PRACTICE AND APPLICATIONS

STUDENT HELP

Extra Practice
to help you master skills is on p. 948.

33. $-3, -1, 3, 4.5$

34. $-4, -2, 2.5, 4$

CHECKING ZEROS Decide whether the given x-value is a zero of the function.

15. $f(x) = x^3 - x^2 + 4x - 4, x = 1$ yes

16. $f(x) = x^3 + 3x^2 - 5x + 8, x = 4$ no

17. $f(x) = x^4 - x^2 - 3x + 3, x = 0$ no

18. $f(x) = x^3 + 5x^2 + x + 5, x = -5$ yes

19. $f(x) = x^3 - 4x^2 + 16x - 64, x = 4i$ yes

20. $f(x) = x^3 - 3x^2 + x - 3, x = -i$ yes

FINDING ZEROS Find all the zeros of the polynomial function.

21. $f(x) = x^4 + 5x^3 + 5x^2 - 5x - 6$ $-3, -2, -1, 1$

22. $f(x) = x^4 + 4x^3 - 6x^2 - 36x - 27$ $-3, -3, -1, 3$

23. $f(x) = x^3 - 4x^2 + 3x$ $0, 1, 3$

24. $f(x) = x^3 + 5x^2 - 4x - 20$ $-5, -2, 2$

25. $f(x) = x^4 + 7x^3 - x^2 - 67x - 60$ $-5, -4, -1, 3$

26. $f(x) = x^4 - 5x^2 - 36$ $\pm 3, \pm 2i$

27. $f(x) = x^3 - x^2 + 49x - 49$ $1, \pm 7i$

28. $f(x) = x^3 - x^2 + 25x - 25$ $1, \pm 5i$

29. $f(x) = x^4 + 6x^3 + 14x^2 + 54x + 45$ $-5, -1, \pm 3i$

30. $f(x) = x^3 + 3x^2 + 25x + 75$ $-3, \pm 5i$

31. $f(x) = x^4 - x^3 - 5x^2 - x - 6$ $-2, 3, \pm i$

32. $f(x) = x^4 + x^3 + 2x^2 + 4x - 8$ $-2, 1, \pm 2i$

33. $f(x) = 2x^4 - 7x^3 - 27x^2 + 63x + 81$ See margin.

34. $f(x) = 2x^4 - x^3 - 42x^2 + 16x + 160$ See margin.

STUDENT HELP

HOMEWORK HELP

Example 1: Exs. 21–54
Example 2: Exs. 21–34
Example 3: Exs. 35–46
Example 4: Exs. 47–54
Example 5: Exs. 55–59

FOCUS ON APPLICATIONS

REAL LIFE UNITED STATES EXPORTS The United States exports more than any other country in the world. It also imports more than any other country.

35. $f(x) = x^3 - 7x^2 + 14x - 8$

36. $f(x) = x^3 - 2x^2 - 19x + 20$

37. $f(x) = x^3 - 2x^2 - 33x + 90$

38. $f(x) = x^3 + 5x^2 - 4x - 20$

39. $f(x) = x^3 + 13x^2 + 50x + 56$

40. $f(x) = x^3 - 8x^2 + x - 8$

41. $f(x) = x^3 - 5x^2 + 9x - 45$

42. $f(x) = x^4 + 32x^2 - 144$

43. $f(x) = x^4 + 10x^2 + 9$

44. $f(x) = x^4 - 6x^3 + 35x^2 - 150x + 250$

45. $f(x) = x^4 - 12x^3 + 53x^2 - 104x + 80$

46. $f(x) = x^5 + x^4 + 8x^3 + 4x^2 - 128x - 192$

WRITING POLYNOMIAL FUNCTIONS Write a polynomial function of least degree that has real coefficients, the given zeros, and a leading coefficient of 1.

35–46. See margin.

35. 2, 1, 4
36. 1, −4, 5
37. −6, 3, 5
38. −5, 2, −2
39. −2, −4, −7
40. 8, $-i$, i
41. $3i$, $-3i$, 5
42. 2, −2, $-6i$
43. i, $-3i$, $3i$
44. $3 - i$, $5i$
45. 4, 4, $2 + i$
46. −2, −2, 3, $-4i$

FINDING ZEROS Use a graphing calculator to graph the polynomial function. Then use the *Zero* (or *Root*) feature of the calculator to find the real zeros of the function.

47. $f(x) = x^3 - x^2 - 5x + 3$ −2.09, 0.57, 2.51
48. $f(x) = 2x^3 - x^2 - 3x - 1$ −0.62, −0.5, 1.62
49. $f(x) = x^3 - 2x^2 + x + 1$ −0.47
50. $f(x) = x^4 - 2x - 1$ −0.47, 1.40
51. $f(x) = x^4 - x^3 - 4x^2 - 3x - 2$ −1.27, 2.86
52. $f(x) = x^4 - x^3 - 3x^2 - x + 1$ 0.42, 2.37
53. $f(x) = x^4 + 3x^2 - 2$ −0.75, 0.75
54. $f(x) = x^4 - x^3 - 20x^2 + 10x + 27$ −4.09, −0.98, 1.47, 4.60

GRAPHING MODELS In Exercises 55–59, you may find it helpful to graph the model on a graphing calculator. 55–57. See margin.

55. **UNITED STATES EXPORTS** For 1980 through 1996, the total exports E (in billions of dollars) of the United States can be modeled by

$$E = -0.131t^3 + 5.033t^2 - 23.2t + 233$$

where t is the number of years since 1980. In what year were the total exports \$312.76 billion? ▶ Source: U.S. Bureau of the Census

56. **EDUCATION DONATIONS** For 1983 through 1995, the amount of priva donations D (in millions of dollars) allocated to education can be modeled by

$$D = 1.78t^3 - 6.02t^2 + 752t + 6701$$

where t is the number of years since 1983. In what year was \$14.3 billion of donations allocated to education? ▶ Source: AAFRC Trust for Philanthropy

57. **SPORTS EQUIPMENT** For 1987 through 1996, the sales S (in millions dollars) of gym shoes and sneakers can be modeled by

$$S = -0.982t^5 + 24.6t^4 - 211t^3 + 661t^2 - 318t + 1520$$

where t is the number of years since 1987. Were there any years in which s were about \$2 billion? Explain. ▶ Source: National Sporting Goods Association

58. **TELEVISION** For 1990 through 2000, the actual and projected amoun on television per person per year in the United States can be modeled by

$$S = -0.213t^3 + 3.96t^2 + 10.2t + 366$$

where S is the amount spent (in dollars) and t is the number of years since During which year was \$455 spent per person on television?
▶ Source: Veronis, Suhler & Associates, Inc. late 1993

59. **POPULATION** Eskimo