5. Convert the grammar

$$S \rightarrow AB|aB,$$
$$A \rightarrow aab|\lambda,$$
$$B \rightarrow bbA$$

into Chomsky normal form.

12. Convert the grammar

$$S \rightarrow ab\,|aS|\,aaS$$

into Greibach normal form.

Sol

5. First we must eliminate λ-productions. This gives

$$S \to AB \,|B|\, aB,$$
$$A \to aab,$$
$$B \to bbA|bb.$$

This has introduced a unit-production, which is not acceptable in the construction of Theorem 6.6. Removal of this unit-production is easy.

$$S \to AB \,|bbA|\, aB|bb,$$
$$A \to aab,$$
$$B \to bbA|bb.$$

We can now apply the construction and get

$$S \rightarrow AB \,|\, V_b V_b A \,|\, V_a B \,|\, V_b V_b,$$
$$A \rightarrow V_a V_a V_b,$$
$$B \rightarrow V_b V_b A \,|\, V_b V_b,$$

and

$$S \rightarrow AB \,|\, V_c A \,|\, V_a B \,|\, V_b V_b,$$
$$A \rightarrow V_d V_b,$$
$$B \rightarrow V_c A \,|\, V_b V_b,$$
$$V_c \rightarrow V_b V_b,$$
$$V_d \rightarrow V_a V_b,$$
$$V_a \rightarrow a,$$
$$V_b \rightarrow b.$$

Sol

12. Solutions: $S \to aV_b \mid aS \mid aV_aS$, $V_a \to a$, $V_b \to b$.