1. (20) Complete the following:
   (a) Multiplying a complex vector by $3i/2$ rotates it by ________ degrees counter-clockwise.
   (b) Dividing a complex vector by $i$ rotates it by ________ degrees counter-clockwise.
   (c) The complex conjugate of $i$ is ________.
   (d) The SI unit for jerk is ________.

2. (25) The figure shows a crank shaker quick return mechanism with its output link in its two extreme positions. Assume that the angle $\alpha$ is known (from a given time ratio). Using analytical position synthesis, write the vector loop equations(s) needed to solve for the unknown lengths $r$ and $b$ of the mechanism. State how many free choices you have. Do not solve the equations.

3. (25) For the mechanism shown, crank $a$ rotates with a given constant angular velocity $\omega_2$. Assume that $a$, $b$, $c$, $d$, $f$, and $\theta_2$ are given. Use complex vectors to express the velocity of D.

4. (30) The figure shows a variation of a scotch yoke mechanism, which is used to convert rotational motion of link 2 to translational motion of link 4. Link 2 is rotating with a constant angular velocity $\omega = 3$ rad/s counter-clockwise as indicated. Using complex vector loop equations, calculate the velocity (with numerical values) of link 4 when $\theta = 45^\circ$. 

$$\omega = 3 \text{ rad/s}$$

$$r = 2.5 \text{ m}$$