

**1.20** Find complex numbers  $t = z_1 + z_2$  and  $s = z_1 - z_2$ , both in polar form, for each of the following pairs:

- (a)  $z_1 = 2 + j3$  and  $z_2 = 1 - j2$ ,
- (b)  $z_1 = 3$  and  $z_2 = j3$ ,
- (c)  $z_1 = 3\angle 30^\circ$  and  $z_2 = 3\angle -30^\circ$ ,
- (d)  $z_1 = 3\angle 30^\circ$  and  $z_2 = 3\angle -150^\circ$ .

**Solution:**

(a)

$$\begin{aligned}t &= z_1 + z_2 = (2 + j3) + (1 - j2) = 3 + j1, \\s &= z_1 - z_2 = (2 + j3) - (1 - j2) = 1 + j5 = 5.1e^{j78.7^\circ}.\end{aligned}$$

(b)

$$\begin{aligned}t &= z_1 + z_2 = 3 + j3 = 4.24e^{j45^\circ}, \\s &= z_1 - z_2 = 3 - j3 = 4.24e^{-j45^\circ}.\end{aligned}$$

(c)

$$\begin{aligned}t &= z_1 + z_2 = 3\angle 30^\circ + 3\angle -30^\circ \\&= 3e^{j30^\circ} + 3e^{-j30^\circ} = (2.6 + j1.5) + (2.6 - j1.5) = 5.2, \\s &= z_1 - z_2 = 3e^{j30^\circ} - 3e^{-j30^\circ} = (2.6 + j1.5) - (2.6 - j1.5) = j3 = 3e^{j90^\circ}.\end{aligned}$$

(d)

$$\begin{aligned}t &= z_1 + z_2 = 3\angle 30^\circ + 3\angle -150^\circ = (2.6 + j1.5) + (-2.6 - j1.5) = 0, \\s &= z_1 - z_2 = (2.6 + j1.5) - (-2.6 - j1.5) = 5.2 + j3 = 6e^{j30^\circ}.\end{aligned}$$

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