Problem 3.1

A static field points uniformly along the positive z-axis. A classical spinning particle, with positive gyromagnetic ratio γ and fixed magnetic moment magnitude μ, has its spin initially in the direction of the static field. A circularly polarized rf field points along the $\hat{y}'$ axis with time-dependent amplitude $B_{1y'}(t)$ (e.g., the rf field may be turned off at a later time) applied on-resonance starting at $t = 0$.

a) Give expressions analogous to Equation (3.33) on p. 46 for all three magnetic-moment vector components in the rotating (prime) reference frame for $t > 0$. Your answer will be in terms of a definite integral.

b) Show that the equation of motion (2.24) on p. 28 is satisfied by your answer in (a) for $\vec{B} \to B_{1y'}\hat{y}'$.

c) Find the generalization of Equation (2.35) on p. 33 needed for this time-dependent case.

Problem 3.2

Show that

$$\hat{x}^{right} = \hat{x}' \cos 2\omega t + \hat{y}' \sin 2\omega t$$

using steps like those used in deriving (3.21). Also show that the time average

$$\frac{1}{T}\int_0^T \hat{x}^{right}(t)\mathrm{d}t$$

approaches zero as $T \to \infty$.

The problems are based on those in Robert W. Brown, Y.-C. Norman Cheng, E. Mark Haacke, Michael R. Thompson, Ramesh Venkatesan. *Magnetic Resonance Imaging: Physical Principles and Sequence Design*, 2nd Edition, Wiley, 2014.