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## **ANEXO A – Dados experimentais**

Experimento 2			
Tempo: 20 min	$V_{AJ}$ : 30,4 L/s	$V_{AT}$ : 1900 L/h	$V_{SP}$ : 18 mL/min
Massa de sementes de soja (g)			
<i>in natura</i>	Recoberta exp.	<i>in natura</i>	Recoberta exp.
0,1076	0,109	0,1302	0,132
0,1084	0,1097	0,1095	0,1115
0,1085	0,1102	0,1199	0,1218
0,1092	0,1109	0,1078	0,1104
0,1107	0,1123	0,1368	0,1396
0,1176	0,1202	0,1218	0,1231
0,1196	0,121	0,1355	0,1375
0,1195	0,1218	0,1164	0,1188
0,1209	0,1233	0,1495	0,1511
0,1209	0,1233	0,1288	0,1304
0,1213	0,1233	0,1219	0,1238
0,1227	0,1235	0,122	0,124
0,1216	0,1245	0,1479	0,1497
0,1234	0,1248	0,139	0,141
0,1236	0,1251	0,1124	0,1143
0,1236	0,1251	0,1809	0,1833
0,1231	0,1257	0,1219	0,1238
0,1255	0,1274	0,1216	0,1235
0,1258	0,1279	0,1326	0,135
0,1263	0,1281	0,142	0,1441
0,1262	0,1283	0,1392	0,1411
0,1289	0,1309	0,139	0,141
0,1291	0,1311	0,1205	0,1224
0,13	0,1315	0,1789	0,1815
0,13	0,132	0,1467	0,1488
0,1304	0,1324	0,1388	0,1404
0,1308	0,1324	0,1543	0,156
0,1304	0,1324	0,111	0,1124
0,1314	0,1334	0,1075	0,1095
0,1315	0,1337	0,131	0,1323
0,131	0,1338	0,1214	0,1229
0,1338	0,1357	0,1124	0,1144
0,1354	0,1366	0,1147	0,1165
0,1352	0,1371	0,1233	0,1252
0,1349	0,1376	0,1415	0,1432
0,1349	0,1376	0,1092	0,1111
0,1374	0,1387	0,1254	0,1268
0,1402	0,1417	0,1321	0,1344
0,1417	0,1429	0,1163	0,1179
0,1434	0,1454	0,1089	0,1104
0,1434	0,1454	0,1318	0,1345
0,1446	0,1463	0,0941	0,0961
0,1498	0,1511	0,1334	0,1353
0,1516	0,1533	0,1418	0,1436
0,1544	0,1561	0,1165	0,1185
0,1584	0,1601	0,112	0,1143
0,1606	0,1626	0,1293	0,1311
0,1614	0,1637	0,1314	0,1332
0,1642	0,1656	0,1286	0,1313
0,1847	0,1865	0,1223	0,1239

<b>Experimento 10</b>			
<b>Tempo: 20 min</b>	<b><math>V_{AJ}</math>: 32,9 L/s</b>	<b><math>V_{AT}</math>: 1500 L/h</b>	<b><math>V_{SP}</math>: 15 mL/min</b>
<b>Massa de sementes de soja (g)</b>			
<i>in natura</i>	<b>Recoberta exp.</b>	<i>in natura</i>	<b>Recoberta exp.</b>
0,0936	0,0944	0,1742	0,1753
0,0979	0,0994	0,1345	0,1358
0,0988	0,1001	0,1194	0,1208
0,1002	0,1012	0,1294	0,1307
0,1009	0,1017	0,1028	0,1038
0,1047	0,1057	0,1237	0,1254
0,1077	0,1085	0,1075	0,1088
0,1078	0,1093	0,118	0,1195
0,1088	0,1098	0,1577	0,1592
0,1103	0,1114	0,1165	0,1175
0,1151	0,1162	0,1149	0,1158
0,1175	0,1189	0,1384	0,1395
0,118	0,1193	0,1272	0,1285
0,1184	0,1197	0,1233	0,1247
0,119	0,1197	0,1023	0,1037
0,119	0,1197	0,1306	0,1322
0,1185	0,1198	0,1358	0,1368
0,1182	0,1202	0,1157	0,117
0,1198	0,1212	0,1011	0,1023
0,1201	0,1216	0,1196	0,1209
0,1201	0,1216	0,1266	0,1278
0,1206	0,122	0,1168	0,1185
0,1211	0,1224	0,1163	0,1176
0,1212	0,1228	0,1217	0,1231
0,1228	0,1241	0,1105	0,1121
0,1238	0,1246	0,1352	0,1363
0,1235	0,1249	0,1038	0,1048
0,1247	0,1255	0,1481	0,1496
0,1248	0,1263	0,1092	0,1109
0,1253	0,1264	0,1208	0,1226
0,1268	0,1275	0,1067	0,1076
0,1268	0,1286	0,1431	0,1444
0,1292	0,1308	0,1193	0,1201
0,1301	0,1313	0,1136	0,115
0,1312	0,132	0,109	0,1103
0,133	0,1341	0,1141	0,1153
0,138	0,139	0,1166	0,1179
0,1384	0,1394	0,1159	0,1177
0,1384	0,1394	0,0972	0,0986
0,1384	0,1394	0,1012	0,1025
0,1384	0,1402	0,1004	0,1017
0,1402	0,1418	0,1182	0,1197
0,1431	0,1448	0,1534	0,1551
0,1446	0,1463	0,1432	0,1443
0,1472	0,1485	0,1142	0,1152
0,1483	0,1496	0,1569	0,158
0,1514	0,1533	0,1138	0,1154
0,153	0,1549	0,1217	0,1233
0,1635	0,165	0,1433	0,145
0,1773	0,1786	0,1354	0,137

<b>Experimento 11</b>			
<b>Tempo: 20 min</b>	<b><math>V_{AJ}</math>: 37,3 L/s</b>	<b><math>V_{AT}</math>: 1500 L/h</b>	<b><math>V_{SP}</math>: 15 mL/min</b>
<b>Massa de sementes de soja (g)</b>			
<b><i>in natura</i></b>	<b>Recoberta exp.</b>	<b><i>in natura</i></b>	<b>Recoberta exp.</b>
0,1022	0,103	0,1363	0,1377
0,1026	0,1036	0,1286	0,1298
0,1055	0,1067	0,1328	0,1338
0,106	0,107	0,1148	0,1159
0,1092	0,1109	0,1271	0,1284
0,112	0,1132	0,1696	0,171
0,1133	0,1144	0,1573	0,1585
0,1144	0,1151	0,1715	0,1733
0,1149	0,1162	0,1052	0,1064
0,1147	0,1163	0,1257	0,1267
0,1156	0,1163	0,1018	0,1033
0,1157	0,1165	0,1362	0,1375
0,115	0,1167	0,1205	0,1217
0,1166	0,1176	0,1212	0,1225
0,1168	0,1181	0,1186	0,1199
0,1175	0,1182	0,1201	0,1213
0,1177	0,1187	0,1322	0,1334
0,1178	0,1193	0,1152	0,1163
0,1185	0,1195	0,1074	0,1085
0,1191	0,1202	0,1418	0,1431
0,1192	0,1203	0,1316	0,1326
0,1207	0,1215	0,1291	0,1306
0,1207	0,1218	0,1173	0,1186
0,1209	0,122	0,1005	0,1014
0,1214	0,1226	0,1182	0,1191
0,1216	0,1229	0,1337	0,1351
0,123	0,1243	0,1137	0,1151
0,1239	0,1246	0,1338	0,1351
0,1243	0,1254	0,107	0,1082
0,1246	0,1254	0,1778	0,1789
0,1247	0,1256	0,1318	0,133
0,1254	0,1268	0,1475	0,1489
0,1258	0,1268	0,1147	0,1158
0,1263	0,1279	0,1035	0,1045
0,1276	0,1284	0,1732	0,1749
0,1275	0,1285	0,1213	0,1228
0,1279	0,1294	0,1169	0,1175
0,1293	0,1305	0,1317	0,1327
0,1312	0,132	0,1519	0,1532
0,1315	0,1324	0,0975	0,0985
0,1318	0,1328	0,1242	0,1255
0,1327	0,1338	0,1128	0,1136
0,1377	0,1385	0,1153	0,1169
0,1376	0,1388	0,1323	0,1335
0,1378	0,1391	0,1201	0,1215
0,1381	0,1392	0,1593	0,1607
0,1429	0,144	0,105	0,1058
0,1502	0,1516	0,1152	0,1169
0,1576	0,1587	0,1276	0,1285
0,1631	0,165	0,1195	0,1208

## **APÊNDICE A – Código computacional utilizado para obtenção dos resultados**

> restart:

Experimento 2:  $t=20$  min;  $V_{aj}=30,4$  L/s;  $V_{at}=1900$  L/h;  $V_{sp}=18$  mL/min;  $h=86,4\%$

> with(plots):

> with(stats):

> printlevel:=3:

> tf:=1200: [s] REF: Tese de mestrado de Duarte (2002).

> tempo:=tf\*[seq(i/4,i=1..4)]:

> Linestyle:=[seq(nops(tempo)-i,i=0..(nops(tempo)-1))]:

> Symbolsize:=[seq(i+2\*nops(tempo),i=1..nops(tempo))]:

> Thickness:=[seq(i,i=0..(nops(tempo)-1))]:

### Informações do experimento

> eta\_exp:=0.864: Experimental. REF: Tese de mestrado de Duarte (2002), página 65.

> V\_aj:=30.4: [L/s] REF: Tese de mestrado de Duarte (2002).

> V\_at:=1900: [L/h] REF: Tese de mestrado de Duarte (2002).

> V\_sp:=18/60: [mL/s] REF: Tese de mestrado de Duarte (2002).

> C\_sus:=0.13: [g/mL] (sólidos/suspensão). REF: Tese de mestrado de Duarte (2002).

> Mt:=2500: [g] massa total de sólidos no leito. REF: Tese de mestrado de Duarte (2002).

> r:=eta\*V\_sp\*C\_sus/Mt: [1/s] Taxa de adição de massa de recobrimento.

### Média, variância e desvio padrão em x

> mu0f\_x:=1-alpha:

> mu0g\_x:=alpha:

> mu0\_x:=mu0f\_x+mu0g\_x:

> mu1f\_x:=B\*alpha^3\*(exp(-tau/alpha)+tau/alpha-1):

> mu1g\_x:=-B\*alpha^3\*(exp(-tau/alpha)-tau/(B\*alpha)-1):

> B:=(1-alpha)/alpha:

> mu1\_x:=simplify(mu1f\_x+mu1g\_x):

> B:='B':



```

> mediaf_x:=simplify(mu1f_x/mu0f_x):
> mediag_x:=simplify(mu1g_x/mu0g_x):
> mediat_x:=simplify(mu1_x/mu0_x): Momento de primeira ordem para todo o leito= média total em x
> mu2f_x:=B*alpha^4*(exp(-tau/alpha)*(4-5*alpha+2*tau/alpha-2*tau)+tau*((tau+2)/alpha-4)+6*alpha-4):
> mu2g_x:=B*alpha^4*(exp(-tau/alpha)*(-2+5*alpha-2*tau/alpha+2*tau)+tau*(tau/(1-alpha)+4)-6*alpha+2):
> mu2_x:=(alpha*tau)^2+2*B*alpha^4*(exp(-tau/alpha)+tau/alpha-1): Momento de segunda ordem
> varf_x:=simplify(mu2f_x-2*mediaf_x*mu1f_x+(mediaf_x)^2*mu0f_x): Variância em x para todo o domínio F
> varg_x:=simplify(mu2g_x-2*mediag_x*mu1g_x+(mediag_x)^2*mu0g_x): Variância em x para todo o domínio G
> var_x:=simplify(mu2_x-(mu1_x)^2): Variância em x para todo o leito
Média, variância e desvio padrão em w
> x:=w*a/(r*B): tau:=a*t/(1-alpha):
> aux:=w/x:
> B:=(1-alpha)/alpha:
> media_modf:=mediaf_x*aux: Média em w para o domínio F
> media_modg:=mediag_x*aux: Média em w para o domínio G
> mediat_mod:=mediat_x*aux: Média total em w
> var_modf:=varf_x*aux^2: Variância em w para o domínio F
> var_modg:=varg_x*aux^2: Variância em w para o domínio G
> var_mod:=var_x*aux^2: Variância total em w
> sigma_modf:=simplify(sqrt(var_modf)): Desvio padrão em w para o domínio F
> sigma_modg:=simplify(sqrt(var_modg)): Desvio padrão em w para o domínio G
> sigma_mod:=simplify(sqrt(var_mod)): Desvio padrão total em w

```

### Solução analítica

```

> solf:=f(w,t)=(1-alpha)*exp(((2*alpha-1)*w*a-a*t*r)/(r*(1-alpha)))*(B*sqrt((t*r-alpha*w)/(w*(1-alpha)))*BesselI(1,2*sqrt((w*a^2*(t*r-alpha*w))/(r^2*(1-alpha))))+BesselI(0,2*sqrt((w*a^2*(t*r-alpha*w))/(r^2*(1-alpha)))))*Heaviside(a*(t*r-alpha*w)/(r*(1-alpha))):

```

```
> solg:=g(w,t)=alpha*exp(((2*alpha-1)*w*a-a*t*r)/(r*(1-alpha)))*(sqrt((w*(1-alpha))/(t*r-
alpha*w))*Bessell(1,2*sqrt((w*a^2*(t*r-alpha*w))/(r^2*(1-
alpha)))))+B*Bessell(0,2*sqrt((w*a^2*(t*r-alpha*w))/(r^2*(1-alpha))))+Dirac(a*(t*r-
alpha*w)/(r*(1-alpha)))*Heaviside(a*(t*r-alpha*w)/(r*(1-alpha))):
```

```
> y:=rhs(solg)+rhs(solg): Solução encontrada para o sistema de equações diferenciais.
```

Eficiência teórica

```
> eta_teo:=(77.96-5.14*x1+1.72*x2+6.15*x3-3.6*x2^2-2.41*x3^2+2.39*x2*x3)/100: REF: Tese
de mestrado de Duarte (2002), página 67 Eq. (41).
```

```
> x1:=(V_aj-32.9)/2.5:
```

```
> x2:=(V_at-1500)/400:
```

```
> x3:=(V_sp*60-15)/3:
```

```
> eta_teo:
```

```
> eta:=.942*eta_teo:
```

### Dados experimentais

```
M_recoberta:=[0.109,0.1097,0.1102,0.1109,0.1123,0.1202,0.121,0.1218,0.1233,0.1233,0.1233,0.
1235,0.1245,0.1248,0.1251,0.1251,0.1257,0.1274,0.1279,0.1281,0.1283,0.1309,0.1311,0.1315,0.
132,0.1324,0.1324,0.1324,0.1334,0.1337,0.1338,0.1357,0.1366,0.1371,0.1376,0.1376,0.1387,0.1
417,0.1429,0.1454,0.1454,0.1463,0.1511,0.1533,0.1561,0.1601,0.1626,0.1637,0.1656,0.1865,0.1
32,0.1115,0.1218,0.1104,0.1396,0.1231,0.1375,0.1188,0.1511,0.1304,0.1238,0.124,0.1497,0.141
,0.1143,0.1833,0.1238,0.1235,0.135,0.1441,0.1411,0.141,0.1224,0.1815,0.1488,0.1404,0.156,0.1
124,0.1095,0.1323,0.1229,0.1144,0.1165,0.1252,0.1432,0.1111,0.1268,0.1344,0.1179,0.1104,0.1
345,0.0961,0.1353,0.1436,0.1185,0.1143,0.1311,0.1332,0.1313,0.1239]:
```

```
M_natura:=[0.1076,0.1084,0.1085,0.1092,0.1107,0.1176,0.1196,0.1195,0.1209,0.1209,0.1213,0.
1227,0.1216,0.1234,0.1236,0.1236,0.1231,0.1255,0.1258,0.1263,0.1262,0.1289,0.1291,0.13,0.13
,0.1304,0.1308,0.1304,0.1314,0.1315,0.131,0.1338,0.1354,0.1352,0.1349,0.1349,0.1374,0.1402,
0.1417,0.1434,0.1434,0.1446,0.1498,0.1516,0.1544,0.1584,0.1606,0.1614,0.1642,0.1847,0.1302,
0.1095,0.1199,0.1078,0.1368,0.1218,0.1355,0.1164,0.1495,0.1288,0.1219,0.122,0.1479,0.139,0.
1124,0.1809,0.1219,0.1216,0.1326,0.142,0.1392,0.139,0.1205,0.1789,0.1467,0.1388,0.1543,0.11
1,0.1075,0.131,0.1214,0.1124,0.1147,0.1233,0.1415,0.1092,0.1254,0.1321,0.1163,0.1089,0.1318
,0.0941,0.1334,0.1418,0.1165,0.112,0.1293,0.1314,0.1286,0.1223]:
```

```

wexp:=[seq((M_recoberta[i]-M_natura[i])/M_natura[i],i=1..nops(M_recoberta))]:
> wexp:=sort(wexp):
> nops(wexp):
> total:=add(i,i=wexp):
> aux2[1]:=1:
> for i from 2 to nops(wexp) do
> aux2[i]:=aux2[i-1]-wexp[nops(wexp)-(i-2)]/total:
> od:
> Aux:=sort([seq(aux2[i],i=1..nops(wexp))]):
> for i from 1 to nops(wexp) do
> Conj[i]:=[wexp[i],Aux[i]]:
> od:
> Conj_w:=seq(Conj[i],i=1..nops(wexp)):
> g1:=pointplot(Conj_w, color=black, axes=boxed, legend=Experimental, axes=boxed,
labels=["w","y"]):
> wexp_min:=min(seq(wexp[i],i=1..nops(wexp))):
> wexp_max:=max(seq(wexp[i],i=1..nops(wexp))):
> mu_w:=describe[mean](wexp):
> sigma_w:=sqrt(describe[variance](wexp)):
g2:=plot(statevalf[cdf,normald[mu_w,sigma_w]],0..wexp_max,style=point,symbol=cross,labels=
["w","y"],legend="Experimental se fosse distribuição normal",axes=boxed,color=black):
> Num_part:=nops(M_natura): Número de partículas da amostra.
> Massa:=add(i,i=M_natura): [g] Massa in natura de 100 partículas (experimental).
> Total_part:=Num_part*Mt/Massa: Estimativa do número de partículas em 2500 g.

```

### **Taxa de circulação de partículas de CFD e segundo Clafin e Fane (1984)**

```

> Part_circ:=evalf(64*Total_part/Mt): [Partículas/s] Taxa de circulação de partículas
> a_CFD:=Part_circ/Total_part: [1/s] Razão entre número de partículas que circula entre os domínios F e G e
número total de partículas.
> dt:=0.035: Diâmetro do tubo draft [m].
> Le:=0.05: Distância da entrada ao tubo draft [m].

```

>  $W := (224.2 * (Le * V_{aj} / 1000)^{0.7} * (Mt / 1000)^{0.3} * dt^{1.22}) * 1000$ :  $V_{aj}$  está dividido por 1000 porque deve estar em  $m^3/s$ ;  $Mt$  está dividido por 1000 porque deve estar em kg;  $W$  está multiplicado por 1000 para que sua unidade seja  $[g/s]$

>  $a_{CIFa} := W / Mt$ :

>  $A := [a_{CIFa}, a_{CFD}]$ :

### Estimativa de $\alpha$

>  $e := [2 * dp, 5 * dp]$ :

>  $\alpha := V_I * (1 - \epsilon_f) / ((V_I + V_{II}) * (1 - \epsilon_f) + (V_{III} + V_{IV}) * (1 - \epsilon_c))$ :

>  $V_{IV} := \pi * H / 3 * (R_c^2 + R_i^2 + R_c * R_i)$ : Volume do tronco de cone localizado na parte cônica do leito de jorro. REF: Spiegel

>  $V_{III} := \pi * R_c^2 * h_i$ : Volume do cilindro contendo partículas acima da parte cônica. REF: Spiegel (cilindro circular reto)

>  $VT_{fonte} := 1/2 * \pi * R_b^2 * H_f$ : Volume do parabolóide de revolução localizado na parte cilíndrica do leito de jorro (após jorro estabelecido). REF: Spiegel

>  $V_I := \text{simplify}(VT_{fonte} - V_{II})$ :

>  $V_{II} := 1/2 * \pi * R_{II}^2 * H_{II}$ :

> for i from 1 to nops(e) do

>  $R_{II} := R_b - e[i]$ :

>  $H_{II} := H_f - e[i]$ :

>  $D_c := 0.21$ : [m] Diâmetro da parte cilíndrica. REF: Duarte (2002).

>  $D_i := 0.035$ : [m] Diâmetro da base. REF: Duarte (2002).

>  $D_b := 2 * D_i$ : [m] Diâmetro axial médio do jorro. REF: Duarte (2006).

>  $R_c := D_c / 2$ : [m] Raio da parte cilíndrica.

>  $R_i := D_i / 2$ : [m] Raio da base.

>  $R_b := D_b / 2$ : [m] Raio axial médio.

>  $H_t := 0.2536$ : [m] Altura total alcançada pelas partículas após jorro estabelecido para uma distância entre o tubo Draft e a base de 0.05 m. REF: Duarte et al.

>  $H := 0.15$ : [m] Altura estática do leito.

>  $H_f := H_t - H$ : [m] Altura da fonte.

>  $h_i := 0$ : [m] Altura inicial de sementes acima da parte cônica.

>  $\epsilon_f := 0.85$ :

```
> epsilon_c:=0.37:
> dp:=0.006:
> alpha_volume[i]:=alpha:
> od:
> Alpha:=seq(alpha_volume[i],i=1..nops(e)):
```

### Comparação de média e desvio padrão em tf

```
> for i from 1 to nops(A) do
> for j from 1 to nops(Alpha) do
> for k from 1 to nops(tempo) do
> a:=A[i]:
> alpha:=Alpha[j]:
> t:=tempo[k]:
> muf[i,j,k]:=media_modf: mug[i,j,k]:=media_modg:
> mu[i,j,k]:=mediat_mod:
> sigmaf[i,j,k]:=sigma_modf: sigmag[i,j,k]:=sigma_modg:
> sigma[i,j,k]:=sigma_mod:
> od:
> 'mu_w'=mu_w:
> 'sigma_w'=sigma_w:
> Erro_media[i,j,nops(tempo)]:=evalf(abs((mu_w-mu[i,j,nops(tempo)])/mu_w*100)):
> Erro_dvp[i,j,nops(tempo)]:=evalf(abs((sigma_w-sigma[i,j,nops(tempo)])/sigma_w*100)):
> od:
> od:
```

### Comparação do modelo com os dados experimentais

```
> t:=t':
> for i from 1 to nops(Alpha) do
> w_max[i]:=r*t/Alpha[i]:
> od:
```

```

> cont:=add(i,i=wexp)/25/nops(wexp):
> conj:={}: for j from 0 to wexp_max by cont do conj:=conj union {j} od:
> Aux:=sort([op(conj)]):
> for i from 1 to nops(A) do
> a:=A[i]:
> for j from 1 to nops(Alpha) do
> alpha:=Alpha[j]:
> for k from 1 to nops(tempo) do
> t:=tempo[k]:
> L:=[evalf(Int(y/aux,w=0..Aux[1],method=_Gquad)),seq(evalf(Int(y/aux,w=Aux[k-
1]..Aux[k],method=_Gquad)),k=2..nops(Aux))]:
> Cumul:=seq(add(L[i],i=1..j),j=1..nops(L)):
> W:=seq(((Aux[k]+Aux[k-1])/2),k=2..nops(Aux)),wexp_max]:
> nops(Cumul): nops(W):
> Conj:=seq([Aux[l],Cumul[l]],l=1..nops(Aux)):
Simulado[i,j,k]:=pointplot(Conj,axes=boxed,color=black,linestyle=Linestyle[k],legend=cat("Sim
ulado para t=",tempo[k],"s."),labels=["w","y"],connect=true):
> od:
> od:
> od:

> for i from 1 to nops(A) do
> for j from 1 to nops(Alpha) do
> print(i,j):
> 'a'=A[i]:
> 'alpha'=Alpha[j]:
> 'r'=r:
> 'eta'=eta:
> "Erro da média"=Erro_media[i,j,nops(tempo)]:
> "Erro do desvio padrão"=Erro_dvp[i,j,nops(tempo)]:

```

```
> display(g1,g2,seq(Simulado[i,j,k],k=1..nops(tempo)),title="Comparação entre simulado e
experimental no experimento 2");
```

```
> od:
```

```
> od:
```

### Gráficos do modelo para os domínios F e G

```
> t:=t':
```

```
> for i from 1 to nops(A) do
```

```
> for j from 1 to nops(Alpha) do
```

```
> for k from 1 to nops(tempo) do
```

```
> a:=A[i]:
```

```
> alpha:=Alpha[j]:
```

```
> t:=tempo[k]:
```

```
> "Erro da média"=Erro_media[i,j,nops(tempo)]:
```

```
> "Erro do desvio padrão"=Erro_dvp[i,j,nops(tempo)]:
```

```
graff[i,j,k]:=plot(rhs(solf)/aux,w=0..1.5*wexp_max,axes=boxed,labels=["w","f"],color=black,lin
estyle=Linestyle[k],legend=cat("t=",tempo[k],"s.")):
```

```
grafg[i,j,k]:=plot(rhs(solg)/aux,w=0..1.5*wexp_max,axes=boxed,labels=["w","g"],color=black,li
nestyle=Linestyle[k],legend=cat("t=",tempo[k],"s.")):
```

```
grafy[i,j,k]:=plot(y/aux,w=0..1.5*wexp_max,axes=boxed,labels=["w","y"],color=black,linestyle=
Linestyle[k],legend=cat("t=",tempo[k],"s.")): od:
```

```
> od:
```

```
> od:
```

```
> for i from 1 to nops(A) do
```

```
> for j from 1 to nops(Alpha) do
```

```
> print(i,j):
```

```
> 'a'=A[i]:
```

```
> 'alpha'=Alpha[j]:
```

```
> print('mu'=seq(muf[i,j,k],k=1..nops(tempo))):
```

```
> print('sigma'=seq(sigmaf[i,j,k],k=1..nops(tempo))):
```

```
> display(seq(graft[i,j,k],k=1..nops(tempo)));
> od:
> od:

> for i from 1 to nops(A) do
> for j from 1 to nops(Alpha) do
> print(i,j):
> 'a'=A[i]:
> 'alpha'=Alpha[j]:
> print('mu'=seq(mug[i,j,k],k=1..nops(tempo)));
> print('sigma'=seq(sigmag[i,j,k],k=1..nops(tempo)));
> display(seq(graftg[i,j,k],k=1..nops(tempo)));
> od:
> od:

> for i from 1 to nops(A) do
> for j from 1 to nops(Alpha) do
> print(i,j):
> 'a'=A[i]:
> 'alpha'=Alpha[j]:
> print('mu'=seq(mu[i,j,k],k=1..nops(tempo)));
> print('sigma'=seq(sigma[i,j,k],k=1..nops(tempo)));
> display(seq(grafy[i,j,k],k=1..nops(tempo)));
> od:
> od:
```



**APÊNDICE B – Curvas de distribuição para todos os experimentos e condições estudadas**

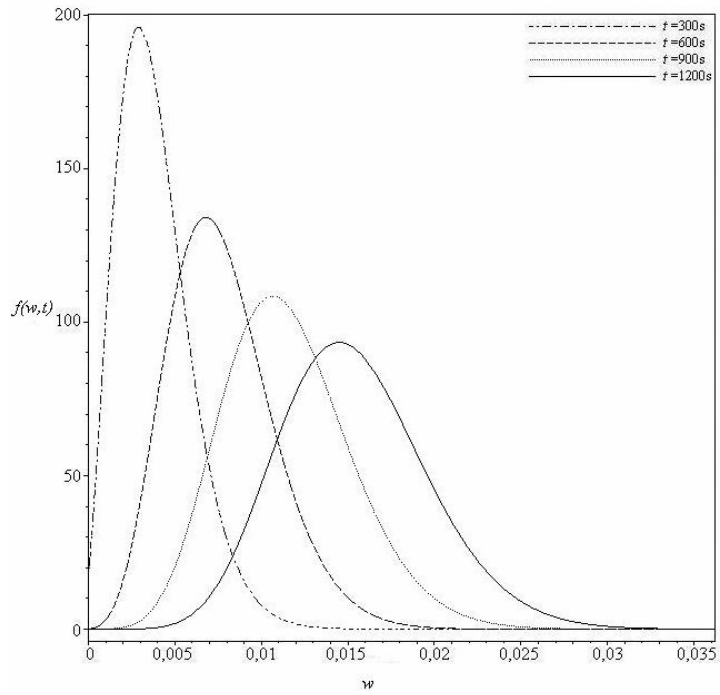


Figura B.1 – Distribuição de frequência no domínio F no experimento 2:  $a_I = 2,1 \cdot 10^{-2}$  e  $a_{II} = 1,39 \cdot 10^{-2}$ .

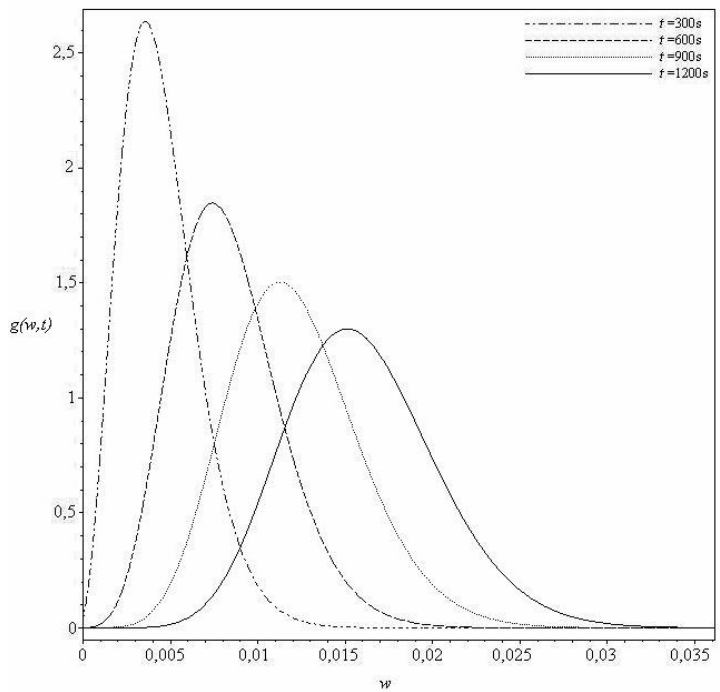


Figura B.2 – Distribuição de frequência no domínio G no experimento 2:  $a_I = 2,1 \cdot 10^{-2}$  e  $a_{II} = 1,39 \cdot 10^{-2}$ .

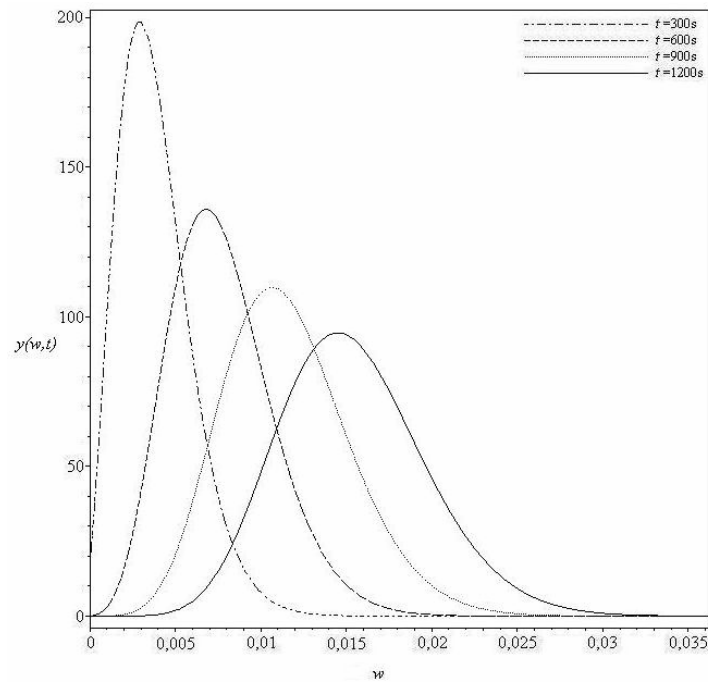


Figura B.3 – Distribuição de freqüência total no experimento 2:  $a_1 = 2,1 \cdot 10^{-2}$  e  $\alpha_1 = 1,39 \cdot 10^{-2}$ .

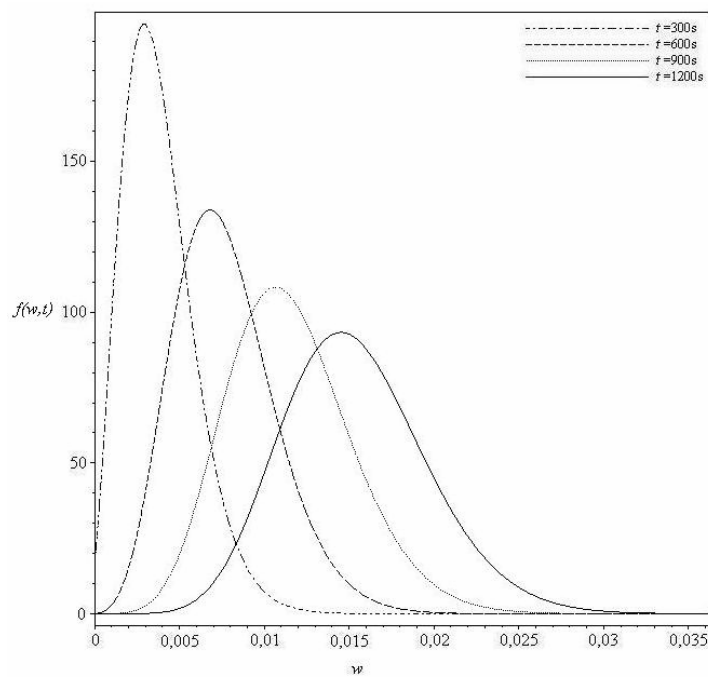


Figura B.4 – Distribuição de freqüência no domínio  $F$  no experimento 2:  $a_1 = 2,1 \cdot 10^{-2}$  e  $\alpha_2 = 2,21 \cdot 10^{-2}$ .

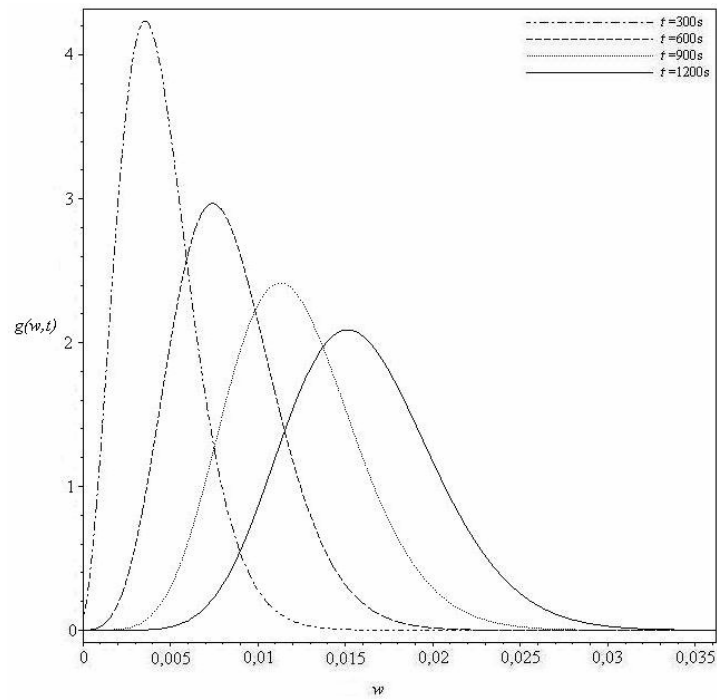


Figura B.5 – Distribuição de frequência no domínio  $G$  no experimento 2:  $a_1 = 2,1 \cdot 10^{-2}$  e  $\alpha_2 = 2,21 \cdot 10^{-2}$ .

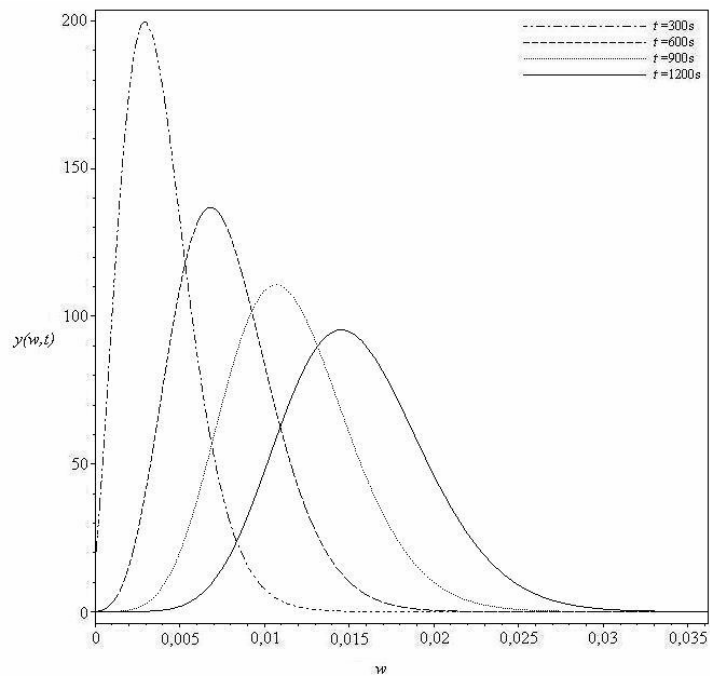


Figura B.6 – Distribuição de frequência total no experimento 2:  $a_1 = 2,1 \cdot 10^{-2}$  e  $\alpha_2 = 2,21 \cdot 10^{-2}$ .

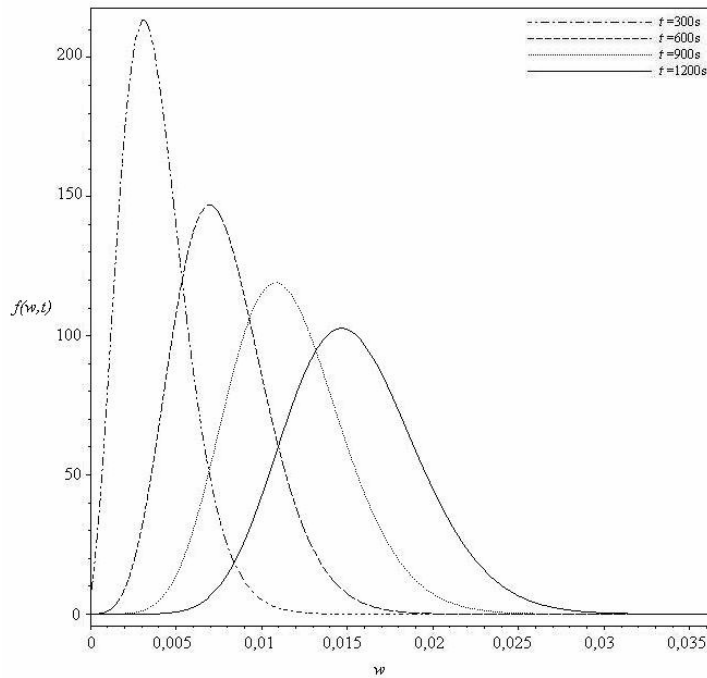


Figura B.7 – Distribuição de frequência no domínio **F** no experimento 2:  $a_2 = 2,56 \cdot 10^{-2}$  e  $\alpha_1 = 1,39 \cdot 10^{-2}$ .

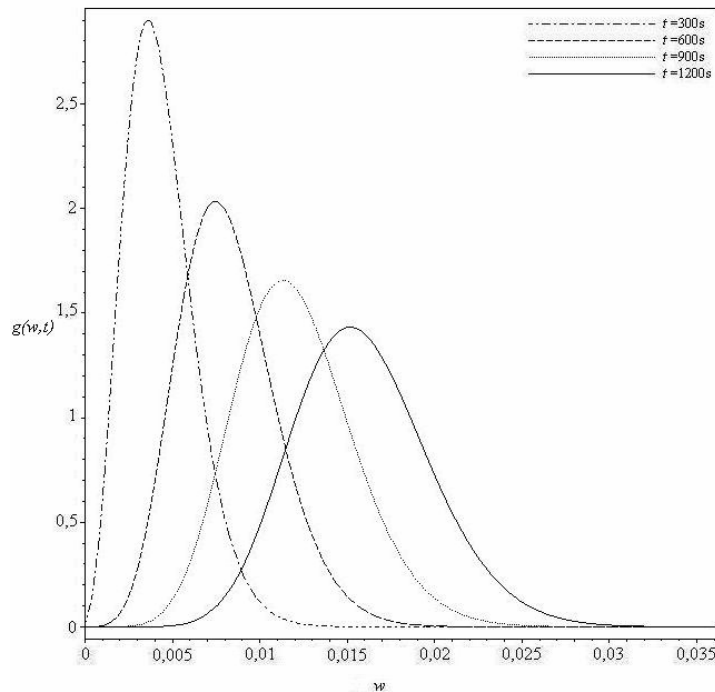


Figura B.8 – Distribuição de frequência no domínio **G** no experimento 2:  $a_2 = 2,56 \cdot 10^{-2}$  e  $\alpha_1 = 1,39 \cdot 10^{-2}$ .

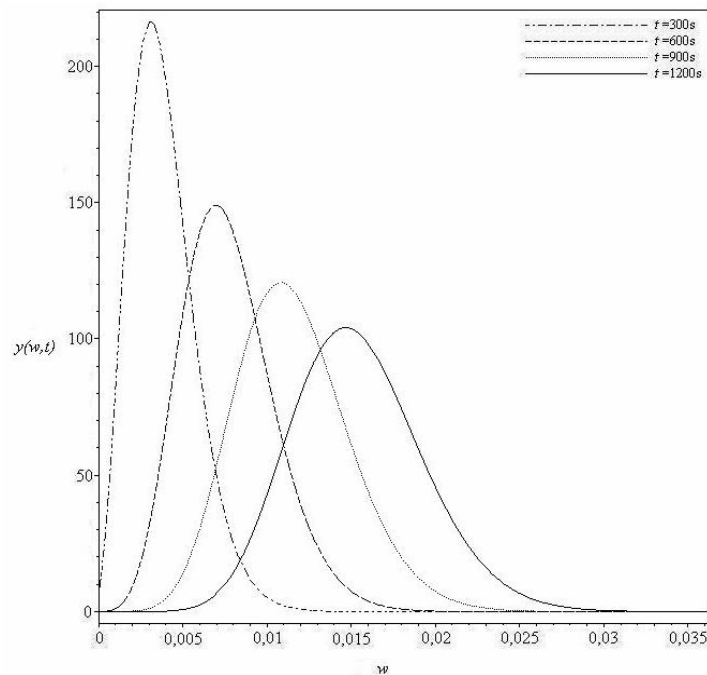


Figura B.9 – Distribuição de frequência total no experimento 2:  $a_2 = 2,56 \cdot 10^{-2}$  e  $\alpha_1 = 1,39 \cdot 10^{-2}$ .

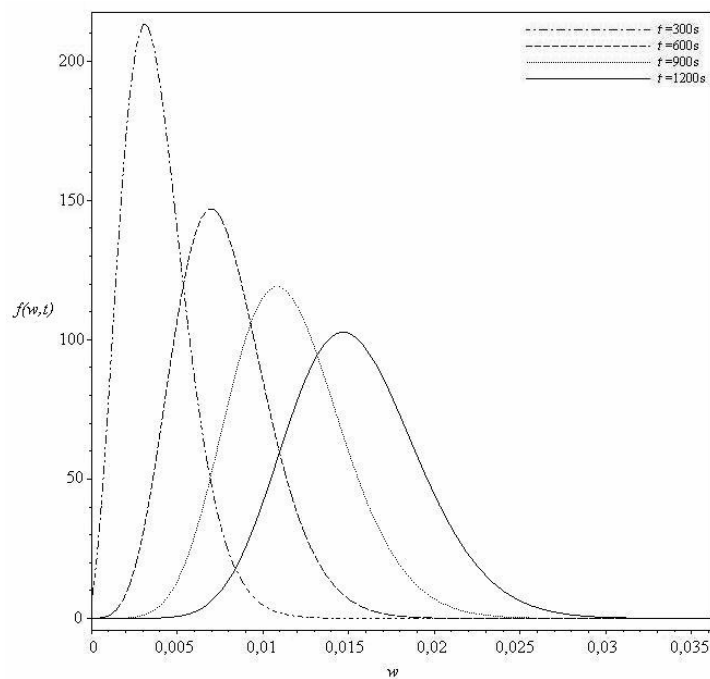


Figura B.10 – Distribuição de frequência no domínio  $F$  no experimento 2:  $a_2 = 2,56 \cdot 10^{-2}$  e  $\alpha_2 = 2,21 \cdot 10^{-2}$ .

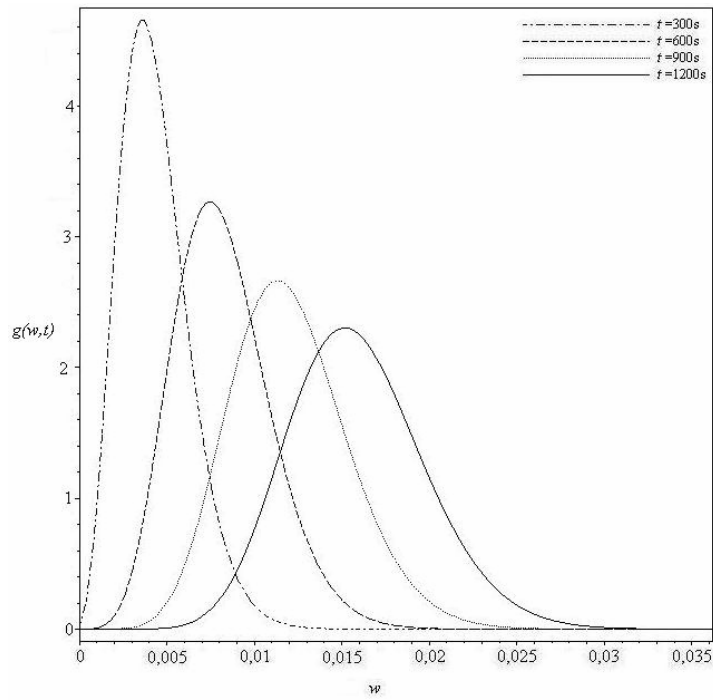


Figura B.11 – Distribuição de frequência no domínio  $G$  no experimento 2:  $a_2 = 2,56 \cdot 10^{-2}$  e  $\alpha_2 = 2,21 \cdot 10^{-2}$ .

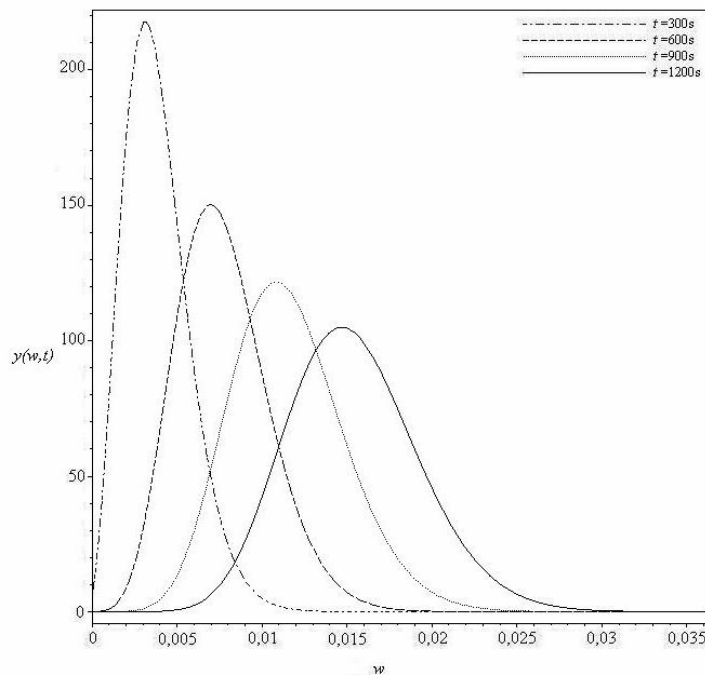


Figura B.12 – Distribuição de frequência total no experimento 2:  $a_2 = 2,56 \cdot 10^{-2}$  e  $\alpha_2 = 2,21 \cdot 10^{-2}$ .

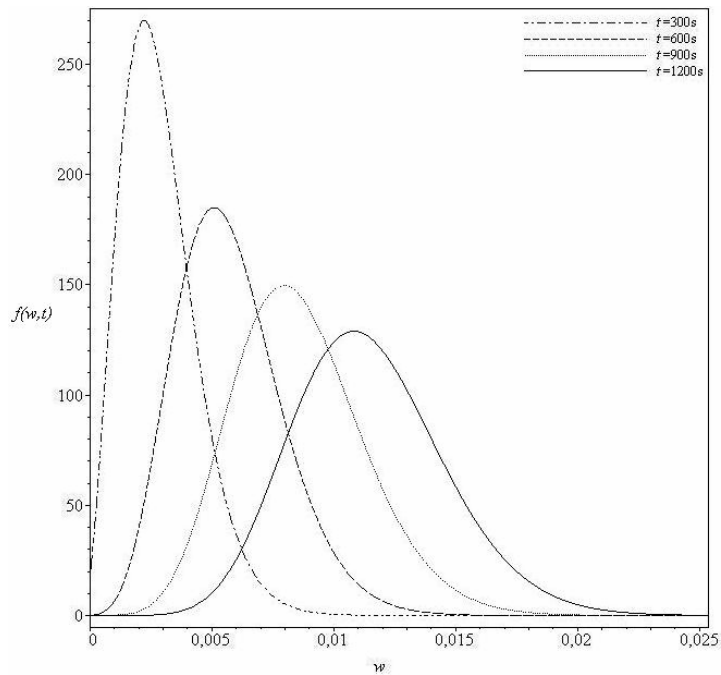


Figura B.13 – Distribuição de frequência no domínio  $F$  no experimento 10:  $a_1 = 2,22 \cdot 10^{-2}$  e  $\alpha_1 = 1,34 \cdot 10^{-2}$ .

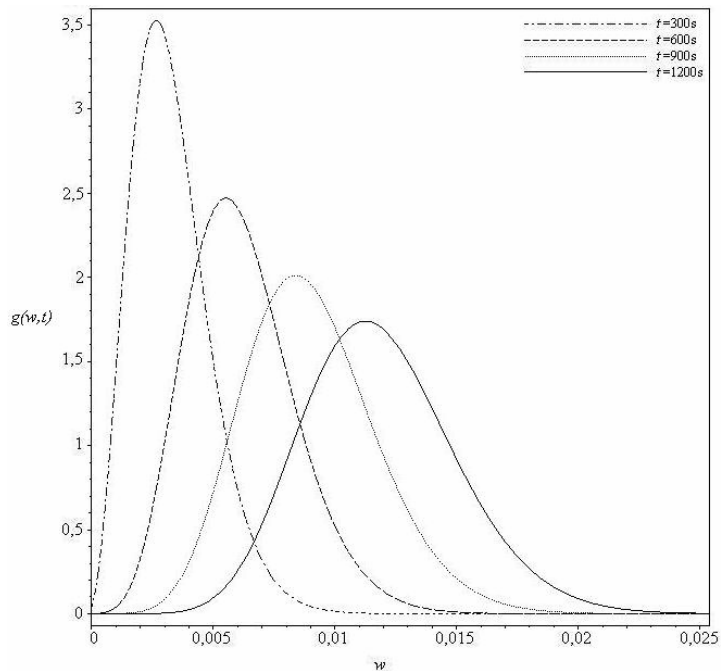


Figura B.14 – Distribuição de frequência no domínio  $G$  no experimento 10:  $a_1 = 2,22 \cdot 10^{-2}$  e  $\alpha_1 = 1,34 \cdot 10^{-2}$ .



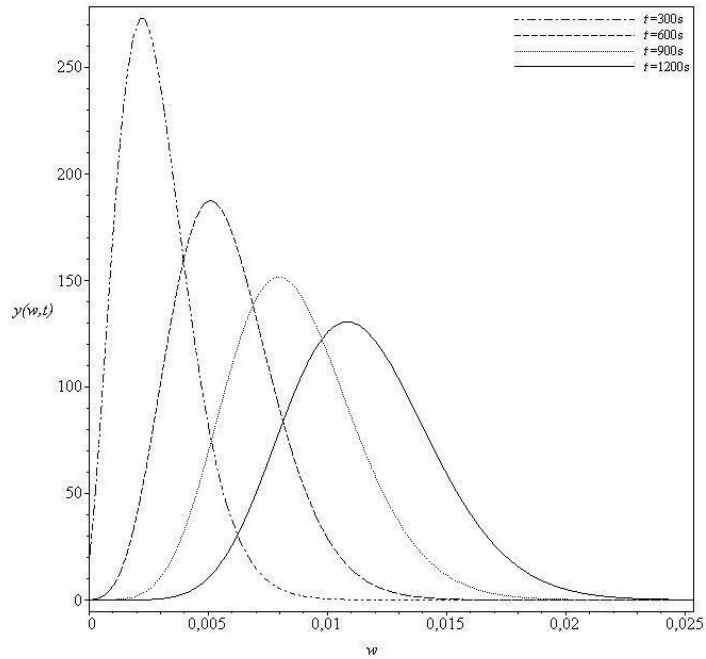


Figura B.15 – Distribuição de frequência total no experimento 10:  $a_1 = 2,22 \cdot 10^{-2}$  e  $\alpha_1 = 1,34 \cdot 10^{-2}$ .

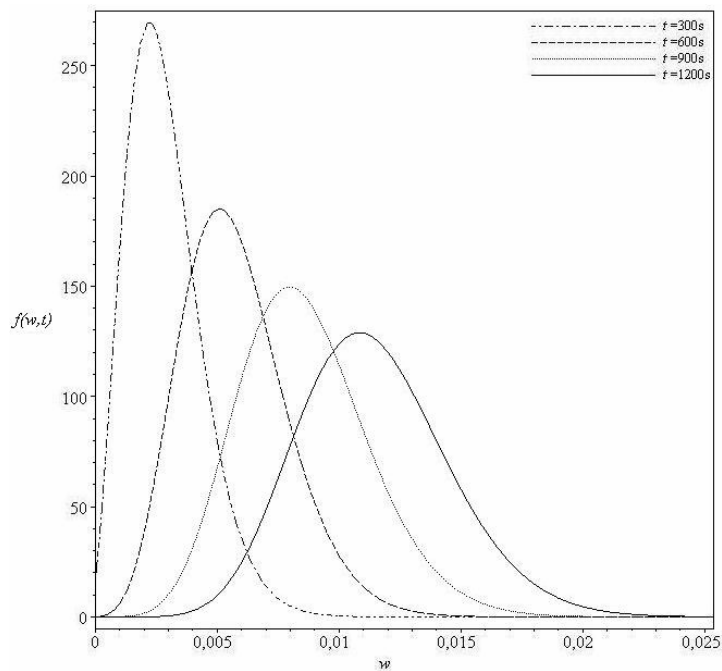


Figura B.16 – Distribuição de frequência no domínio  $F$  no experimento 10:  $a_1 = 2,22 \cdot 10^{-2}$  e  $\alpha_2 = 2,14 \cdot 10^{-2}$ .

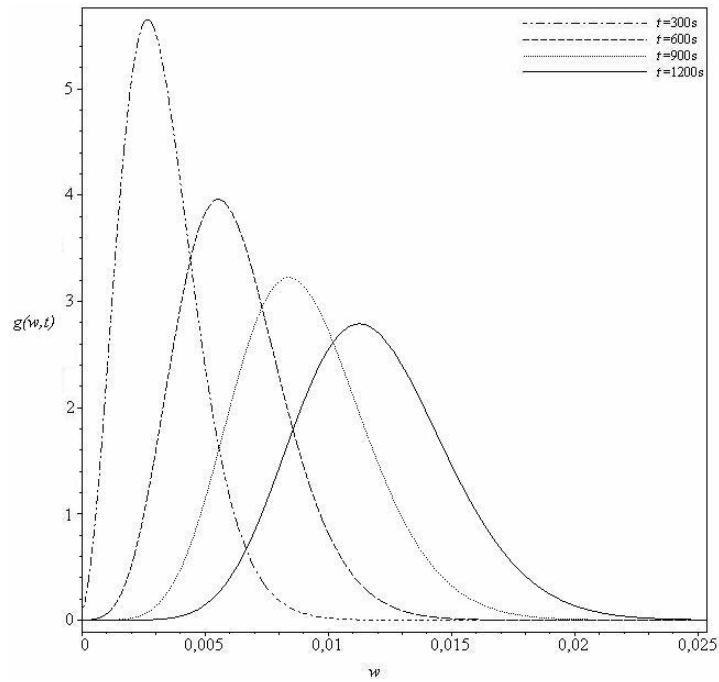


Figura B.17 – Distribuição de frequência no domínio  $\mathbf{G}$  no experimento 10:  $a_1 = 2,22 \cdot 10^{-2}$  e  $\alpha_2 = 2,14 \cdot 10^{-2}$ .

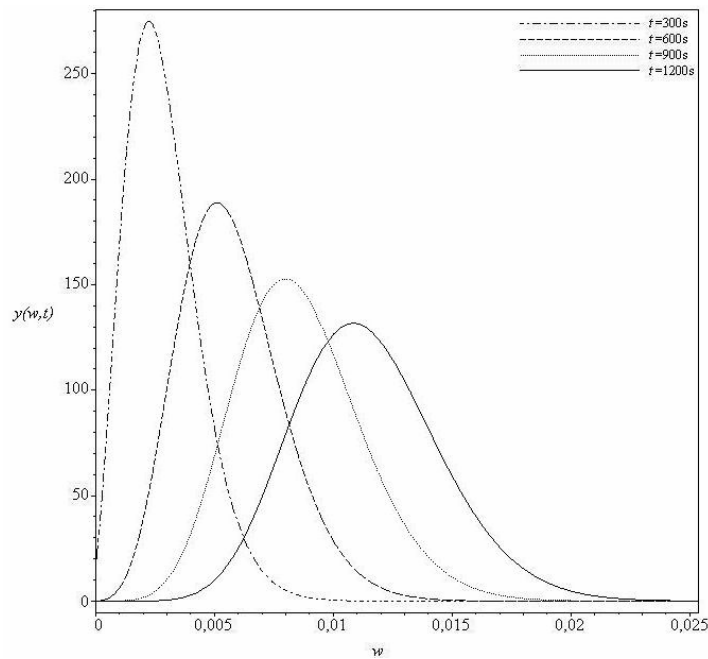


Figura B.18 – Distribuição de frequência total no experimento 10:  $a_1 = 2,22 \cdot 10^{-2}$  e  $\alpha_2 = 2,14 \cdot 10^{-2}$ .

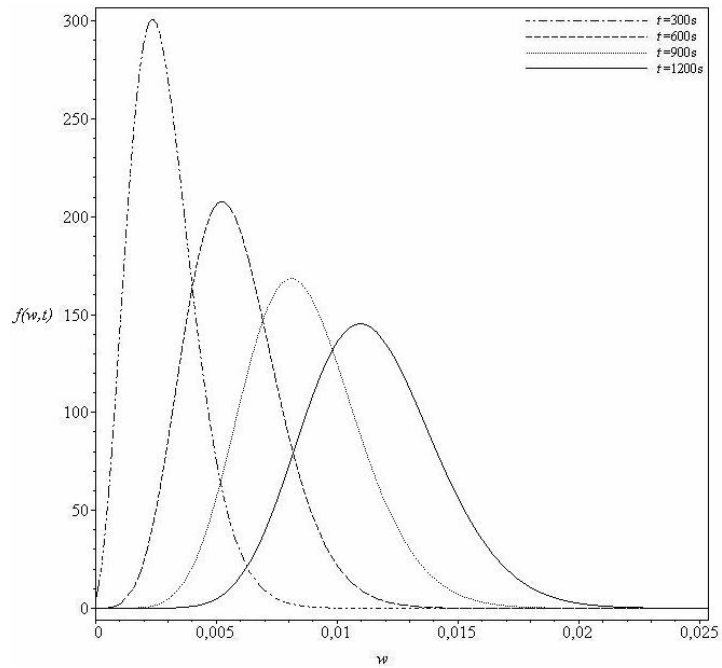


Figura B.19 – Distribuição de frequência no domínio  $\mathbf{F}$  no experimento 10:  $a_2 = 2,84 \cdot 10^{-2}$  e  $\alpha_I = 1,34 \cdot 10^{-2}$ .

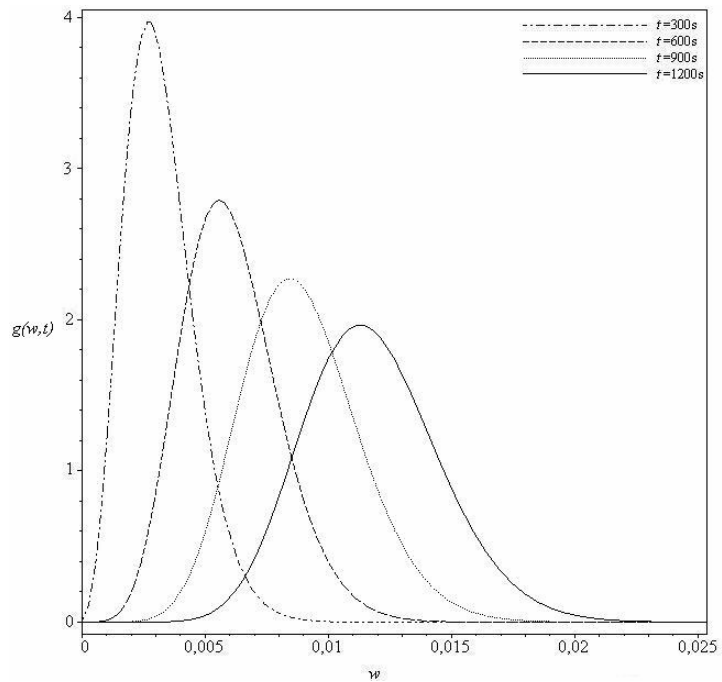


Figura B.20 – Distribuição de frequência no domínio  $\mathbf{G}$  no experimento 10:  $a_2 = 2,84 \cdot 10^{-2}$  e  $\alpha_I = 1,34 \cdot 10^{-2}$ .

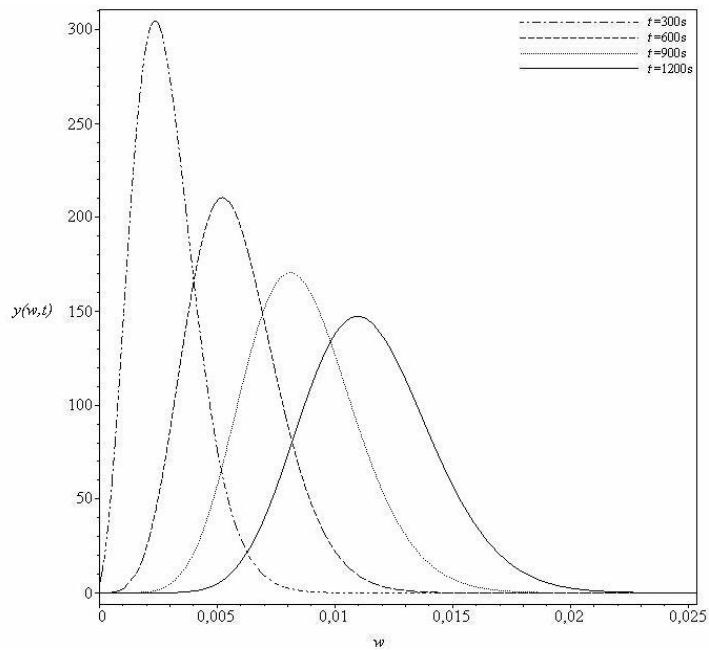


Figura B.21 – Distribuição de frequência total no experimento 10:  $\alpha_2 = 2,84 \cdot 10^{-2}$  e  $\alpha_1 = 1,34 \cdot 10^{-2}$ .

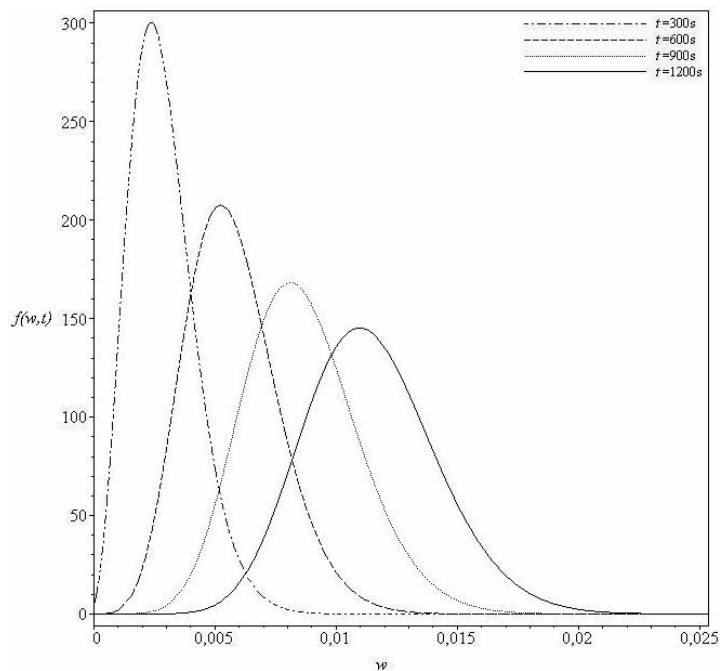


Figura B.22 – Distribuição de frequência no domínio  $F$  no experimento 10:  $\alpha_2 = 2,84 \cdot 10^{-2}$  e  $\alpha_2 = 2,14 \cdot 10^{-2}$ .

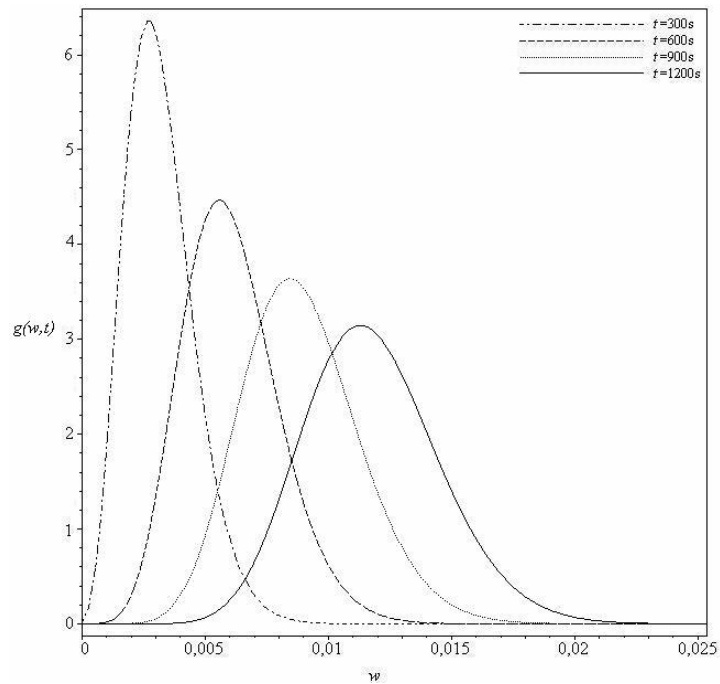


Figura B.23 – Distribuição de frequência no domínio **G** no experimento 10:  $a_2 = 2,84 \cdot 10^{-2}$  e  $\alpha_2 = 2,14 \cdot 10^{-2}$ .

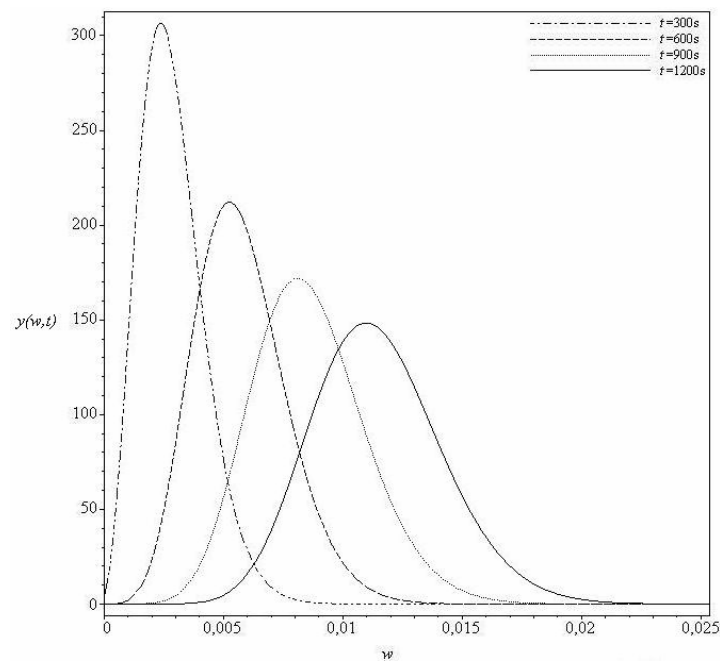


Figura B.24 – Distribuição de frequência total no experimento 10:  $a_2 = 2,84 \cdot 10^{-2}$  e  $\alpha_2 = 2,14 \cdot 10^{-2}$ .

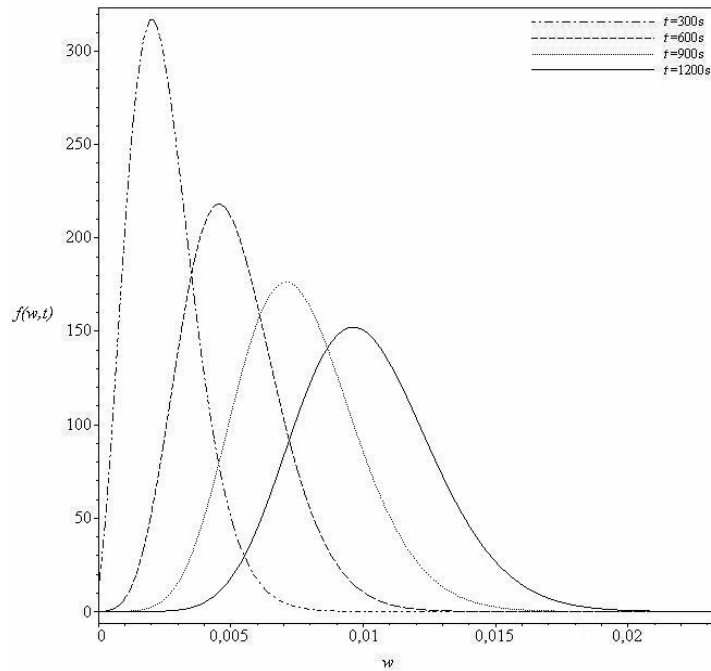


Figura B.25 – Distribuição de frequência no domínio **F** no experimento 11:  $a_l = 2,43 \cdot 10^{-2}$  e  $\alpha_l = 2,02 \cdot 10^{-2}$ .

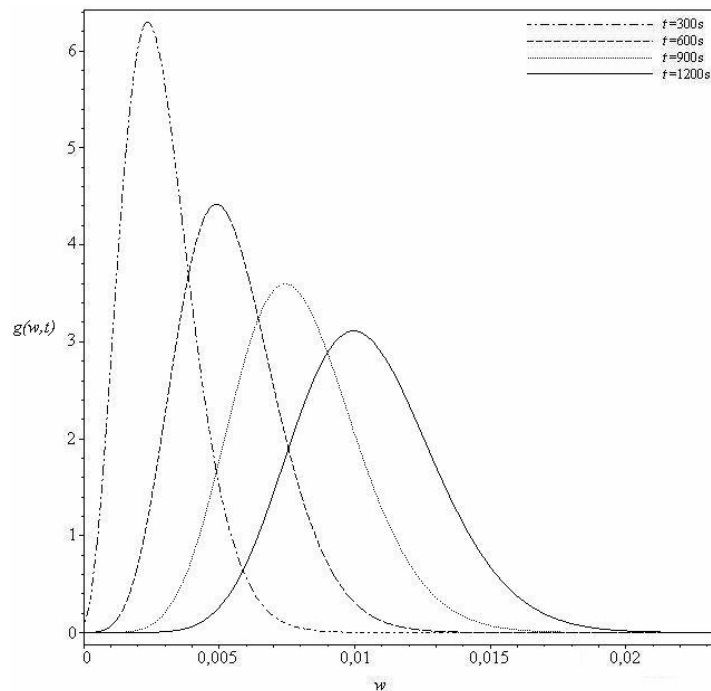


Figura B.26 – Distribuição de frequência no domínio **G** no experimento 11:  $a_l = 2,43 \cdot 10^{-2}$  e  $\alpha_l = 2,02 \cdot 10^{-2}$ .

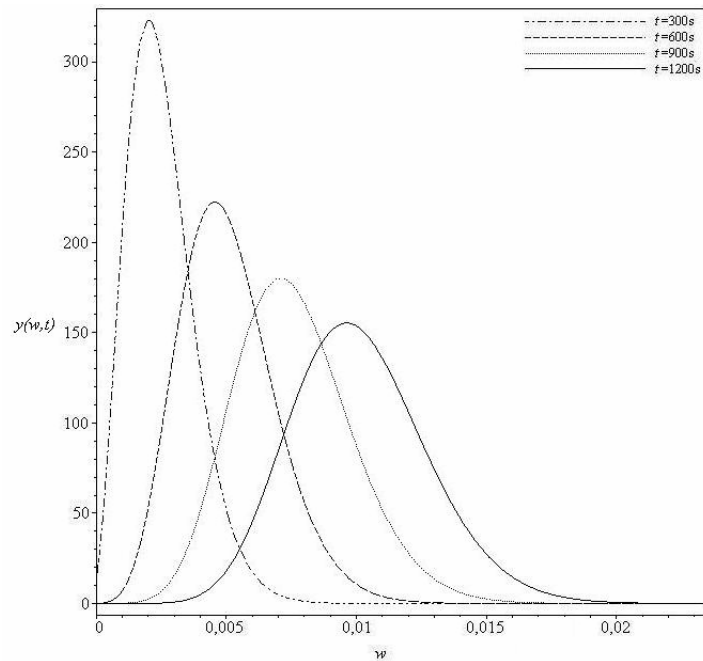


Figura B.27 – Distribuição de frequência total no experimento 11:  $a_1 = 2,43 \cdot 10^{-2}$  e  $\alpha_1 = 2,02 \cdot 10^{-2}$ .

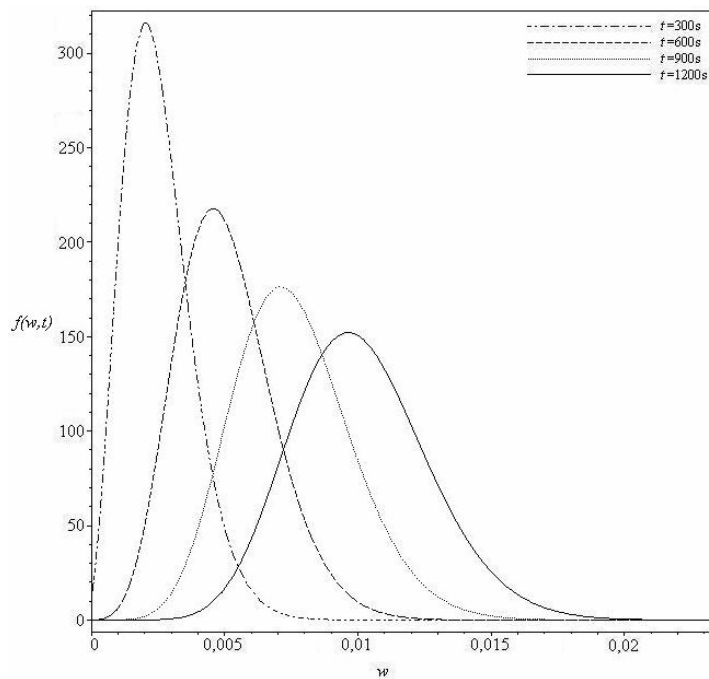


Figura B.28 – Distribuição de frequência no domínio **F** no experimento 11:  $a_1 = 2,43 \cdot 10^{-2}$  e  $\alpha_2 = 3,3 \cdot 10^{-2}$ .

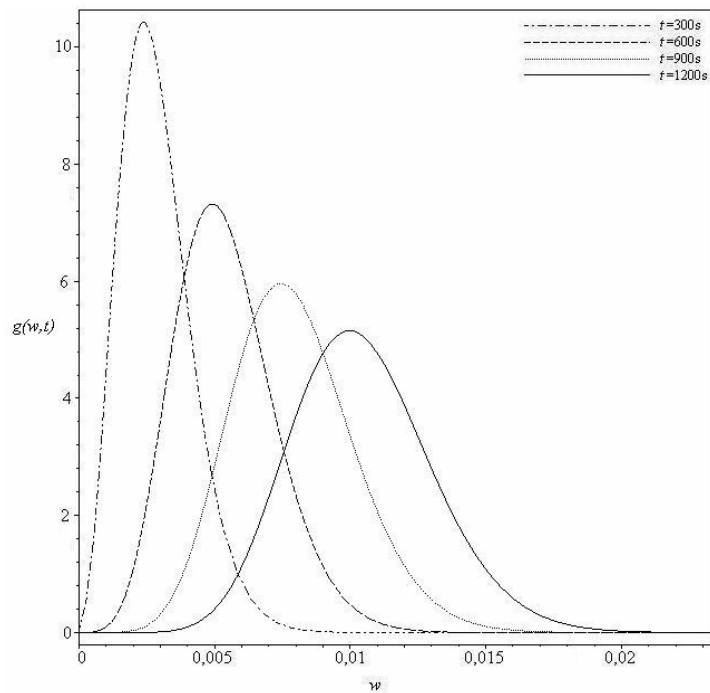


Figura B.29 – Distribuição de frequência no domínio  $G$  no experimento 11:  $a_1 = 2,43 \cdot 10^{-2}$  e  $\alpha_2 = 3,3 \cdot 10^{-2}$ .

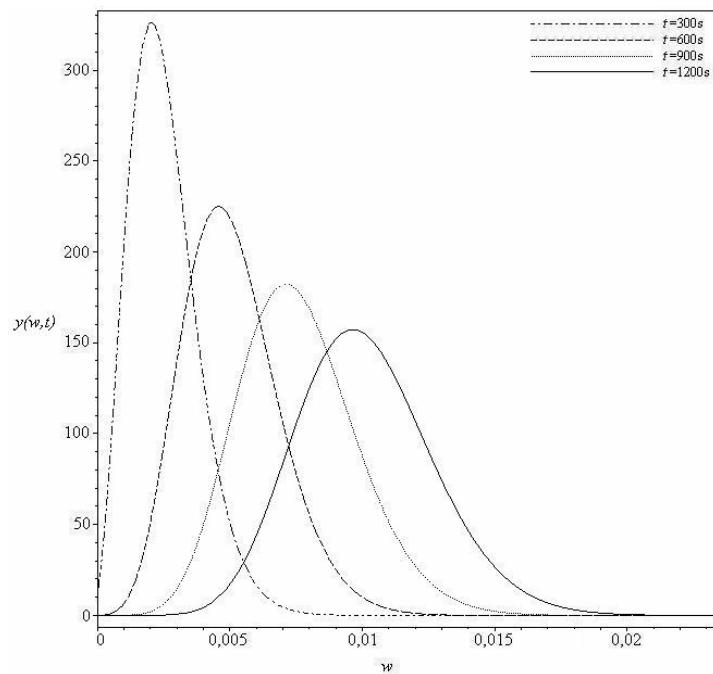


Figura B.30 – Distribuição de frequência total no experimento 11:  $a_1 = 2,43 \cdot 10^{-2}$  e  $\alpha_2 = 3,3 \cdot 10^{-2}$ .



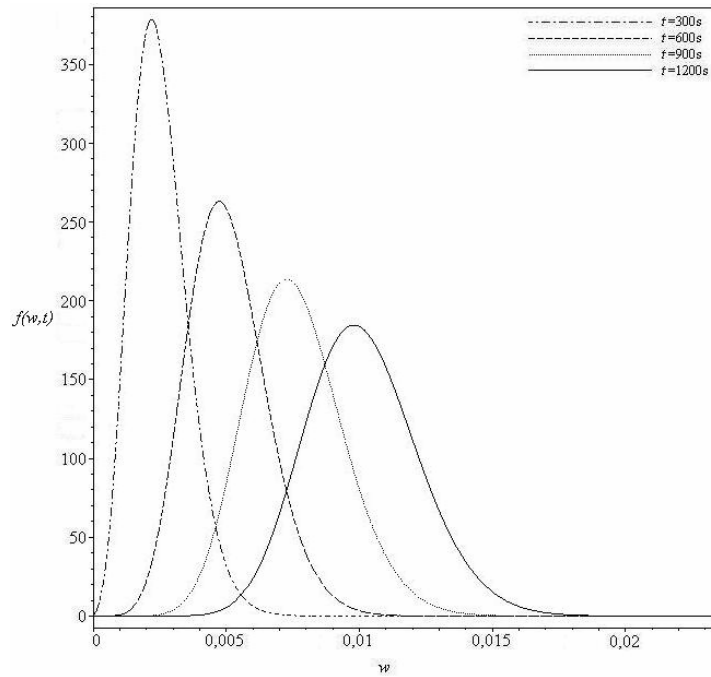


Figura B.31 – Distribuição de frequência no domínio **F** no experimento 11:  $a_2 = 3,6 \cdot 10^{-2}$  e  $\alpha_2 = 3,3 \cdot 10^{-2}$ .

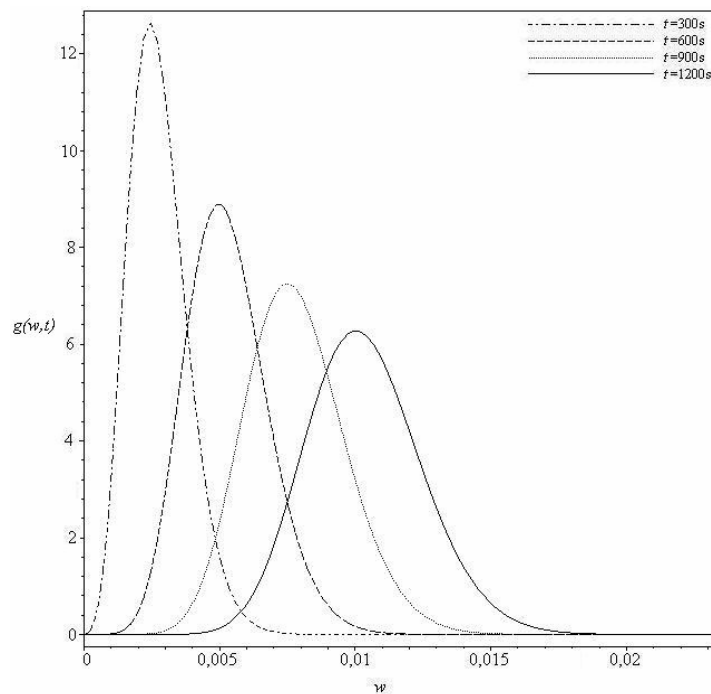


Figura B.32 – Distribuição de frequência no domínio **G** no experimento 11:  $a_2 = 3,6 \cdot 10^{-2}$  e  $\alpha_2 = 3,3 \cdot 10^{-2}$ .

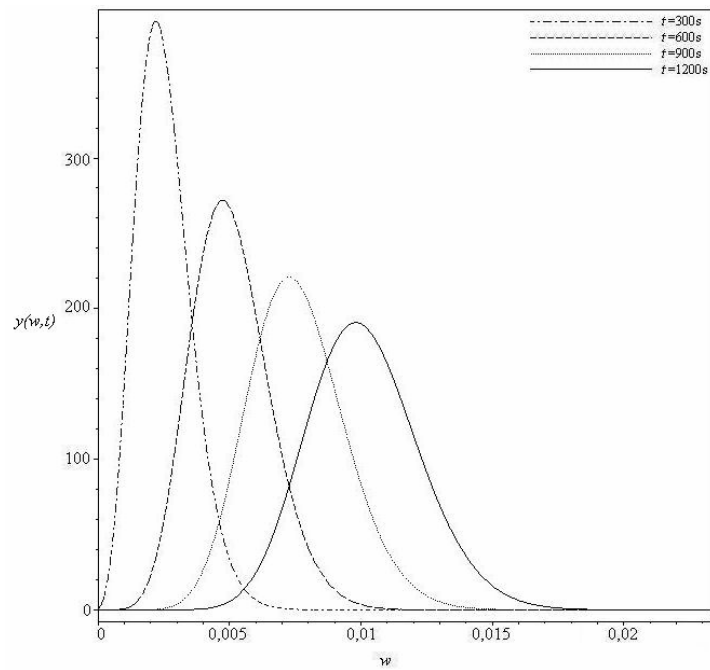


Figura B.33 – Distribuição de frequência total no experimento 11:  $a_2 = 3,6 \cdot 10^{-2}$  e  $a_2 = 3,3 \cdot 10^{-2}$ .