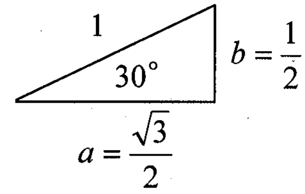
EE411, Test 8, Oct. 29, 2004. Name (printed): KEY

No Calculators. One sheet of notes permitted. Clearly show all work needed to obtain your answer.

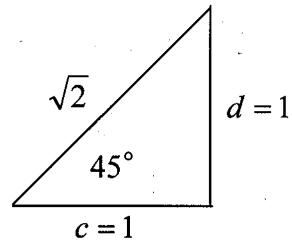
For problems 1 - 4, your answers should be numbers or fractions with numbers, but **should not contain** variables a, b, c, d, or sines, cosines, tangents. It is OK to include $\sqrt{2}$ and $\sqrt{3}$.



Problem 1. Express $\frac{(a+jb)}{(c-jd)}$ in polar form.

$(a+jb) \to 1\angle 30^\circ$, $(c-jd) \to \sqrt{2}\angle -45^\circ$

$$\frac{1\angle 30}{\sqrt{2}\angle -45} = \boxed{\frac{1}{\sqrt{2}}\angle 75^\circ}$$



Problem 2. Express $(b+ja)\bullet(d+jc)$ in rectangular form.

$$bd + jad + jbc - ac = (bd - ac) + j(ad + bc)$$

$$= \left(\tfrac{1}{2}\cdot 1 - \tfrac{\sqrt{3}}{2}\cdot 1\right) + j\left(\tfrac{\sqrt{3}}{2}\cdot 1 + \tfrac{1}{2}\cdot 1\right) = \left(\tfrac{1}{2} - \tfrac{\sqrt{3}}{2}\right) + j\left(\tfrac{\sqrt{3}}{2} + \tfrac{1}{2}\right)$$

$$= \boxed{\left(\frac{1-\sqrt{3}}{2}\right) + j\left(\frac{\sqrt{3}+1}{2}\right)}$$

Problem 3. Express $(c - jd)^5$ in rectangular form.

$$c - jd = \sqrt{2}\angle -45^\circ, \text{ so } \left[\sqrt{2}\angle -45^\circ\right]^5 = (\sqrt{2})^5 \angle 5(-45^\circ) = 4\sqrt{2}\angle -225^\circ$$

$$= 4\sqrt{2}\angle 135^\circ$$

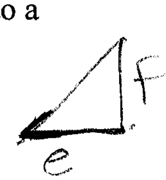
$$= 4\sqrt{2}\left[\cos(135^\circ) + j\sin(135^\circ)\right] = 4\sqrt{2}\left(\frac{-1}{\sqrt{2}}\right) + j4\sqrt{2}\left(\frac{+1}{\sqrt{2}}\right)$$

$$= \boxed{-4 + j4}$$

Problem 4. Express $\sqrt[3]{(a - jb)}$ in polar form.

$$\left[1\angle -30\right]^{1/3} = \sqrt[3]{1}\angle \frac{-30}{3} = \boxed{1\angle -10^\circ}$$

Problem 5. Use phasors to combine the expression $\left|2\cos(\omega t + 30^\circ) + 3\cos(\omega t - 45^\circ)\right|$ into a single cosine function. You may include the arctangent function in your answer.



$$2\cos 30^\circ + j2\sin 30^\circ + 3\cos(-45^\circ) + j3\sin(-45^\circ)$$

$$2\left(\tfrac{\sqrt{3}}{2}\right) + j2\left(\tfrac{1}{2}\right) + 3\left(\tfrac{1}{\sqrt{2}}\right) + j3\left(\tfrac{-1}{\sqrt{2}}\right)$$

$$= \underbrace{\left(\sqrt{3} + \frac{3}{\sqrt{2}}\right)}_{e} + j\underbrace{\left(1 - \frac{3}{\sqrt{2}}\right)}_{f} = e + jf$$

$$\boxed{\sqrt{e^2 + f^2}\cos\left[\omega t + \tan^{-1}\left(\frac{f}{e}\right)\right]}$$