In each of problems 1-3 solve the initial value problem on the specified interval.

1. $y' - 3y = e^{2x}$ on $(-\infty, \infty)$ with $y = 0$ when $x = 0$.

2. $xy' - 2y = x^5$ on $(0, \infty)$ with $y = 1$ when $x = 1$.

3. $y' + xy = x^3$ on $(-\infty, \infty)$ with $y = 0$ when $x = 0$.

4. Find all solutions of $y' \sin x + y \cos x = 1$ on the interval $(0, \pi)$. Prove that exactly one of these solutions has a finite limit as $x \to 0$, and another has a finite limit as $x \to \pi$.

5. The half-life of radium is approximately 1000 years. Find what percentage of a given quantity of radium disintegrates in 100 years.

6. If a strain of bacteria grows at a rate proportional to the amount present and if the population doubles in one hour, by how much will it increase at the end of two hours?

In each of the problems 7-10 find all solutions on the specified interval.

7. $y'' - 4y = 0$.

8. $y'' + 4y = 0$.

9. $y'' - 4y' = 0$.

10. $y'' - 2y' + 3y = 0$.