1. The following assembly consists of a 20-mm-diameter aluminum bar $ABC$ with fixed collar at $B$ and a 10-mm-diameter steel rod $CD$. Determine the displacement of point $D$ when the assembly is loaded as shown. Neglect the size of the collar at $B$ and the connection at $C$. $E_{steel}=150$ GPa, $E_{aluminum}=60$ GPa. (25%)

![Diagram of the assembly with applied loads and dimensions.]

2. Draw the shear and moment diagrams for the following beam. (25%)
3. The collar $P$ slides outward at a constant relative speed $u$ along rod $AB$, which rotates counterclockwise with a constant angular velocity $\omega$ of 20 rpm. Knowing that $r = 250$ mm when $\theta = 0$ and that the collar reaches $B$ when $\theta = 90^\circ$, determine the magnitude and direction of the absolute acceleration of the collar $P$ just as it reaches $B$. (25%)

4. A tiny 2-kg collar $C$ can slide freely on a thin ring of mass 3 kg and radius 250 mm. The ring is welded to a short vertical shaft, which can rotate freely in a fixed bearing. Initially the ring has an angular velocity of 35 rad/s and the collar is at the top of the ring ($\theta = 0$) when it is given a slight nudge. Neglecting the effect of friction, determine (a) the angular velocity of the ring as the collar passes through the position $\theta = 90^\circ$ (10%), (b) the corresponding velocity of the collar relative to the ring. (15%) Note that the acceleration of gravity $g = 9.81$ m/s$^2$ and the mass moment of inertia of the ring about the axis of rotation is $\frac{1}{2}m_RR^2$ where $m_R$ is the mass of the ring. (兩題共 25%)