z b e b \ k j _ ^ g _ f \ f _ k y p < w l h f k e m q Z _ i v h l _ j b h
\ Z p b b k n h j f b j m x l k y g Z m e j g j \ g _
W d h g h f b q _ k d b c w n n _ d l h l i j _ ^ h k l Z \ e _ g b y j Z k k
13,14 f e g j K e _ ^ h \ Z l _ e v g h i j _ ^ h k l Z \ e _ g b _ j Z k k j h q d b i
m k e h \ n b _ e b q _ g b y h [ t _ f Z i j h ^ i Z b ` g g Z _ l i h e h ` b l _ e v g u c w
g h f b q _ k d b c w n n _ d l \ j Z e g j _ a Z ] h ^

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;?EHJKVKD-HHKKBCKDBC MGB<?JKBL?L

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kq_l kf_s_gby hkb gZ]jmadb \ klhjhgm iZevpZ\ Dhgk
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jZ[hlZlv gZ lj_gbjh\dZo jZagu_ kihkh[u l_ogbdb [hjv[u

Bkihevah\Zgb_ jZajZ[hlZggh]h lj_gZ`_jZ \ lj_gbjh
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M>D
KBKL?F: IJ?>MIJ?@>?GBY :<:JBCGUO KBLM:PBC
IJB BKIHEVAH<:GBB ;ULH<UO =:AH<UO IEBL

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Kh\j_f_ggu_ we_kj_g^kl\Z we_dljhgbdb iha\heyxl Z
abjh\Zlv fgh]b_ ijhp_kku \ ijhfure_gghklb b [ulm JZk
pbx kbkl_fu dhgljhey iZjZf_ljh\ [ulh\uo ]Zah\uo iebl
qZcgbdb ihke_ \udbiZgby \h^u fh]ml klZlv ijbqbghc i
ihke_ \udbiZgby \h^u ihkm^Z dZd ijZ\beh [ukljh ijboh^bl

Kbkl_fu [_ahiZkghklb kh\j_f_gguo iebl ij_^mkfZljb
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\ rlZlghf j_`bf_ Kbkl_fu gZ kh\j_f_gguo fb-djhijhp
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\ukb\ m^h[kl\h bkihevah\Zgby iebl

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dm __ baf_g_gby \u^Z\Zlv kb]gZe gZ ij_>dZZgb_dbb_ il
l_fi_jZlmju mklZgZ\eb\Zxlky \ ]Zah\mx iebl m b fh]m
l_fi_jZlmjm \ gb`g_c iehkdhklb ex[hc bkihevaZm_fhc
pby k bZlhq\ h[jZ[Zlu\Z_lky fbdjhijhp_kkhjhf Kbljmdlmj
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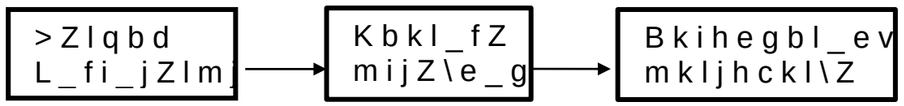


Jb.k1. Kljmdlmjgzy ko_fZ kbkl_fu mijZ\e_gby

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ijh]ghabjh\Zlv i_j_oh^ \ hiZkgu_ j_`bfu ljh_^_ggh_
ihdZaZeh qlh jZajZ[Zlu\Z_fZyZ kjbZkkihfaZgZ1Z\Zkh[ge_^mxs
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1. GhfbgZevguc j_`bf
2. J_`bf \udbiZgby `b^dhklb khijh\h`^Zxsbcky j_a
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3. lj_\ur_gb_ l_fi_jZlmju ihkm^u \ur_ aZ^Zggh]h ij_
4. Ohehklhc oh^ ^he]h\j_f_ggZy jZ[hlZ hldjulhc ]Za

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J:KIBK:GB? :<LH;MKH< $1'52,' $33/,&$7,21

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>ey jZajZ[hldb bkihevah\Zeb gh\uc jZa\b\Zxsb Xamarin Hg iha\hey_l jZajZ[Zlu\Zlv djhkkieZlnhjf_ggu ^ey fh[bevguo mkljhckl\k_bkihevah\Zgbyklb yaudZ hijh]jZff \ZgbyC ljb bkihevah\Zgbb ;DPDULQ fu lZd`_ bf__f ih \k_f \hafh`ghklyf 6'. ieZlnhjfu b jh^ghfm f_oZgbafm ah\Zl_evkdh]h bgl_jn_ckZ jZajZ[hldb [ueZ bkihevah\Zg l_dZ dexkl Xamarin Android ij_^hklZ\eyxsZy Android SDK

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>ey ihkljh_gby hilbfZevgh]h fZjrjmlZ f_`^m hklZgh [jZg Ze]hjblf >_cdklju Hg y\ey_lky h^gbf ba gZb[he_ ]hjblfh\ r_gby aZ^Zqb h djZlqZcr_f imlb < h[s_f kem hkgh\Zg gZ ijbibku\Zgbb \_jrbgZf \j_f_gguo ihf_lhd \_jrbgu ^Z_l \_jogxx ]jZgbpm ^ebgu imlb hl g_dhlhj jZkkfZljb\Z_fhc \_jrbg_ Wlb ihf_ldb ihkl_i_ggh mf_g svx g_dhlhjhc bl_jZpbhgghc ijhp_^mju b gZ dZ`^h lhevdh h^gZ ba \j_f_gguo ihf_lhd klZgh\blky ihklhyg au\Z_l gZ lh qlh ihf_ldZ m`_ g_ y\ey_lky _jog_c ]jZ ^ebgm djZlqZcr_]h imlb bkkfZljb\Z_fhc \

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K I B K H D E B L ? J : L M J U

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## B K K E ? > H < : G B ? I J H P D ? H K G L : D L G H C J ? E V C ? K < G : J D B
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m \ _ e b q b l v m k b e b _ j Z a j m r _ g b y k \ Z j g h ] h k h _ ^ b g _ g b y k
> Z e _ _ i j b f _ g b e b k b k l _ f m Z \ h f Z l b q _ k d h ] h m i j Z \ e _ g
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d j h g r l _ c g Z e b n l Z i h a \ h e y x s b d j Z l g j h f m f _ g v r _ g b b
w e _ d l j h w g _ j ] b b i h l j _ [ e y _ f h c d h g l Z d l g h c f Z % b g h c h
i j h q g h k l v k g h _ g ^ b y \ k j Z \ g _ g b b k j _ ` b f h f k \ Z j d b j _ d h f
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MATHEMATICAL MODELLING OF THE UNDERGROUND DUMP TRUCK TRANSMISSION

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The MoAZ underground dump truck has a hydromechanical transmission, including lock-up torque converter and constant-mesh gearbox. The gearshift is performed by an electronic control system which improves the performance of the truck. During gearshift the gearbox clutch operation is characterized by a high level load on the friction plates and high pressure on the friction surfaces. As a result, the clutch load calculation is a crucial step of overall transmission control. Thus, the purpose of the research is transmission mathematical modeling with the transient response analysis during gearshift.

The initial phase of the mathematical modeling is to create a dynamic model of the object of research. Its construction is based on the law of conservation of energy, which allows reflecting the physical processes of the technical object function correctly. Significant attention is paid to the adequate representation of the structure of the object.

The development of dynamic models of hydromechanical transmission was carried out taking into account the need to identify the dependencies between the quality indices of transient processes and the main parameters of transmission, influencing the character of the transient response.

The maximum torques $/_{ìk\_v}$ in the transmission elements and dynamic factors $G_ç$ were taken as the indicators of the quality of the transient response during gearshift. At the same time the operation processes of the gearbox clutches were evaluated.

The dynamic factor can be defined as

$$G_ç L \frac{/_{ìk\_v}}{/_{øk\_v} Q_{ÓÓ}} á$$

where $/_{øk\_v}$ ±the maximum engine torque $Q_{ÓÓ}$ ±the transmission ratio at current gear.

The specific power and specific slip work of engaged clutches were taken as the criteria for assessment of these processes.

The structure of the developed transmission mathematical model helped to identify the dynamic load on the propeller shafts, gearbox shafts, on the axle shafts and tires.

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# Artificial intervertebral disc

as a result of which a patient received the implant of a skull piece. A printed skull is not a monolithic piece of plastic, it is made of 23 bones that make up our skull.

Artificial intervertebral disc is an example of an interaction of the artificial and human cells. 3D printer uses a special material with a high content of stem cells. Once the stem cells come into contact with the native cells of intervertebral disc, they are transformed into common tissue, thereby restoring a damaged place. Even if the disk is completely destroyed, a lab can create an entirely new disc that will be perfect for the spine of this particular patient.

Researchers of the Princeton University developed a bionic ear, which contains sensitive airwaves antenna and living cells. The resulting objective of the researchers is the testing of ear technology combining electrical and biological components in a living tissue. Potentially such devices can be used not only for "the expansion of the auditory range to the radio frequency", but also, for example, for remote monitoring of the state of prostheses.

3D printers allow surgeons to rapidly produce inexpensive 3D models to obtain information, which reduces the operation time, and accelerates the recovery of the patient. For successful orthopedic and maxillofacial surgery it is essential to build the exact contour of the implant. Also dentistry 3D-printers allow you to make temporary crowns.



# 3D printing

3D printing is a process of taking digital 3D model and turning that digital file into a physical object. The creation of a 3D printed object is achieved using additive processes. In an additive process an object is created by laying down successive layers of material until the entire object is created.

3D Printers are loaded with cartridges of living cells. 3D printer prints tissue in the same way as a usual printer. These cells come out of a printer head in order to produce a 3D object. These cells build up an organ in many layers.

With the help of a 3D printer, we can print many prostheses taking into account the individual characteristics of a person. Some of these prostheses are very complicated. The main reason of their complication is that they have microcavities.

Bioprinting is a very new area of scientific and medical research that involves "printing" biological matter and material for use in prosthetics, replacement organs, veins and human tissues.

Research Company from Oxford has reported about a successful operation,

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kjhd kem`[u

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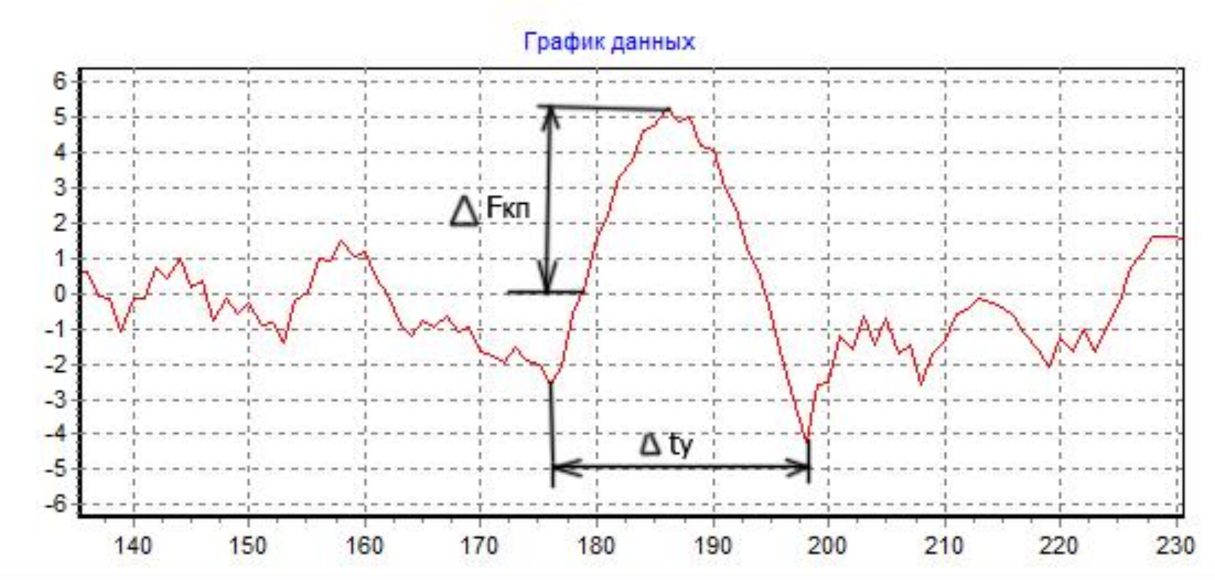


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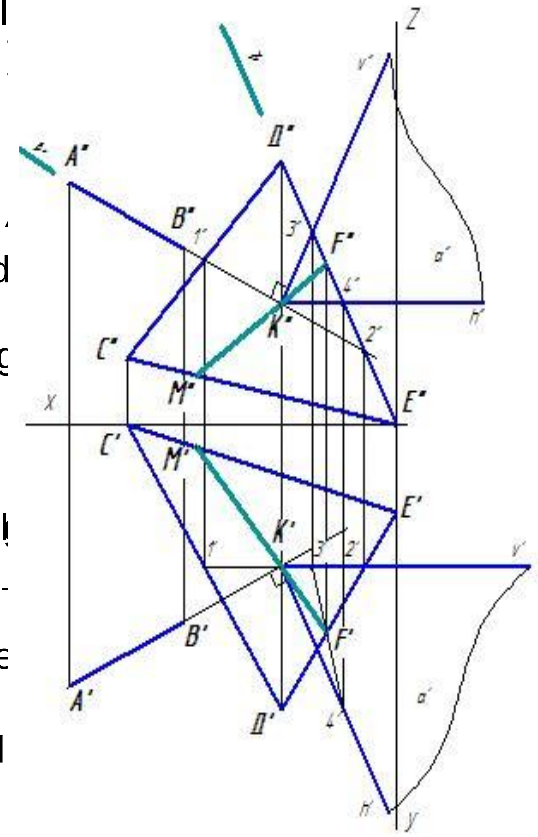

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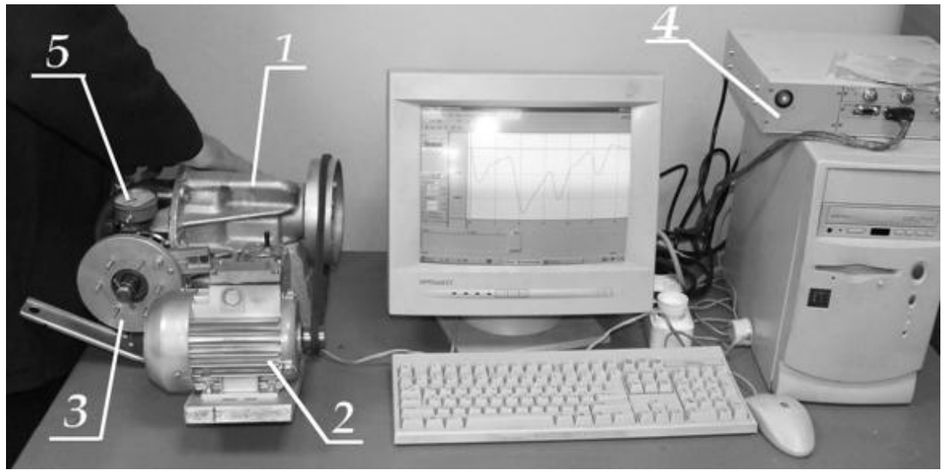


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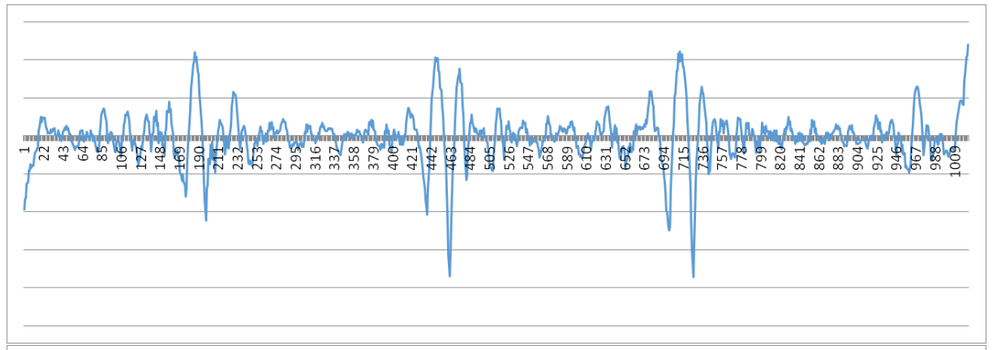

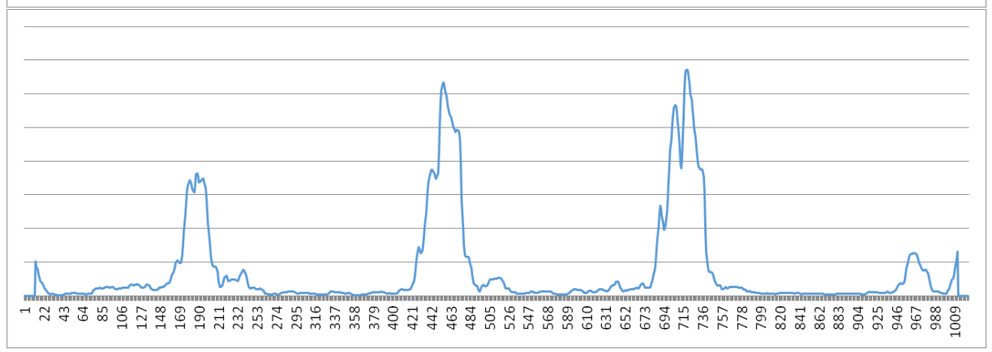

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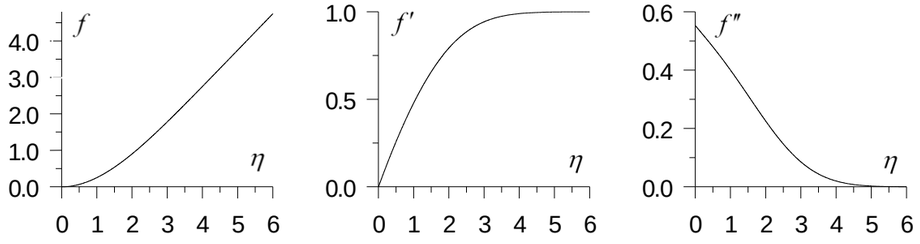
$$(2\pi-\beta)f'''+\pi f f''+\beta\left(1-f'^{2}\right)=0;$$

$$f(0)=0,\quad f'(0)=0,\quad f'(\infty)=1,$$

]^_$f(\eta)$-[_ajZaf_jgZy nmgd$\eta$bl_ajZdaZ_jgZy Z\lhfh_^_evgZ j_f_ggZy m]he ZlZdb gZ[_]Zxs_]h ihlhdZ Qbkd_ggh_ ^Zqb ihemqZxl-jdZhagghdkgbufb f_lh^Zfb

< gZklhys_c jZ[hl_ wlhejmq_gbh_dZgdbj_aZ^Zqb Dhrb f_lh^hf J-Dgm]lZ ^ey j_ZebaZpbb dhlhjh]h$f''(0)$.[m_lky lhkdhevfd$f'(\infty)=1$ lh ih^[bjZy ©\bedmª ih^oh^fy$f''(0)$,o agZq ^ey dhlhjh$f'\left(\eta\ge\eta^{*}\right)>1$, $f'\left(\eta\ge\eta^{*}\right)<1$ $\left(\eta^{*}\gg1\right)$ Z aZl_f ihke_^h\Zl_e __ mf_gvrZy f_lh^hf iheh\bggh]h ^_e_gby$f''(0)$,oh^bf ^ey dhlhjh$f'\left(\eta\ge\eta^{*}\right)=1\pm\varepsilon$ ($\varepsilon-$ aZ^ZggZy ih]j_rghk.lv ijbGZ jbk _^_gu ]jZnbdb jZkq_lguo$f(\eta)$,$f'(\eta)$,$f''(\eta)$c ihemq_gguo baeh`_gguf kihkh[hf$\beta=\pi/4$eyb $\varepsilon=10^{-12}$ <uiheg_gb_ mkeh\b $f'\left(\eta\ge\eta^{*}\right)=1\pm\varepsilon$ ^hklb]gmlh$\eta^{*}\pm3$b ijb wlh$f''(0)=0.5532952741657$.

Wlbf kihkh[hf j_r_gb_ jZkkfZljb\Z_fhc aZ^Zqb fh`_l ex[hc gZi_j_^ aZ^Zgghc lhqghklvx b ^ey jZaebqguo a

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KIBKHD EBL?J:LMJU

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kj_^Simulation lhykgyy \ur_kdZaZggh_ gm`gh hlfZ_lblv
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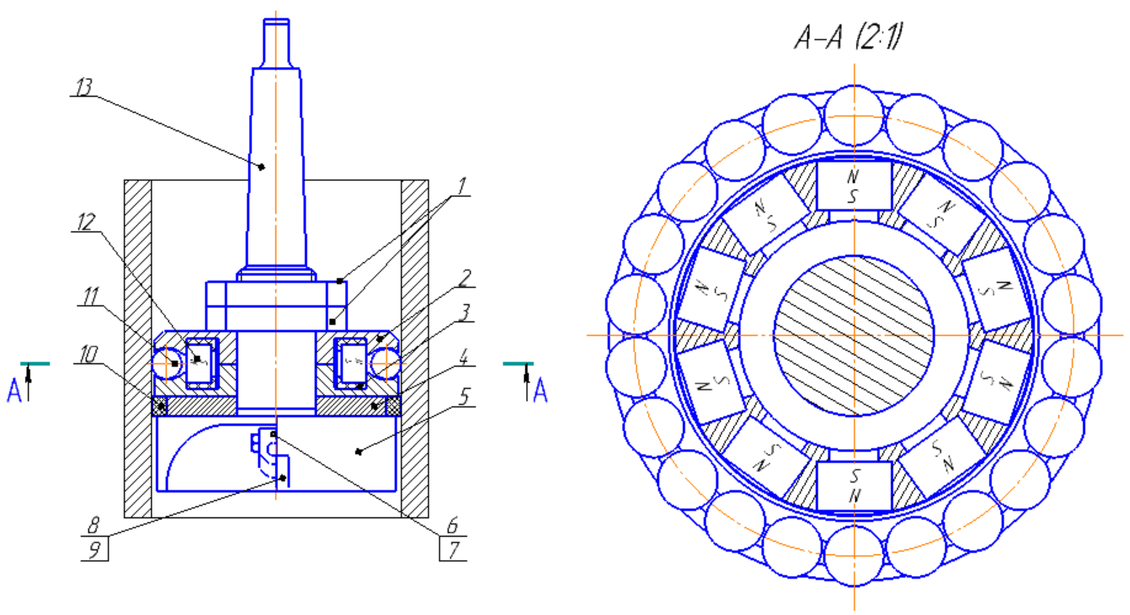

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194

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63

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rbgu
B ihke_^gbfb nZdlhjZfb ©jZ[hlZxsbfb dZd [u \
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Z\lhihdjurdb



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m^Zjgh_ \hlab^_cih h[jZ[Zlu\Z_fhc ih_joghklbm^_lZeb
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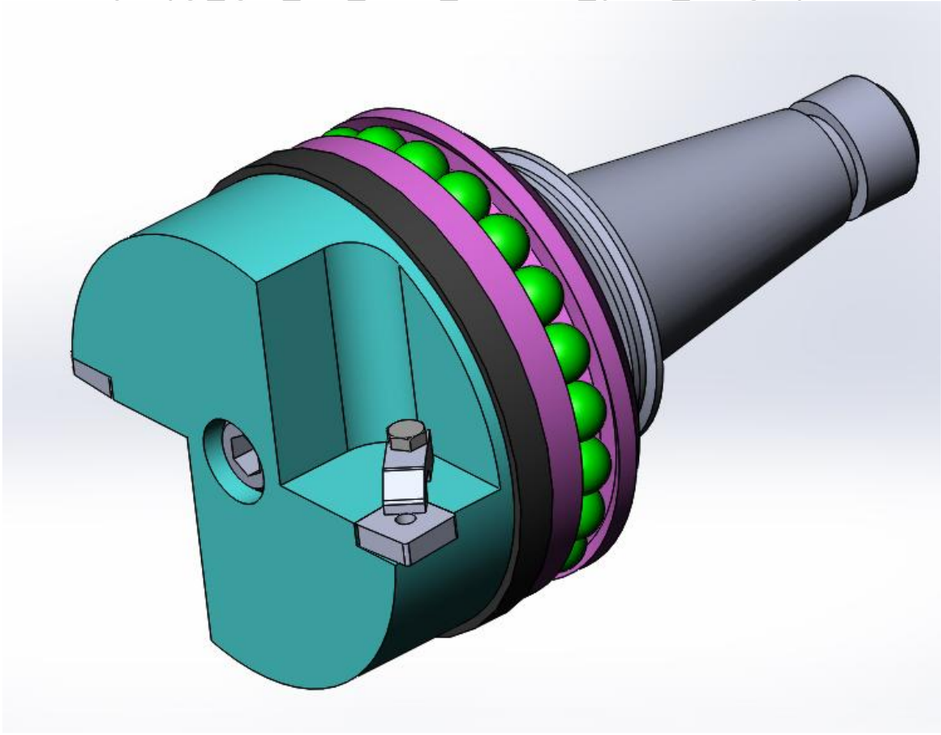

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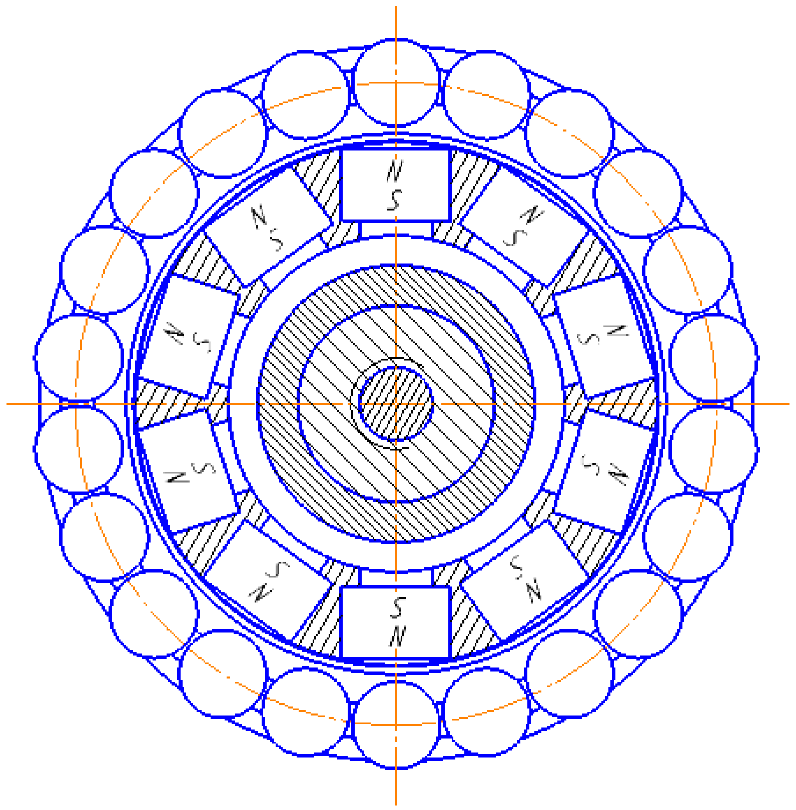

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М > D 621.791.763.2

ANALYSE DU PROCESSUS DU BRASSAGE DES GAZ DE PROTECTION LORS DE LEUR FOURNITURE COMBINÉE DANS LA ZONE DE SOUDAGE

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/D FDUDFWpULVWLTXH SULQFLSDOH GX SURFH FRPELQpH HVW OD IRXUQLWXUH LQGpSHQGDQWH par les canaux, GLVSRVpV FRD[LDOHPHQW protection, des jets de gaz SURFp brassent partiellement et influencent OHV SURFHVVXV GH WUDQ G pOHFWURGH HW p OHFWUL/D JRXUQLWXUH FRPE protection permet de changer leur FRQVRPPDWLRQ GH IDo ajuster la composition FKLPLTXH GH O DWPRVSKqU SUREOqPH GH OD GpWHUPLQDWLRQ GH OD FRP SURWHFWULFH HVW DVVH] FRPSOH[H SDUFH T LQIOXDQFHQW OH SURFpGp. GX EUDVVDJH GHV MH

3RXU pWXGLHU O LQIOXHQFH sur la composition GHV J O DWPRVSKqUH JD]HXVH RQW pWp réalisées des simulations sur ordinateur, pendant lesquelles dans l'environnement de OpenFOAM le PRGqOH PDWKpPDWLTXH GH O pPDQDWLRQ GX JD] FRD[LDX[ GH OD WX\qUH GH EU€OXUH j JD] D pW SDUDPqWUHV LQWpUHVVDQWV WHOV TXH OH GpELW YROXPp FDUERQH OD FKDOHXU GpJDJpH SDU O DUF pOH PDWLqUHV VROLGHV 3RXU SUpFLVHU O LQIOXHQFH dans les zones les plus importantes GH jets de gaz. Au cours de la simulation OH GLR[\GH GH FDUERQH D pWp IRX IRXUQL SDU OH FDQDO FHQWUDO /H UDWLR GX GLR[\GH GH FDUERQH constant et constituait 15 l/min. Le débit d argon variait GDQV OD SODJH GH O PLQ MXVTX j O PLQ

$ OD VXLWH GH OD VLPXODWLRQ PDWKpPDWLTXH O pPDQDWLRQ GHV JD] GH SURWHFWLRQ RQ a obtenu des FRPSRVDQWV GH JD] GDQV OHV SRLQWV GLYHUV GRQQpHV M¶DL GpWHUPLQp OH GpELW GH GLR[\GH G REWHQLU OD FRPSRVLWLRQ FKLPLTXH RSWLPDO zone de l'arc.

М > D
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: KK?F?GH<:
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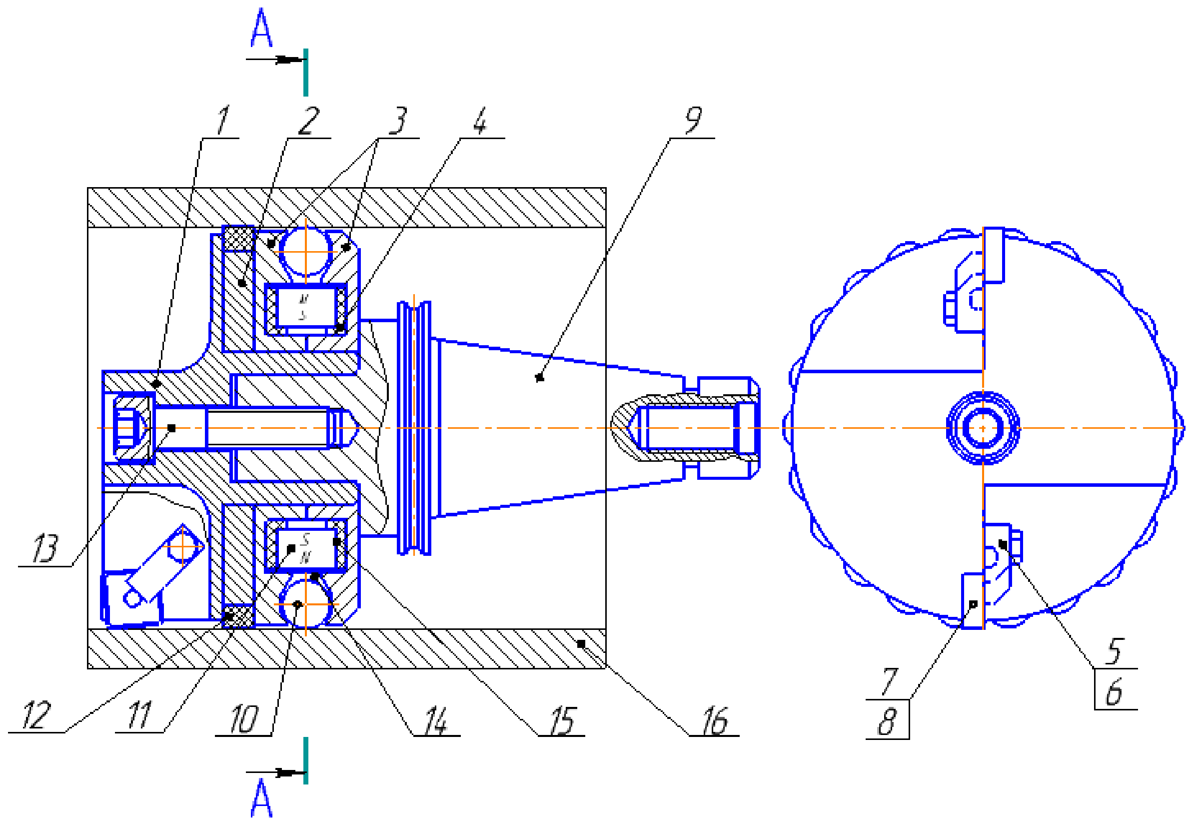


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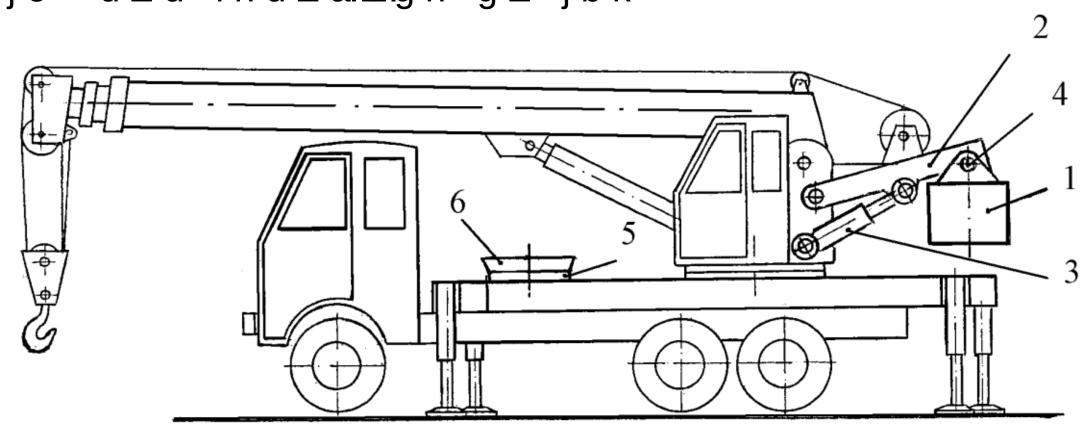


Jbk. 1. :\lhfh[bevguc djZg kh kt_fguf ijhlb\h_khf

FZkkZ ijhlb\h_kZ \fh`_l khklZ\eylv ^h « li_bj_lhe__ D
^blky \ ljZgkihjlgh_ ihehh`_gb_ b ^\b]Zlvky gZ ^jm]hc h
ljb wlhf ijhlb\h_k g_ hdZau\Z_l g_[eZ]hijbylgh]h \ha
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