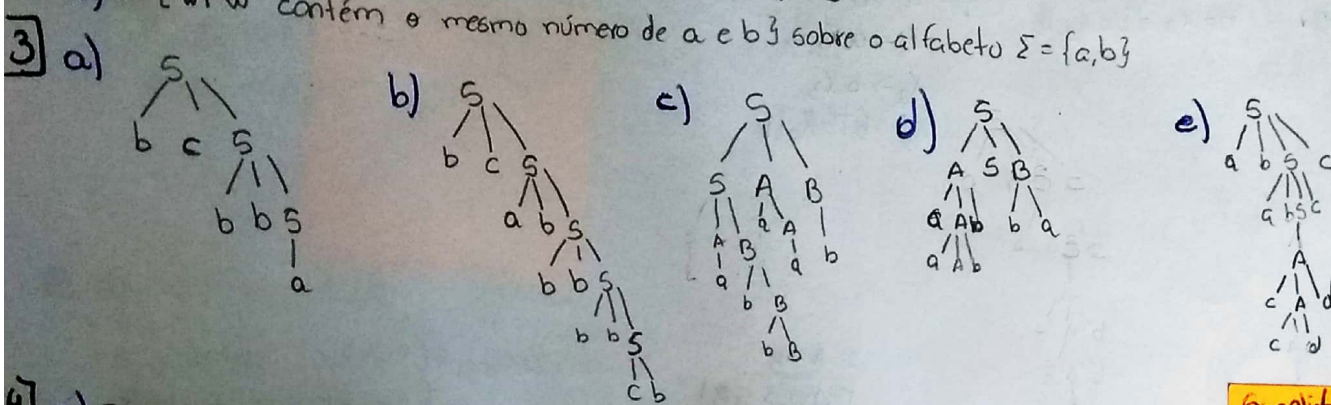


Lista A2
Versão final

- 1) $G = (\{S, A\}, \{0, 1\}, \{S \rightarrow A1A1A1A, A \rightarrow 0A1A1A1E\}, S)$
 b) $G = (\{S, A\}, \{0, 1\}, \{S \rightarrow A1A1A1A, A \rightarrow 0A1A1A1E\}, S)$
 c) $G = (\{S, A\}, \{a, b\}, \{S \rightarrow AAS1E, A \rightarrow b1a\}, S)$
 d) $G = (\{S, A\}, \{a, b\}, \{S \rightarrow aA1bA, A \rightarrow aS1bS1E\}, S)$
 e) $G = (\{S, A\}, \{a, b\}, \{S \rightarrow bSb1A, A \rightarrow aA1E\}, S)$
 f) $G = (\{S, A, C\}, \{a, b, c\}, \{S \rightarrow AC, A \rightarrow abb1aAbb, C \rightarrow cC1c\}, S)$
 g) $G = (\{S, A, B\}, \{a, b\}, \{S \rightarrow AB1E, A \rightarrow aAB1E, B \rightarrow bBA1E\}, S)$

- 2) a) $L = \{w \mid w \text{ é a palavra } abbb\}$ sobre o alfabeto $\Sigma = \{a, b\}$
 b) $L = \{a^{2n}b^m \mid n, m \geq 0\}$ sobre o alfabeto $\Sigma = \{a, b\}$
 c) $L = \{(ab)^n(cd)^m(ba)^n(dc)^n \mid n, m \geq 0\}$ sobre o alfabeto $\Sigma = \{a, b, c, d\}$
 d) $L = \{a^n b^{2m} \mid n \geq 0, m \geq 0\}$ sobre o alfabeto $\Sigma = \{a, b\}$
 e) $L = \{w \mid w \text{ contém o mesmo número de } a \text{ e } b\}$ sobre o alfabeto $\Sigma = \{a, b\}$



- 4) a) $S \rightarrow AB1SCB$
 $A \rightarrow aA1C$
 $B \rightarrow bB1b$
 $C \rightarrow cC1E$
- 1º $A \rightarrow E$:
 $V_E = \{C, A, S\}$
 $S \rightarrow AB1SCB1B$
 $A \rightarrow aA1C1a$
 $B \rightarrow bB1b$
 $C \rightarrow cC1C$
- 2º $A \rightarrow B$:
 Fecha-S = $\{B\}$
 Fecha-A = $\{C\}$
 Fecha-B = \emptyset
 Fecha-C = \emptyset
 $S \rightarrow AB1SCB1b1b1b$
 $A \rightarrow aA1c1a1c$
 $B \rightarrow bB1b$
 $C \rightarrow cC1c$
- 3º Geradores e Atingíveis:
 Geradores = $\{S, A, B, C\}$
 Geradores = Atingíveis
 $P_{\text{simpl}} = \{S \rightarrow AB1SCB1S1b1b1b, A \rightarrow aA1c1a1c, B \rightarrow bB1b, C \rightarrow cC1c\}$
 $G_{\text{simpl}} = (\{S, A, B, C\}, \{a, b, c\}, P_{\text{simpl}}, S)$

Simplificação:
 Remoção: $A \rightarrow E$
 $A \rightarrow B$
 Geradores e Atingíveis

- FNC: 1 Simplificar ✓
- 2) ≥ 2
 $S \rightarrow AB1SCB1S1b1b1b$
 $A \rightarrow Ta1Tc1a1c$
 $B \rightarrow Tb1b1b$
 $C \rightarrow Tc1C1c$
 $Ta \rightarrow a$
 $Tb \rightarrow b$
 $Tc \rightarrow c$
- 3) ≥ 3
 $S \rightarrow AB1SV11S1b1b1b$
 $A \rightarrow Ta1Tc1a1c$
 $B \rightarrow Tb1b1b$
 $C \rightarrow Tc1C1c$
 $Ta \rightarrow a$
 $Tb \rightarrow b$
 $Tc \rightarrow c$
 $V_1 \rightarrow CB$
- $G_{\text{FNC}} = (\{S, A, B, C, T_a, T_b, T_c, V_1\}, \{a, b, c\}, \{Ta \rightarrow a, Tb \rightarrow b, Tc \rightarrow c, V_1 \rightarrow CB, C \rightarrow Tc1C1c, B \rightarrow Tb1b1b, A \rightarrow Ta1Tc1a1c, S \rightarrow AB1SV11S1b1b1b\}, S)$

FNC: 1 Simplificar
 2 ≥ 2
 3 ≥ 3
 4 ≥ 4

- 4 Remoção
 $S = X_1 \rightarrow X_2X_31X_4X_51X_6X_71X_8X_91X_{10}X_{11}1X_{12}X_{13}1X_{14}X_{15}1X_{16}X_{17}1X_{18}X_{19}1X_{20}X_{21}1X_{22}X_{23}1X_{24}X_{25}1X_{26}X_{27}1X_{28}X_{29}1X_{30}X_{31}1X_{32}X_{33}1X_{34}X_{35}1X_{36}X_{37}1X_{38}X_{39}1X_{40}X_{41}1X_{42}X_{43}1X_{44}X_{45}1X_{46}X_{47}1X_{48}X_{49}1X_{50}X_{51}1X_{52}X_{53}1X_{54}X_{55}1X_{56}X_{57}1X_{58}X_{59}1X_{60}X_{61}1X_{62}X_{63}1X_{64}X_{65}1X_{66}X_{67}1X_{68}X_{69}1X_{70}X_{71}1X_{72}X_{73}1X_{74}X_{75}1X_{76}X_{77}1X_{78}X_{79}1X_{80}X_{81}1X_{82}X_{83}1X_{84}X_{85}1X_{86}X_{87}1X_{88}X_{89}1X_{90}X_{91}1X_{92}X_{93}1X_{94}X_{95}1X_{96}X_{97}1X_{98}X_{99}1X_{100}X_{101}1X_{102}X_{103}1X_{104}X_{105}1X_{106}X_{107}1X_{108}X_{109}1X_{110}X_{111}1X_{112}X_{113}1X_{114}X_{115}1X_{116}X_{117}1X_{118}X_{119}1X_{120}X_{121}1X_{122}X_{123}1X_{124}X_{125}1X_{126}X_{127}1X_{128}X_{129}1X_{130}X_{131}1X_{132}X_{133}1X_{134}X_{135}1X_{136}X_{137}1X_{138}X_{139}1X_{140}X_{141}1X_{142}X_{143}1X_{144}X_{145}1X_{146}X_{147}1X_{148}X_{149}1X_{150}X_{151}1X_{152}X_{153}1X_{154}X_{155}1X_{156}X_{157}1X_{158}X_{159}1X_{160}X_{161}1X_{162}X_{163}1X_{164}X_{165}1X_{166}X_{167}1X_{168}X_{169}1X_{170}X_{171}1X_{172}X_{173}1X_{174}X_{175}1X_{176}X_{177}1X_{178}X_{179}1X_{180}X_{181}1X_{182}X_{183}1X_{184}X_{185}1X_{186}X_{187}1X_{188}X_{189}1X_{190}X_{191}1X_{192}X_{193}1X_{194}X_{195}1X_{196}X_{197}1X_{198}X_{199}1X_{200}X_{201}1X_{202}X_{203}1X_{204}X_{205}1X_{206}X_{207}1X_{208}X_{209}1X_{210}X_{211}1X_{212}X_{213}1X_{214}X_{215}1X_{216}X_{217}1X_{218}X_{219}1X_{220}X_{221}1X_{222}X_{223}1X_{224}X_{225}1X_{226}X_{227}1X_{228}X_{229}1X_{230}X_{231}1X_{232}X_{233}1X_{234}X_{235}1X_{236}X_{237}1X_{238}X_{239}1X_{240}X_{241}1X_{242}X_{243}1X_{244}X_{245}1X_{246}X_{247}1X_{248}X_{249}1X_{250}X_{251}1X_{252}X_{253}1X_{254}X_{255}1X_{256}X_{257}1X_{258}X_{259}1X_{260}X_{261}1X_{262}X_{263}1X_{264}X_{265}1X_{266}X_{267}1X_{268}X_{269}1X_{270}X_{271}1X_{272}X_{273}1X_{274}X_{275}1X_{276}X_{277}1X_{278}X_{279}1X_{280}X_{281}1X_{282}X_{283}1X_{284}X_{285}1X_{286}X_{287}1X_{288}X_{289}1X_{290}X_{291}1X_{292}X_{293}1X_{294}X_{295}1X_{296}X_{297}1X_{298}X_{299}1X_{300}X_{301}1X_{302}X_{303}1X_{304}X_{305}1X_{306}X_{307}1X_{308}X_{309}1X_{310}X_{311}1X_{312}X_{313}1X_{314}X_{315}1X_{316}X_{317}1X_{318}X_{319}1X_{320}X_{321}1X_{322}X_{323}1X_{324}X_{325}1X_{326}X_{327}1X_{328}X_{329}1X_{330}X_{331}1X_{332}X_{333}1X_{334}X_{335}1X_{336}X_{337}1X_{338}X_{339}1X_{340}X_{341}1X_{342}X_{343}1X_{344}X_{345}1X_{346}X_{347}1X_{348}X_{349}1X_{350}X_{351}1X_{352}X_{353}1X_{354}X_{355}1X_{356}X_{357}1X_{358}X_{359}1X_{360}X_{361}1X_{362}X_{363}1X_{364}X_{365}1X_{366}X_{367}1X_{368}X_{369}1X_{370}X_{371}1X_{372}X_{373}1X_{374}X_{375}1X_{376}X_{377}1X_{378}X_{379}1X_{380}X_{381}1X_{382}X_{383}1X_{384}X_{385}1X_{386}X_{387}1X_{388}X_{389}1X_{390}X_{391}1X_{392}X_{393}1X_{394}X_{395}1X_{396}X_{397}1X_{398}X_{399}1X_{400}X_{401}1X_{402}X_{403}1X_{404}X_{405}1X_{406}X_{407}1X_{408}X_{409}1X_{410}X_{411}1X_{412}X_{413}1X_{414}X_{415}1X_{416}X_{417}1X_{418}X_{419}1X_{420}X_{421}1X_{422}X_{423}1X_{424}X_{425}1X_{426}X_{427}1X_{428}X_{429}1X_{430}X_{431}1X_{432}X_{433}1X_{434}X_{435}1X_{436}X_{437}1X_{438}X_{439}1X_{440}X_{441}1X_{442}X_{443}1X_{444}X_{445}1X_{446}X_{447}1X_{448}X_{449}1X_{450}X_{451}1X_{452}X_{453}1X_{454}X_{455}1X_{456}X_{457}1X_{458}X_{459}1X_{460}X_{461}1X_{462}X_{463}1X_{464}X_{465}1X_{466}X_{467}1X_{468}X_{469}1X_{470}X_{471}1X_{472}X_{473}1X_{474}X_{475}1X_{476}X_{477}1X_{478}X_{479}1X_{480}X_{481}1X_{482}X_{483}1X_{484}X_{485}1X_{486}X_{487}1X_{488}X_{489}1X_{490}X_{491}1X_{492}X_{493}1X_{494}X_{495}1X_{496}X_{497}1X_{498}X_{499}1X_{500}X_{501}1X_{502}X_{503}1X_{504}X_{505}1X_{506}X_{507}1X_{508}X_{509}1X_{510}X_{511}1X_{512}X_{513}1X_{514}X_{515}1X_{516}X_{517}1X_{518}X_{519}1X_{520}X_{521}1X_{522}X_{523}1X_{524}X_{525}1X_{526}X_{527}1X_{528}X_{529}1X_{530}X_{531}1X_{532}X_{533}1X_{534}X_{535}1X_{536}X_{537}1X_{538}X_{539}1X_{540}X_{541}1X_{542}X_{543}1X_{544}X_{545}1X_{546}X_{547}1X_{548}X_{549}1X_{550}X_{551}1X_{552}X_{553}1X_{554}X_{555}1X_{556}X_{557}1X_{558}X_{559}1X_{560}X_{561}1X_{562}X_{563}1X_{564}X_{565}1X_{566}X_{567}1X_{568}X_{569}1X_{570}X_{571}1X_{572}X_{573}1X_{574}X_{575}1X_{576}X_{577}1X_{578}X_{579}1X_{580}X_{581}1X_{582}X_{583}1X_{584}X_{585}1X_{586}X_{587}1X_{588}X_{589}1X_{590}X_{591}1X_{592}X_{593}1X_{594}X_{595}1X_{596}X_{597}1X_{598}X_{599}1X_{600}X_{601}1X_{602}X_{603}1X_{604}X_{605}1X_{606}X_{607}1X_{608}X_{609}1X_{610}X_{611}1X_{612}X_{613}1X_{614}X_{615}1X_{616}X_{617}1X_{618}X_{619}1X_{620}X_{621}1X_{622}X_{623}1X_{624}X_{625}1X_{626}X_{627}1X_{628}X_{629}1X_{630}X_{631}1X_{632}X_{633}1X_{634}X_{635}1X_{636}X_{637}1X_{638}X_{639}1X_{640}X_{641}1X_{642}X_{643}1X_{644}X_{645}1X_{646}X_{647}1X_{648}X_{649}1X_{650}X_{651}1X_{652}X_{653}1X_{654}X_{655}1X_{656}X_{657}1X_{658}X_{659}1X_{660}X_{661}1X_{662}X_{663}1X_{664}X_{665}1X_{666}X_{667}1X_{668}X_{669}1X_{670}X_{671}1X_{672}X_{673}1X_{674}X_{675}1X_{676}X_{677}1X_{678}X_{679}1X_{680}X_{681}1X_{682}X_{683}1X_{684}X_{685}1X_{686}X_{687}1X_{688}X_{689}1X_{690}X_{691}1X_{692}X_{693}1X_{694}X_{695}1X_{696}X_{697}1X_{698}X_{699}1X_{700}X_{701}1X_{702}X_{703}1X_{704}X_{705}1X_{706}X_{707}1X_{708}X_{709}1X_{710}X_{711}1X_{712}X_{713}1X_{714}X_{715}1X_{716}X_{717}1X_{718}X_{719}1X_{720}X_{721}1X_{722}X_{723}1X_{724}X_{725}1X_{726}X_{727}1X_{728}X_{729}1X_{730}X_{731}1X_{732}X_{733}1X_{734}X_{735}1X_{736}X_{737}1X_{738}X_{739}1X_{740}X_{741}1X_{742}X_{743}1X_{744}X_{745}1X_{746}X_{747}1X_{748}X_{749}1X_{750}X_{751}1X_{752}X_{753}1X_{754}X_{755}1X_{756}X_{757}1X_{758}X_{759}1X_{760}X_{761}1X_{762}X_{763}1X_{764}X_{765}1X_{766}X_{767}1X_{768}X_{769}1X_{770}X_{771}1X_{772}X_{773}1X_{774}X_{775}1X_{776}X_{777}1X_{778}X_{779}1X_{780}X_{781}1X_{782}X_{783}1X_{784}X_{785}1X_{786}X_{787}1X_{788}X_{789}1X_{790}X_{791}1X_{792}X_{793}1X_{794}X_{795}1X_{796}X_{797}1X_{798}X_{799}1X_{800}X_{801}1X_{802}X_{803}1X_{804}X_{805}1X_{806}X_{807}1X_{808}X_{809}1X_{810}X_{811}1X_{812}X_{813}1X_{814}X_{815}1X_{816}X_{817}1X_{818}X_{819}1X_{820}X_{821}1X_{822}X_{823}1X_{824}X_{825}1X_{826}X_{827}1X_{828}X_{829}1X_{830}X_{831}1X_{832}X_{833}1X_{834}X_{835}1X_{836}X_{837}1X_{838}X_{839}1X_{840}X_{841}1X_{842}X_{843}1X_{844}X_{845}1X_{846}X_{847}1X_{848}X_{849}1X_{850}X_{851}1X_{852}X_{853}1X_{854}X_{855}1X_{856}X_{857}1X_{858}X_{859}1X_{860}X_{861}1X_{862}X_{863}1X_{864}X_{865}1X_{866}X_{867}1X_{868}X_{869}1X_{870}X_{871}1X_{872}X_{873}1X_{874}X_{875}1X_{876}X_{877}1X_{878}X_{879}1X_{880}X_{881}1X_{882}X_{883}1X_{884}X_{885}1X_{886}X_{887}1X_{888}X_{889}1X_{890}X_{891}1X_{892}X_{893}1X_{894}X_{895}1X_{896}X_{897}1X_{898}X_{899}1X_{900}X_{901}1X_{902}X_{903}1X_{904}X_{905}1X_{906}X_{907}1X_{908}X_{909}1X_{910}X_{911}1X_{912}X_{913}1X_{914}X_{915}1X_{916}X_{917}1X_{918}X_{919}1X_{920}X_{921}1X_{922}X_{923}1X_{924}X_{925}1X_{926}X_{927}1X_{928}X_{929}1X_{930}X_{931}1X_{932}X_{933}1X_{934}X_{935}1X_{936}X_{937}1X_{938}X_{939}1X_{940}X_{941}1X_{942}X_{943}1X_{944}X_{945}1X_{946}X_{947}1X_{948}X_{949}1X_{950}X_{951}1X_{952}X_{953}1X_{954}X_{955}1X_{956}X_{957}1X_{958}X_{959}1X_{960}X_{961}1X_{962}X_{963}1X_{964}X_{965}1X_{966}X_{967}1X_{968}X_{969}1X_{970}X_{971}1X_{972}X_{973}1X_{974}X_{975}1X_{976}X_{977}1X_{978}X_{979}1X_{980}X_{981}1X_{982}X_{983}1X_{984}X_{985}1X_{986}X_{987}1X_{988}X_{989}1X_{990}X_{991}1X_{992}X_{993}1X_{994}X_{995}1X_{996}X_{997}1X_{998}X_{999}1X_{1000}X_{1001}1X_{1002}X_{1003}1X_{1004}X_{1005}1X_{1006}X_{1007}1X_{1008}X_{1009}1X_{1010}X_{1011}1X_{1012}X_{1013}1X_{1014}X_{1015}1X_{1016}X_{1017}1X_{1018}X_{1019}1X_{1020}X_{1021}1X_{1022}X_{1023}1X_{1024}X_{1025}1X_{1026}X_{1027}1X_{1028}X_{1029}1X_{1030}X_{1031}1X_{1032}X_{1033}1X_{1034}X_{1035}1X_{1036}X_{1037}1X_{1038}X_{1039}1X_{1040}X_{1041}1X_{1042}X_{1043}1X_{1044}X_{1045}1X_{1046}X_{1047}1X_{1048}X_{1049}1X_{1050}X_{1051}1X_{1052}X_{1053}1X_{1054}X_{1055}1X_{1056}X_{1057}1X_{1058}X_{1059}1X_{1060}X_{1061}1X_{1062}X_{1063}1X_{1064}X_{1065}1X_{1066}X_{1067}1X_{1068}X_{1069}1X_{1070}X_{1071}1X_{1072}X_{1073}1X_{1074}X_{1075}1X_{1076}X_{1077}1X_{1078}X_{1079}1X_{1080}X_{1081}1X_{1082}X_{1083}1X_{1084}X_{1085}1X_{1086}X_{1087}1X_{1088}X_{1089}1X_{1090}X_{1091}1X_{1092}X_{1093}1X_{1094}X_{1095}1X_{1096}X_{1097}1X_{1098}X_{1099}1X_{1100}X_{1101}1X_{1102}X_{1103}1X_{1104}X_{1105}1X_{1106}X_{1107}1X_{1108}X_{1109}1X_{1110}X_{1111}1X_{1112}X_{1113}1X_{1114}X_{1115}1X_{1116}X_{1117}1X_{1118}X_{1119}1X_{1120}X_{1121}1X_{1122}X_{1123}1X_{1124}X_{1125}1X_{1126}X_{1127}1X_{1128}X_{1129}1X_{1130}X_{1131}1X_{1132}X_{1133}1X_{1134}X_{1135}1X_{1136}X_{1137}1X_{1138}X_{1139}1X_{1140}X_{1141}1X_{1142}X_{1143}1X_{1144}X_{1145}1X_{1146}X_{1147}1X_{1148}X_{1149}1X_{1150}X_{1151}1X_{1152}X_{1153}1X_{1154}X_{1155}1X_{1156}X_{1157}1X_{1158}X_{1159}1X_{1160}X_{1161}1X_{1162}X_{1163}1X_{1164}X_{1165}1X_{1166}X_{1167}1X_{1168}X_{1169}1X_{1170}X_{1171}1X_{1172}X_{1173}1X_{1174}X_{1175}1X_{1176}X_{1177}1X_{1178}X_{1179}1X_{1180}X_{1181}1X_{1182}X_{1183}1X_{1184}X_{1185}1X_{1186}X_{1187}1X_{1188}X_{1189}1X_{1190}X_{1191}1X_{1192}X_{1193}1X_{1194}X_{1195}1X_{1196}X_{1197}1X_{1198}X_{1199}1X_{1200}X_{1201}1X_{1202}X_{1203}1X_{1204}X_{1205}1X_{1206}X_{1207}1X_{1208}X_{1209}1X_{1210}X_{1211}1X_{1212}X_{1213}1X_{1214}X_{1215}1X_{1216}X_{1217}1X_{1218}X_{1219}1X_{1220}X_{1221}1X_{1222}X_{1223}1X_{1224}X_{1225}1X_{1226}X_{1227}1X_{1228}X_{1229}1X_{1230}X_{1231}1X_{1232}X_{1233}1X_{1234}X_{1235}1X_{1236}X_{1237}1X_{1238}X_{1239}1X_{1240}X_{1241}1X_{1242}X_{1243}1X_{1244}X_{1245}1X_{1246}X_{1247}1X_{1248}X_{1249}1X_{1250}X_{1251}1X_{1252}X_{1253}1X_{1254}X_{1255}1X_{1256}X_{1257}1X_{1258}X_{1259}1X_{1260}X_{1261}1X_{1262}X_{1263}1X_{1264}X_{1265}1X_{1266}X_{1267}1X_{1268}X_{1269}1X_{1270}X_{1271}1X_{1272}X_{1273}1X_{1274}X_{1275}1X_{1276}X_{1277}1X_{1278}X_{1279}1X_{1280}X_{1281}1X_{1282}X_{1283}1X_{1284}X_{1285}1X_{1286}X_{1287}1X_{1288}X_{1289}1X_{1290}X_{1291}1X_{1292}X_{1293}1X_{1294}X_{1295}1X_{1296}X_{1297}1X_{1298}X_{1299}1X_{1300}X_{1301}1X_{1302}X_{1303}1X_{1304}X_{1305}1X_{1306}X_{1307}1X_{1308}X_{1309}1X_{1310}X_{1311}1X_{1312}X_{1313}1X_{1314}X_{1315}1X_{1316}X_{1317}1X_{1318}X_{1319}1X_{1320}X_{1321}1X_{1322}X_{1323}1X_{1324}X_{1325}1X_{1326}X_{1327}1X_{1328}X_{1329}1X_{1330}X_{1331}1X_{1332}X_{1333}1X_{1334}X_{1335}1X_{1336}X_{1337}1X_{1338}X_{1339}1X_{1340}X_{1341}1X_{1342}X_{1343}1X_{1344}X_{1345}1X_{1346}X_{1347}1X_{1348}X_{1349}1X_{1350}X_{1351}1X_{1352}X_{1353}1X_{1354}X_{1355}1X_{1356}X_{1357}1X_{1358}X_{1359}1X_{1360}X_{1361}1X_{1362}X_{1363}1X_{1364}X_{1365}1X_{1366}X_{1367}1X_{1368}X_{1369}1X_{1370}X_{1371}1X_{1372}X_{1373}1X_{1374}X_{1375}1X_{1376}X_{1377}1X_{1378}X_{1379}1X_{1380}X_{1381}1X_{1382}X_{1383}1X_{1384}X_{1385}1X_{1386}X_{1387}1X_{1388}X_{1389}1X_{1390}X_{1391}1X_{1392}X_{1393}1X_{1394}X_{1395}1X_{1396}X_{1397}1X_{1398}X_{1399}1X_{1400}X_{1401}1X_{1402}X_{1403}1X_{1404}X_{1405}1X_{1406}X_{1407}1X_{1408}X_{1409}1X_{1410}X_{1411}1X_{1412}X_{1413}1X_{1414}X_{1415}1X_{1416}X_{1417}1X_{1418}X_{1419}1X_{1420}X_{1421}1X_{1422}X_{1423}1X_{1424}X_{1425}1X_{1426}X_{1427}1X_{1428}X_{1429}1X_{1430}X_{1431}1X_{1432}X_{1433}1X_{1434}X_{1435}1X_{1436}X_{1437}1X_{1438}X_{1439}1X_{1440}X_{1441}1X_{1442}X_{1443}1X_{1444}X_{1445}1X_{1446}X_{1447}1X_{1448}X_{1449}1X_{1450}X_{1451}1X_{1452}X_{1453}1X_{1454}X_{1455}1X_{1456}X_{1457}1X_{1458}X_{1459}1X_{1460}X_{1461}1X_{1462}X_{1463}1X_{1464}X_{1465}1X_{1466}X_{1467}1X_{1468}X_{1469}1X_{1470}X_{1471}1X_{1472}X_{1473}1X_{1474}X_{1475}1X_{1476}X_{1477}1X_{1478}X_{1479}1X_{1480}X_{1481}1X_{1482}X_{1483}1X_{1484}X_{1485}1X_{1486}X_{1487}1X_{1488}X_{1489}1X_{1490}X_{1491}1X_{1492}X_{1493}1X_{1494}X_{1495}1X_{1496}X_{1497}1X_{1498}X_{1499}1X_{1500}X_{1501}1X_{1502}X_{1503}1X_{1504}X_{1505}1X_{1506}X_{1507}1X_{1508}X_{1509}1X_{1510}X_{1511}1$

1. $A \rightarrow \epsilon$ OK

2. $A \rightarrow B$:

$G_{\text{Simpl}} = (\{S, A, B\}, \{a, b\}, \{S \rightarrow AB, A \rightarrow aB, B \rightarrow bbB \mid b\}, S)$

Fecho-S = \emptyset
 Fecho-A = $\{C\}$
 Fecho-B = \emptyset
 $S \rightarrow AB \in SB$
 $A \rightarrow aB$
 $B \rightarrow bbB \mid b$

FNC: ② > 2

$S \rightarrow AB$
 $A \rightarrow TaB$
 $B \rightarrow TbTbB \mid b$
 $Ta \rightarrow a$
 $Tb \rightarrow b$

③ > 3

$S \rightarrow AB$
 $A \rightarrow TaB$
 $B \rightarrow TbV_1 \mid b$
 $V_1 \rightarrow TbB$
 $Ta \rightarrow a$
 $Tb \rightarrow b$

$G_{\text{FNC}} = (\{S, A, B, Ta, Tb, V_1\}, \{a, b\}, \{S \rightarrow AB, A \rightarrow TaB, B \rightarrow TbV_1 \mid b, V_1 \rightarrow TbB, Tb \rightarrow b, Ta \rightarrow a\}, S)$

FNG:

① Simplification OK

② Renomear

$S = X_1 \rightarrow X_2X_3$
 $A = X_2 \rightarrow aX_3$
 $B = X_3 \rightarrow bbX_3 \mid b$

③ $A \rightarrow AS$ r s s

④ OK

(Sec) $Tb \rightarrow b$
 $X_1 \rightarrow aX_3$
 $X_2 \rightarrow aX_3$
 $X_3 \rightarrow bTbX_3 \mid b$

$FNG = (\{X_1, X_2, X_3, Tb\}, \{a, b\}, \{Tb \rightarrow b, X_1 \rightarrow aX_3, X_2 \rightarrow aX_3, X_3 \rightarrow bTbX_3 \mid b\})$

FNG:

Renomear
 $A \rightarrow AS$ r s s
 Recursive esq
 (Sec)

1. $A \rightarrow \epsilon$:

$VE = \{C, A, S\}$

$S \rightarrow AB \mid BCS \mid BS \mid B$
 $A \rightarrow aA \mid c$
 $B \rightarrow bbB \mid b$
 $C \rightarrow cC$

$S \rightarrow AB \mid BCS \mid BS \mid B$
 $A \rightarrow aA \mid a \mid c \mid c$
 $B \rightarrow bbB \mid b$
 $C \rightarrow cC \mid c$

2. $A \rightarrow B$:

Fecho-S = $\{B\}$
 Fecho-A = \emptyset
 Fecho-B = \emptyset
 Fecho-C = \emptyset
 $S \rightarrow AB \mid BCS \mid BS \mid bb \mid b$
 $b \rightarrow bbB \mid b$
 $C \rightarrow cC \mid c$
 $A \rightarrow aA \mid cC \mid a \mid c$

$G_{\text{Simpl}} = (\{S, A, B, C\}, \{a, b, c\}, \{S \rightarrow AB \mid BCS \mid BS \mid b \mid b, A \rightarrow aA \mid cC \mid a \mid c, B \rightarrow bbB \mid b, C \rightarrow cC \mid c\}, S)$

FNG: $S = X_1 \rightarrow X_2X_3 \mid X_3X_4 \mid X_3X_1 \mid bb \mid X_3 \mid b$ ⑤ OK

$A = X_2 \rightarrow aX_2 \mid cX_4 \mid a \mid c$
 $B = X_3 \rightarrow bbX_3 \mid b$
 $C = X_4 \rightarrow cX_4 \mid c$

$G_{\text{FNG}} = (\{X_1, X_2, X_3, X_4, Tb\}, \{a, b, c\}, \{Tb \rightarrow b, X_1 \rightarrow aX_2 \mid cX_4 \mid a \mid c, X_2 \rightarrow bTbX_3 \mid b, X_3 \rightarrow aX_2 \mid cX_4 \mid a \mid c, X_4 \rightarrow aX_2X_3 \mid cX_4X_3 \mid cX_3 \mid bTbX_3X_4X_1 \mid bX_1X_1 \mid bTbX_3X_1 \mid bX_1 \mid b \mid bTbX_3\}, S)$

FNC: ③ > 2

$S \rightarrow AB \mid BCS \mid BS \mid TbTb \mid B \mid b$
 $A \rightarrow TaA \mid cC \mid a \mid c$
 $B \rightarrow TbTb \mid b$
 $C \rightarrow TcC \mid c$
 $Ta \rightarrow a$
 $Tb \rightarrow b$
 $Tc \rightarrow c$

③ > 3

$S \rightarrow AB \mid BV_1 \mid BS \mid TbTb \mid B \mid b$
 $V_1 \rightarrow CS$
 $A \rightarrow TaA \mid TcC \mid a \mid c$
 $B \rightarrow TbV_2 \mid b$
 $C \rightarrow TcC \mid c$
 $V_2 \rightarrow TbB$
 $Ta \rightarrow a$
 $Tb \rightarrow b$
 $Tc \rightarrow c$

$G_{\text{FNC}} = (\{V_1, V_2, S, A, B, C\}, \{a, b, c\}, \{S \rightarrow AB \mid BV_1 \mid BS \mid TbTb \mid B \mid b, V_1 \rightarrow CS, V_2 \rightarrow TbB, A \rightarrow TaA \mid TcC \mid a \mid c, B \rightarrow TbV_2 \mid b, C \rightarrow TcC \mid c, Ta \rightarrow a, Tb \rightarrow b, Tc \rightarrow c\}, S)$

d) $S \rightarrow aAd/A$
 $A \rightarrow Bc/E$
 $B \rightarrow Acl/a$

1° $A \rightarrow E$
 $S \rightarrow aAd/A/ad$
 $A \rightarrow Bc$
 $B \rightarrow Acl/a/c$

2° $A \rightarrow B$
 $Fechas = \{A\}$
 $Fechas - A = \emptyset$
 $Fechas - B = \emptyset$
 $P_{simpl} = \{S \rightarrow aAd/Bc/ad, A \rightarrow Bc, B \rightarrow Acl/a/c\}$

$G_{simpl} = (\{S, A, B\}, \{a, b, c\}, P_{simpl}, S)$

FNC: ① Simplificada

② $\rightarrow 2$
 $S \rightarrow TaATd/BTc/TaTd$
 $A \rightarrow BTc$
 $B \rightarrow ATc/a/c$

③ $\rightarrow 3$
 $S \rightarrow TaV_1/BTc/TaTd$
 $V_1 \rightarrow ATd$
 $A \rightarrow BTc$
 $B \rightarrow ATc/a/c$
 $Ta \rightarrow a$
 $Tb \rightarrow b$
 $Tc \rightarrow c$

$G_{FNC} = (\{S, A, B, Ta, Tb, Tc, V_1\}, \{a, b, c\}, \{Ta \rightarrow a, Tb \rightarrow b, Tc \rightarrow c, A \rightarrow BTc, V_1 \rightarrow ATd, S \rightarrow TaV_1/BTc/TaTd\}, S)$

FNG: $S \rightarrow X_1 \rightarrow aX_2d/t_3c/ad$ ③ OK
 $A = X_2 \rightarrow X_3c$ ④ OK
 $B = X_3 \rightarrow X_2c/a/c$

Sec 6 $P_{FNG} = \{S \rightarrow aX_1, X_1 \rightarrow aX_2d/atd/atc/atc/aR_1/tc/aR_1/tc, X_2 \rightarrow atc/atc/aR_1/tc/aR_1/tc, X_3 \rightarrow a/c/aR_1, R_1 \rightarrow ctc/atc/aR_1, tc \rightarrow c, td \rightarrow d\}$

e) $S \rightarrow A/ABa/AbA$
 $A \rightarrow Aa/E$
 $B \rightarrow Bb/BC$
 $C \rightarrow CB/CA/bB$

1° $A \rightarrow E$
 $F = \{A, S\}$
 $S \rightarrow ABa/ABa/AbA/a/a$
 $A \rightarrow Aa/a/a$
 $B \rightarrow Bb/BC$
 $C \rightarrow CB/bB/CA/CA$

2° $A \rightarrow B$
 $Fechas = \emptyset$
 $Fechas - A = \emptyset$
 $Fechas - B = \emptyset$
 $Fechas - C = \emptyset$

3° $G_{simpl} = (\{S, A\}, \{a, b\}, \{S \rightarrow ABa/ABa/AbA/a/a, A \rightarrow Aa/a/a\}, S)$

FNG: $S \rightarrow X_1 \rightarrow X_2bX_2/X_2b/bX_2/b/X_2a/a$ ③ $A_1^2 \rightarrow A_5$ y ss OK
 $A = X_2 \rightarrow X_2a/a$

④ $X_2 \rightarrow a/aR_1$
 $R_1 \rightarrow a/aR_1$
 $a \rightarrow a$
 $b \rightarrow b$

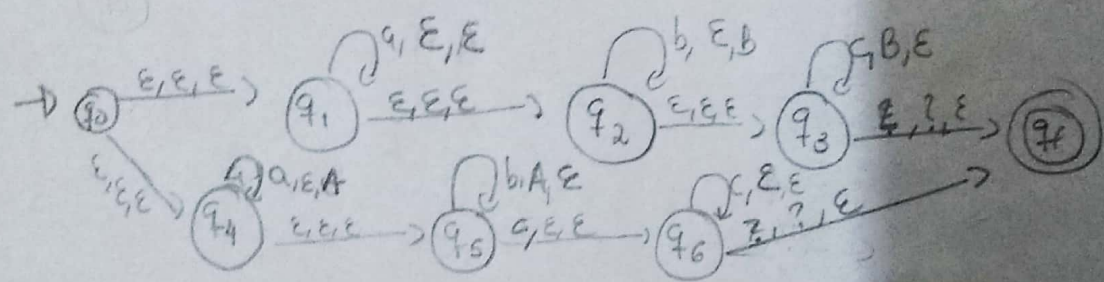
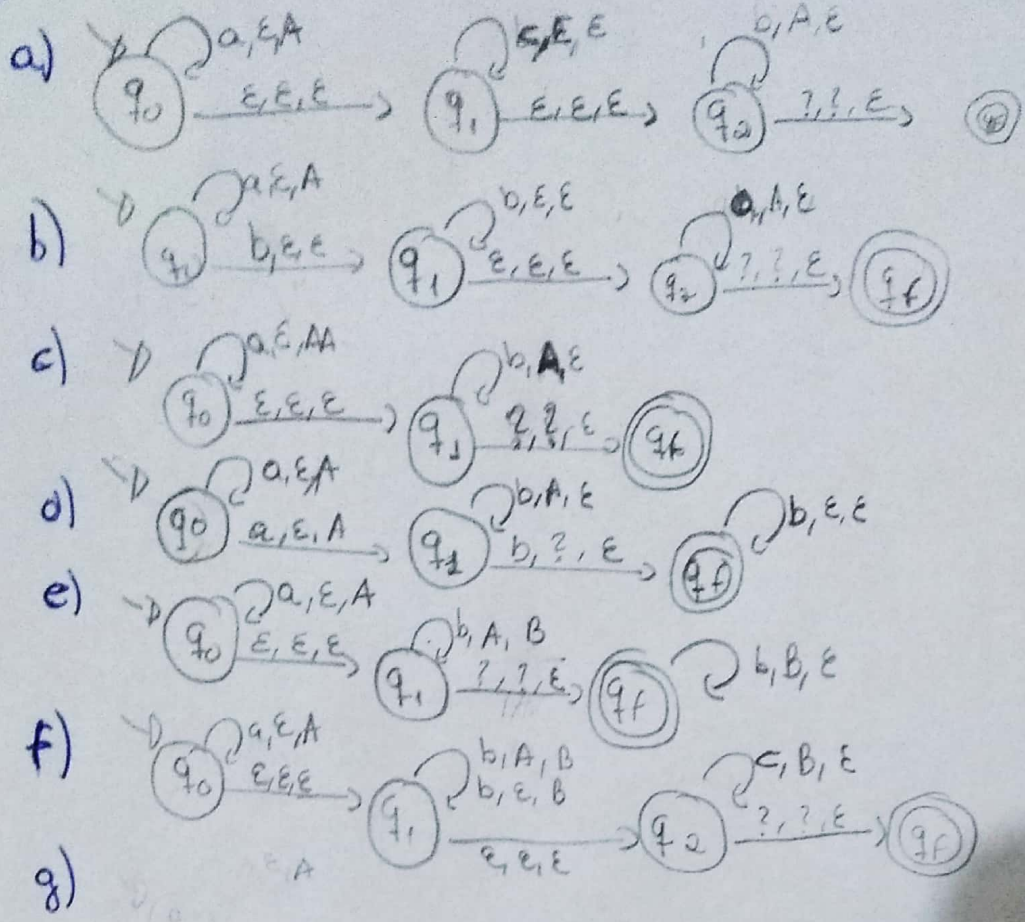
$G_{FNG} = (\{X_1, X_2, R_1, ta, Tb\}, \{a, b\}, P_{FNG}, S)$

FNC: ① $S \rightarrow ATbA/ATb/TbA/b/ATa/a$
 $A \rightarrow ATa/a$

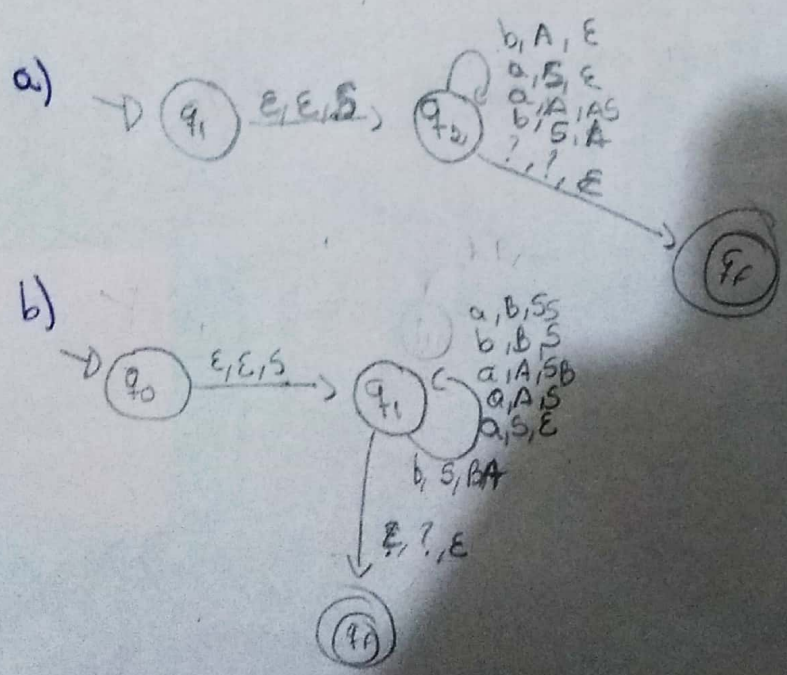
③ $S \rightarrow AV_1/ATb/TbA/b/ATa/a$
 $A \rightarrow ATa/a$
 $V_1 \rightarrow TbA$

$G_{FNC} = (\{S, A, V_1\}, \{a, b\}, \{S \rightarrow AV_1/ATb/TbA/b/ATa/a, A \rightarrow ATa/a, V_1 \rightarrow TbA\}, S)$

5



6



7) a) Seja L livre de contexto, p o comprimento do bombeamento.

$$w = a^p b^p c^p d^p$$

$$w \in L \text{ e } |w| > p$$

Decompondo w em $\Rightarrow w = uxvyz$ tq $|xvy| \leq p, |xy| \geq 1$
 $\forall i \in \mathbb{N}, ux^i v y^i z \in L$

$w \in L \text{ e } |w| > p$
 Decompor w .
 $|xvy| \leq p$
 $|xy| \geq 1$

Caso 1: xvy possui combinações: $a^r b^s$ ou $b^r c^s$ ou $c^r d^s$, $0 < r+s \leq p$.
 Se bombear $ux^2 v y^2 z$ temos um aumento no comprimento bombeado, nessa situação teremos um desbalanceamento as proporções de a, b, c e d , gerando palavras fora da linguagem.
 Logo $ux^2 v y^2 z \notin L$.

Chega-se em uma contradição e L não é livre de contexto.

b) Seja L livre de contexto; p o comprimento do bombeamento.

$$\text{Seja: } w = a^p (bb)^p a^p$$

$$w \in L \text{ e } |w| > p$$

Decompondo w em: $w = uxvyz$ tq $|xvy| \leq p, |xy| \geq 1$ e $\forall i \in \mathbb{N}, ux^i v y^i z \in L$

Caso 1: xyz possui apenas o primeiro conjunto de a 's ou apenas (bb) 's ou o conjunto de a 's apenas. Ao bombear $ux^2 v y^2 z$, em qualquer uma das situações, haverá aumento no comprimento bombeado. Teremos o desbalanceamento das proporções de a 's, (bb) 's e a 's, gerando palavras que não estão na linguagem, então $ux^2 v y^2 z \notin L$.

Caso 2: xvy possui apenas uma combinação dos primeiros a 's com os (bb) 's ou combinação dos (bb) 's com os segundos a 's, sendo assim, $a^r (bb)^s$ ou $(bb)^r a^s$, $0 < r+s \leq p$.
 Como $|xvy| \leq p$, não pode haver a 's em ambas as partes de (bb) 's, teremos palavras que não pertencem na linguagem, nesse caso $ux^2 v y^2 z \notin L$.

Por contradição a linguagem L não é LLC.

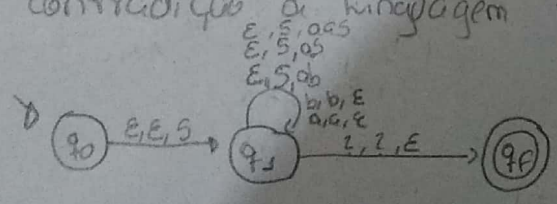
c) Seja L livre de contexto; p o comprimento do bombeamento. $w = a^p (bb)^p (aa)^p b^p$ então $w \in L$ e $|w| > p$. Portanto w pode ser decomposto em $w = uxvyz$ tq $|xvy| \leq p, |xy| \geq 1$ e $\forall i \in \mathbb{N}, ux^i v y^i z \in L$.

xvy possui apenas uma combinação de a 's e (bb) 's ou (bb) 's e (aa) 's ou (aa) 's e b 's, ou seja, $a^r (bb)^s$ ou $(bb)^r (aa)^s$ ou $(aa)^r b^s$, $0 < r+s \leq p$. Em qualquer uma das situações ao bombear $ux^2 v y^2 z$ haverá aumento desproporcional no número de a 's, (bb) 's, (aa) 's e b 's, gerando palavras que não estão na linguagem, então $ux^2 v y^2 z \notin L$.

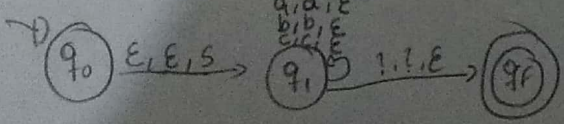
Por contradição a linguagem não é Livre de Contexto.

Pilha Descendente
 1. Empilha símbolo inicial
 2. topo = variável: substitui por todos os prod
 3. topo = terminal

8) a)



b)



| | | | |
|---|-----|---|---|
| S | | | |
| - | A/B | | |
| S | A | A | |
| A | B | B | A |
| a | b | b | a |

Aceita a palavra abba.

6)

| | | |
|--------|-----|-----|
| - | | |
| S, B | - | |
| A | B | A |
| a | b | a |

Não aceita a palavra aba.

c) S, B

| | | | | |
|------|------|------|---|---|
| A | S, B | | | |
| S, B | A | S, B | | |
| - | S, B | A | A | |
| A | A | B | B | B |
| a | a | b | b | b |

Acerta a palavra aabbb

d) S, C

| | | | | |
|-----------|-----------|--------|--------|-----|
| d) S, C | | | | |
| S, A | S, C | | | |
| — | S, C, A | B | | |
| S, A | B | B | S, C | |
| B | A, C | A, C | A, C | B |
| b | a | a | a | b |

Aceita a palavra bacab.

10) a) $D_0: S \rightarrow BC /_0$
 $B \rightarrow b /_0$
 $C \rightarrow c /_0$
 \Rightarrow
 $D_1: B \rightarrow b /_0$
 $S \rightarrow BC /_0$
 $C \rightarrow c /_1$
 \Rightarrow
 $D_2: C \rightarrow c /_1$
 $S \rightarrow BC /_0$
 \Rightarrow Aceita a palavra bc.

c) $D_0: S \rightarrow aSb/0$
 $S \rightarrow aB/0$
 $S \rightarrow a/0$
 $B \rightarrow bB/0$
 $B \rightarrow b/0$

\Rightarrow

$D_1: S \rightarrow aSb/0$
 $S \rightarrow aB/0$
 $S \rightarrow a/0$
 $S \rightarrow aSb/1$
 $S \rightarrow aB/1$
 $S \rightarrow a/1$
 $B \rightarrow bB/1$
 $B \rightarrow b/1$

\Rightarrow

$D_2: S \rightarrow aSb/1$
 $S \rightarrow aB/1$
 $S \rightarrow a/1$
 $S \rightarrow aSb/2$
 $S \rightarrow aB/2$
 $S \rightarrow a/2$
 $B \rightarrow bB/2$
 $B \rightarrow b/2$

\Rightarrow

$D_3: B \rightarrow bB/2$
 $B \rightarrow b/2$
 $S \rightarrow aSb/0$
 $B \rightarrow bB/3$
 $B \rightarrow b/3$
 $S \rightarrow aB/1$

Aceto polonio aqb

d) $D_0: S \rightarrow a a B S b / 0$
 $S \rightarrow \cdot a B / 0$
 $B \rightarrow \cdot b B / 0$
 $B \rightarrow \cdot b / 0$

\Rightarrow

$D_1: S \rightarrow a \cdot B S b / 0$
 $S \rightarrow a \cdot B / 0$
 $B \rightarrow \cdot b B / 1$
 $B \rightarrow \cdot b / 1$

\Rightarrow

$D_2: B \rightarrow b \cdot B / 1$
 $B \rightarrow b \cdot / 1$
 $B \rightarrow \cdot b B / 2$
 $B \rightarrow \cdot b / 2$

\Rightarrow

$D_3: S \rightarrow a \cdot B S b / 2$
 $S \rightarrow a \cdot B / 2$
 $B \rightarrow \cdot b B / 3$
 $B \rightarrow \cdot b / 3$

\Rightarrow

$D_4: B \rightarrow b \cdot B / 3$
 $B \rightarrow b \cdot B / 3$

D4: $B \rightarrow b/3$
 $B \rightarrow b \cdot B/3$
 $S \rightarrow aB \cdot b/2$
 $S \rightarrow aB \cdot /2$
 $S \rightarrow aB5 \cdot b/0$
 $S \rightarrow \cdot aBb/4$
 $S \rightarrow \cdot aB/4$