• You must show enough work to justify your answers. Unless otherwise instructed, give exact answers, not approximations (e.g., $\sqrt{2}$, not 1.414).

• This problem set has 5 problems.

Good luck!
Problem 1.

A. \[ \int x\sqrt{2x+1} \, dx. \]

B. \[ \int x \cos(2x) \, dx. \]

C. \[ \int \ln(x)^2 \, dx. \]

D. \[ \int x^6 \ln(x) \, dx \]

E. \[ \int \sin^2(x) \cos^5(x) \, dx. \]

F. \[ \int \tan^3(x) \sec^3(x) \, dx. \]

G. \[ \int \tan^2(x) \sec^3(x) \, dx. \]

H. \[ \int \frac{1}{2x^2 + 4x + 10} \, dx \]

I. \[ \int \frac{1}{x\sqrt{a^2 - x^2}} \, dx. \]

J. \[ \int \frac{dx}{(a^2 + x^2)^{3/2}}. \]

K. \[ \int \frac{\sqrt{x^2 - a^2}}{x} \, dx. \]

L. \[ \int \frac{2x^2 + x + 1}{x(x+1)^2} \, dx. \]
M.

\[ \int \frac{2x^2 + 2x + 1}{x(x^2 + 1)} \, dx \]

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**Problem 2.** In each part, give the form of the partial fraction decomposition. This is a formula involving undetermined coefficients. **Do not find the coefficients!** (No calculation is required).

A.

\[ \frac{x^3 + 2x + 1}{(x - 1)(x - 2)(x + 3)} \]

B.

\[ \frac{1}{x(x^2 + 1)} \]

C.

\[ \frac{x^4 + 1}{x(x^2 + 1)^2} \]

D.

\[ \frac{x^3}{(x - 2)^2(x + 2)^2(x - 1)} \]

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**Problem 3.** In each part, solve the differential equation.

A.

\[ \frac{dy}{dx} - \frac{2}{x} y = x^2. \]

B.

\[ \frac{dy}{dx} + 4y = 2e^x. \]

C.

\[ \frac{dy}{dx} = y(y - 1). \]

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**Problem 4.** A tank contains 200 gallons of water. At the beginning of the problem there are 100 pounds of salt dissolved in the tank. Salt water enters the tank at a rate of 5 gallons per minute. Each gallon of incoming salt water contains 1 pound dissolved salt. The mixture in the tank is kept
prosaically uniform by stirring, and 5 gallons of salt water is drained from the tank per minute. Find the amount (number of pounds) of salt in the tank as a function of time. How long will it be until there are 175 pounds of salt in the tank?

Problem 5. In each part, determine if the improper integral converges or diverges. If it converges, find the value.

A. \[ \int_0^\infty e^{-2x} \, dx \]

B. \[ \int_0^1 \frac{1}{x^2} \, dx \]