TCB

4.37 Find phasor form

a. $v(t) = \underbrace{155}_{\text{magnitude}} \cos(377t \underbrace{-25°}_{\text{angle}})\ V$

$V(j\omega) = 155 \angle -25°\ V$

Note: I would normally suggest using radians but the problem was set up in degrees.

b. $v(t) = 5 \sin(1{,}000t - 40°)\ V$

$= 5 \cos(1{,}000t - 130°)\ V$ (mag. = 5, angle = −130°)

$V(j\omega) = 5 \angle -130°\ V$

$\sin(\theta) = \cos(\theta - 90°)$

We use cos() as our reference so we need to shift sin() by 90deg to turn it into a cos().

c. $i(t) = 10\cos(10t + 63°) + 15\cos(10t - 42°)\ A$

$I(j\omega) = 10 \angle 63° + 15 \angle -42°\ A$

Convert to rectangular form for addition

$I(j\omega) = 10\cos(63°) + j10\sin(63°) + 15\cos(-42°) + j15\sin(-42°)A$

$= 4.54 + j8.91 + 11.15 - j10.04\ A$

$= 15.69 - j1.13\ A$

$= \sqrt{15.69^2 + 1.13^2} \angle \tan^{-1}\left(\frac{-1.13}{15.69}\right) A = 15.73 \angle -4.12°\ A$

d. $i(t) = 460\cos(500\pi t - 25°) - 220\sin(500\pi t + 15°)\ A$

Note: can only add if same frequency

$= 460 \angle -25° - 220 \angle -75°\ A$

$= 416.90 - j194.4 - (56.94 - j212.5)\ A$

$= 359.96 + j18.10\ A$

$= 360.4 \angle 2.88°\ A$

TCB

4.38 Convert to polar

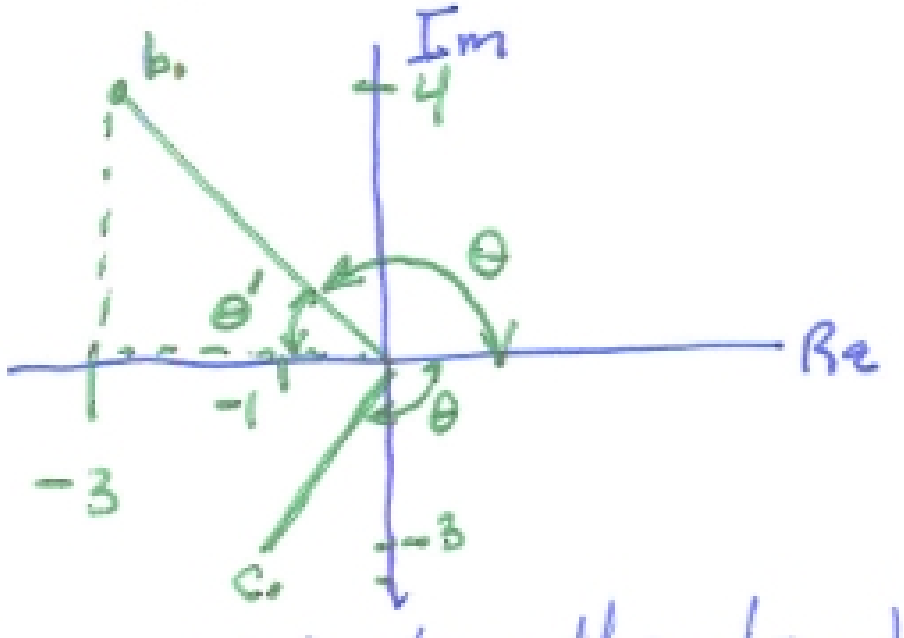
a. $4+j4 = \sqrt{4^2+4^2}\,\angle\tan^{-1}\left(\frac{4}{4}\right) = 4\sqrt{2}\,\angle 45°$

b. $-3+j4 = \sqrt{3^2+4^2}\,\angle\tan^{-1}\left(\frac{4}{3}\right) = 5\,\angle 126.9°$

$= 5\,\angle 2.21\ \text{rad}$

c. $j+2-j4-3 = -1-j3 = 3.16\,\angle -108.4°$

Additional information for b & c



We are looking for θ. Draw the number in the complex plane to better understand θ.

Solution ①: Find θ' in the triangle

$\theta' = \tan^{-1}\left(\frac{4}{3}\right) = 53.1°$

$\theta = 180° - 53.1° = 126.9°$

Solution ②:

$\tan(\theta'' + n\pi) = -\frac{4}{3}$ for $n = 0, \pm1, \pm2, \ldots$

Calculator returns $\theta'' = -53.1°$ assuming $n=0$, you now need to find the correct n so that

$-180° < \theta \leq 180°$

$n=1 \rightarrow \theta = -53.1° + 180° = 126.9°$

(Same reasoning for c.)

TCB

4.39 Convert to polar, then compute product

a. $(50+j10)(4+j8) = (50.99\angle 11.3°)(8.94\angle 63.43°)$

$= 456.1\angle 74.7°$

Note that you can multiple rectangular numbers

$(50+j10)(4+j8) = 50\cdot 4 + j50\cdot 8 + j10\cdot 4 + j^2 10\cdot 8$

$j^2 = -1$

$= 200 + j400 + j40 - 80$

$= 120 + j440 = 456.1\angle 1.3 \text{ rad}$

$= 456.1\angle 74.75°$

b) $(j2-2)(4+j5)(2+j7)$

$= (2.82\angle 135°)(6.40\angle 51.34°)(7.28\angle 74.05°) = 131.8\angle 260.4°$

the angle is typically shown between $+180°$ and $-180°$

$260.4° - 360° = -99.6°$

$= 131.8\angle -99.6°$

Using rectangular form

$(j2-2)(4+j5)(2+j7) = (j2-2)(8+j28+j10-35)$

$= (j2-2)(-27+j38) = -j54 - 76 + 54 - j76$

$= -22 - j130 = 131.8\angle 260.4° = 131.8\angle -99.6°$