**Homework-1** Due Monday Feb.-19, 2024 prior to class

1. [5 pts] A record player rotates at 33 rpm (rotations per minute). A glass of wine accidentally spills over its surface. Should you treat this flow using GFD or classical fluid dynamics? Assume the spilled volume of 20 ml spreads within 2 seconds over an area of about 25 $cm^2$.

2. [10 pts] Derive the expression of acceleration in polar co-ordinates $(r, \phi)$ for the tangential component $a_\phi$ from $x(r,\phi)=r\cos(\phi)$ and $y(r,\phi)=r\sin(\phi)$ that is

   (a) $a_\phi = r\, d^2\phi/dt^2 + 2\, dr/dt\, d\phi/dt$ in a non-rotating and

   (b) $a_\phi = r'\, d^2\phi'/dt^2 + 2\, dr'/dt\, d\phi'/dt + 2\,\Omega\, dr'/dt$ in a rotating frame

   where $r'= r$ is the same radial distance in rotating and non-rotating systems while and $\phi'= \phi-\Omega t$, that is, the angle $\phi$ is rotated by $\Omega t$ in the rotating system

3. A particle in a non-rotating reference frame moves in a horizontal plane with velocity $dx/dt=\text{const.}=u_0$ and $dy/dt=0$ passing $x=0$ and $y=2$ at time $t=0$ (Figure).
   (a) What force must be applied to ensure this motion in a non-rotating frame? [5pts]