PLEASE PRINT and box final results. Use only pencil or blue or black ink. Show all work for full credit. Work must be clear and unambiguous for credit. Please place your name on the upper right-hand corner of every worksheet. Labels for your work must be unambiguous. Please USE ONLY ONE-SIDE of a sheet of paper. Calculators may NOT be used. This exam must be your own independent work. Unless otherwise stated, the notation is the same as used in lecture and the textbook.

Very SPECIAL Rule: Work each problem on a separate sheet or set of sheets of paper. Plus, please try to leave some "staple space" in the upper LHS of sheet.

If you agree with this statement: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment."*; then please **PRINT** and **SIGN** your name.

NAME (Print and Signature): _____

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DO NOT TURN OVER OR OPEN until instructed.

Some integrals and expressions, used while working some problems, that you may wish to recall.

$$\int x\,\sin(ax)\,dx = \frac{1}{a^2}\sin(ax) - \frac{x}{a}\cos(ax) \qquad \int x\,\cos(ax)\,dx = \frac{1}{a^2}\cos(ax) + \frac{x}{a}\sin(ax)$$

$$\int_a^b f\,\frac{dg}{dx}\,dx = -\int_a^b \frac{df}{dx}\,g\,dx + f\,g\Big|_a^b \qquad \int_0^\infty x^n e^{-x/a}\,dx = n!\,a^{n+1}$$

$$\int_0^\infty x^{2n} e^{-x^2/a^2}\,dx = \sqrt{\pi}\,\frac{(2n)!}{n!}\left(\frac{a}{2}\right)^{2n+1} \qquad \int_0^\infty x^{2n+1} e^{-x^2/a^2}\,dx = \frac{n!}{2}\,a^{2n+1}$$

$$\int x\,\sin^2(ax)\,dx = \frac{x^2}{4} - \frac{x\,\sin(2ax)}{4a} - \frac{\cos(2ax)}{8a^2} \qquad \int \sin(ax)\,\cos(ax)\,dx = \frac{1}{2a}\sin^2(ax)$$

$$\int x^2\,\sin^2(ax)\,dx = \frac{x^3}{6} - \left(\frac{x^2}{4a} - \frac{1}{8a^3}\right)\sin(ax) - \frac{x\cos(2ax)}{4a^2}$$

$$\int \sin^2(ax)\,dx = \frac{1}{2}x - \frac{1}{4a}\sin(2ax) \qquad \int \cos^2(ax)\,dx = \frac{1}{2}x + \frac{1}{4a}\sin(2ax)$$

$$\int x\,\cos^3(ax)\,dx = \frac{x\,\sin(3ax)}{12a} + \frac{\cos(3ax)}{36a^2} + \frac{3x\,\sin(ax)}{4a} + \frac{3\,\cos(ax)}{4a^2}$$

$$\sin 2\theta = 2\sin\theta\cos\theta \;\Big|\; e^{i\theta} = \cos\theta + i\sin\theta \;\Big|\; \sinh x = \frac{1}{2}(e^x - e^{-x}) \;\Big|\; \cosh x = \frac{1}{2}(e^x + e^{-x})$$

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) + \frac{1}{r^2\,\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right) + \frac{1}{r^2\,\sin^2\theta}\left(\frac{\partial^2}{\partial\phi^2}\right)$$

$$\vec{\nabla} = \hat{r}\frac{\partial}{\partial r} + \hat{\theta}\frac{1}{r}\frac{\partial}{\partial\theta} + \hat{\phi}\frac{1}{r\,\sin\theta}\frac{\partial}{\partial\phi}$$

$$\int \sin^5 x\,dx = -\cos x + \frac{2}{3}\cos^3 x - \frac{1}{5}\cos^5 x$$

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NOTE: failure to use only one side of sheet or to comply with the one problem per sheet(s) rule will result in reduction of at least 10 points.