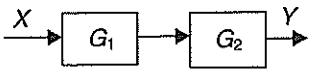
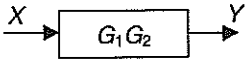
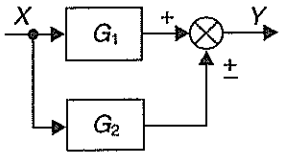
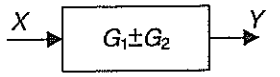
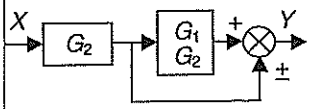
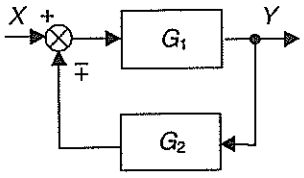
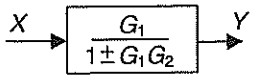
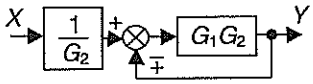
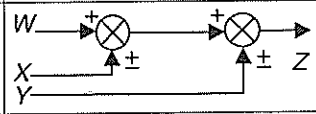
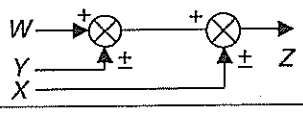
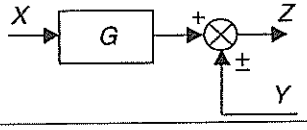
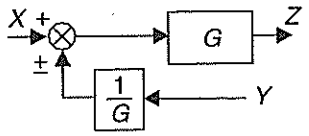
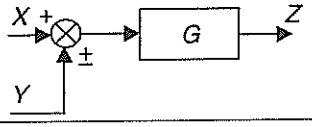
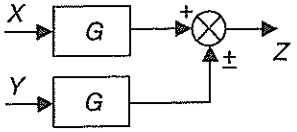
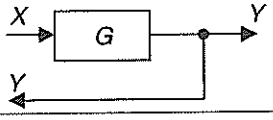
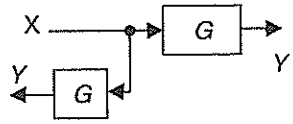
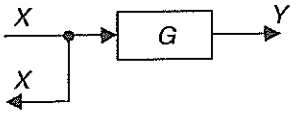
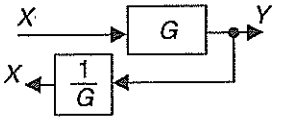
## 4.2.2 Block diagram manipulation

There are occasions when there is interaction between the control loops and, for the purpose of analysis, it becomes necessary to re-arrange the block diagram configuration. This can be undertaken using Block Diagram Transformation Theorems.

**Table 4.1** Block Diagram Transformation Theorems

| Transformation | Equation | Block diagram | Equivalent block diagram |
|---|---|---|---|
| 1. Combining blocks in cascade | $Y=(G_1G_2)X$ |  |  |
| 2. Combining blocks in parallel; or eliminating a forward loop | $Y=G_1X\pm G_2X$ |  |  |
| 3. Removing a block from a forward path | $Y=G_1X\pm G_2X$ | |  |
| 4. Eliminating a feedback loop | $Y=G_1(X\pm G_2Y)$ |  |  |
| 5. Removing a block from a feedback loop | $Y=G_1(X\pm G_2Y)$ | |  |
| 6. Rearranging summing points | $Z=W\pm X\pm Y$ |  |  |
| 7. Moving a summing point ahead of a block | $Z=GX\pm Y$ |  |  |
| 8. Moving a summing point beyond a block | $Z=G(X\pm Y)$ |  |  |
| 9. Moving a take-off point ahead of a block | $Y=GX$ |  |  |
| 10. Moving a take-off point beyond a block | $Y=GX$ |  |  |