Homework 3

Homework 3-1

0.0/1.0 point (graded)

Calculate the auto-correlation function $\varphi_Y(t)$ for a dynamic process $Y(t) = A\sin(\omega_1 t + \pi)$. Choose the correct answer from the following choices.

- $\varphi_Y(t) = \frac{A^2}{2}\cos(\omega_1 t)$
- $\varphi_Y(t) = \frac{A^2}{2}\sin(\omega_1 t)$
- $\varphi_Y(t) = \frac{A^2}{2}\cos(\omega_1 t + \pi)$
- $\varphi_Y(t) = \frac{A^2}{2}\sin(\omega_1 t + \pi)$

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You have used 0 of 2 attempts

Homework 3-2

0.0/1.0 point (graded)

Calculate the auto-correlation function $\varphi_Y(t)$ for a dynamic process $Y(t) = A\cos(\omega_1 t) + B\xi(t)$, where $\xi(t)$ is the White noise introduced in Part 1. Choose the correct answer from the following choices.

- $\varphi_Y(t) = \frac{A^2}{2}\cos(\omega_1 t) + AB\sqrt{\cos(\omega_1 t)\,\delta(t)} + B^2\delta(t)$
- $\varphi_Y(t) = \frac{A^2}{2}\cos(\omega_1 t) + AB\sqrt{2\cos(\omega_1 t)\,\delta(t)} + B^2\delta(t)$
- $\varphi_Y(t) = \frac{A^2B^2}{2}\cos(\omega_1 t)\,\delta(t)$
- $\varphi_Y(t) = \frac{A^2}{2}\cos(\omega_1 t) + B^2\delta(t)$
- $\varphi_Y(t) = \frac{A^2}{2}\cos(\omega_1 t) - B^2\delta(t)$

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Homework 3-3

0.0/1.0 point (graded)

Estimate the diffusion constant D of spherical particles with radius $a = 1\mu$m immersed in water at $T = 300$K using the Stokes-Einstein relation (Eq.(32))

$$D = \frac{k_B T}{6\pi a\eta} \tag{32}$$

and the following parameters

- Viscosity of water at room temperature: $\eta = 0.85 \times 10^{-3}$ Pa·s
- The Boltzmann constant: $k_B = 1.380649 \times 10^{-23}$J·K^{-1}

Choose the value closest to your answer from the following choices.

- $2.6 \times 10^{-7}\,\mathrm{m^2 \cdot s^{-1}}$
- $2.6 \times 10^{-13}\,\mathrm{m^2 \cdot s^{-1}}$
- $2.6 \times 10^{-19}\,\mathrm{m^2 \cdot s^{-1}}$
- $2.6 \times 10^{-7}\,\mathrm{m^{-2} \cdot s}$
- $2.6 \times 10^{-13}\,\mathrm{m^{-2} \cdot s}$
- $2.6 \times 10^{-19}\,\mathrm{m^{-2} \cdot s}$

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Homework 3-4

0.0/1.0 point (graded)

Calculate the right-hand-side of Eq.(47) using the correlation function given in Eq.(26).

$$\varphi_V(t) = \frac{3\tilde{D}}{\zeta m} \exp\left(-\frac{\zeta}{m}|t|\right) \quad (26)$$

$$D = \frac{1}{3}\int_0^\infty \mathrm{d}t\, \varphi_V(t) \quad (47)$$

Choose the correct result for D from the following choices.

- ◯ $\tilde{D}$
- ◯ $6\tilde{D}t$
- ◯ $\frac{\tilde{D}}{k_B T \zeta}$
- ◯ $\frac{m\tilde{D}}{\zeta}$
- ◯ $\frac{\tilde{D}}{\zeta^2}$

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Homework 3-5

0.0/2.0 points (graded)

Replace $F_0 \rightarrow 2F_0$ in Eq.(41), then redo all the calculations to derive the equation corresponding to equation Eq.(47). Choose the correct equation, relating the diffusion constant D to the velocity auto-correlation funciton $\varphi_V\,(t)$, from the following choices.

- ◯ $D = \frac{2}{3} \int_0^\infty \mathrm{d}t\ \varphi_V\,(t)$
- ◯ $D = \frac{\sqrt{2}}{3} \int_0^\infty \mathrm{d}t\ \varphi_V\,(t)$
- ◯ $D = \frac{1}{3} \int_0^\infty \mathrm{d}t\ \varphi_V\,(t)$
- ◯ $D = \frac{1}{3\sqrt{2}} \int_0^\infty \mathrm{d}t\ \varphi_V\,(t)$
- ◯ $D = \frac{1}{6} \int_0^\infty \mathrm{d}t\ \varphi_V\,(t)$

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