1a) $u = u(r^2, p^2, r\cdot p)$

then $[u, M] = 0$ M is angular momentum

$$[u, \Pi_\ell] = -\partial_{p_i} u \, \partial_{x_i} \Pi_\kappa + \partial_{p_i} M_\kappa \partial_{x_i} u$$

$$\Pi_u = \varepsilon_{u\ell m} x_\ell p_m$$

$$\Rightarrow [u, M_u] = -\partial_{p_i} u \, \varepsilon_{\kappa i m} p_m + \partial_{x_i} u \, \varepsilon_{u\ell i} x_\ell$$

$$= -\varepsilon_{\kappa i m} p_m \partial_{p_i} u + \varepsilon_{u\ell i} x_\ell \partial_{x_i} u$$

$\varepsilon_{\kappa i m} p_m p_i = 0 \Rightarrow$ only the 3 argument can contribute

$$= (\varepsilon_{\kappa i m} p_m x_i - \varepsilon_{u\ell i} x_\ell p_i) \partial_s u$$

$$= 0$$

1b) $F_i = u r_i + v p_i$

then $[F_i, \Pi_j] = +\varepsilon_{ijk} F_k$

- show it separately for each term

$$[u r_i, \Pi_j] = [u, \Pi_j] r + u [r_i, \Pi_j]$$

$$[r_i, \Pi_j] = + \partial_{r_k} r_i \, \partial_{p_k} M_j = + \delta_{ik} \varepsilon_{jek} r_e = + \varepsilon_{jei} r_e$$

$$[p_i, \Pi_j] = -\partial_{p_k} p_i \, \partial_{r_k} \Pi_j = -\delta_{ik} \varepsilon_{jem} p_m \delta_{ek} = -\varepsilon_{jim} p_m$$

$$\Rightarrow [F_i, \Pi_j] = +\varepsilon_{ijk} F_k$$