

$$1. \quad x^3 - 3x^2 = 0$$

$$x^2(x-3) = 0$$

$$x^2 = 0 \quad x-3 = 0$$

$$\boxed{x=0, \text{M.2} \quad x=3}$$

$$2. \quad 2x^3 - 6x^2 = 0$$

$$2x^2(x-3) = 0$$

$$2x^2 = 0 \quad x-3 = 0$$

$$\boxed{x=0, \text{M.2} \quad x=3}$$

$$3. \quad 3x^4 + 15x^2 - 72 = 0$$

$$3(x^4 + 5x^2 - 24) = 0$$

$$3(x^2 + 8)(x^2 - 3) = 0$$

$$x^2 + 8 = 0 \quad x^2 - 3 = 0$$

$$x^2 = -8 \quad x^2 = 3$$

$$\boxed{x = \pm 2i\sqrt{2}} \quad \boxed{x = \pm \sqrt{3}}$$

$$4. \quad x^3 + 54 = 27$$

$$x^3 + 27 = 0$$

$$(x+3)(x^2 - 3x + 9) = 0$$

$$x+3 = 0 \quad x^2 - 3x + 9 = 0$$

$$\boxed{x = -3} \quad 3 \pm \frac{\sqrt{9 - 4(1)(9)}}{2}$$

$$3 \pm \frac{\sqrt{-27}}{2}$$

$$3 \pm \frac{3i\sqrt{3}}{2}$$

$$\boxed{x = \frac{3}{2} \pm \frac{3i\sqrt{3}}{2}}$$

$$\begin{aligned}
 5. \quad & x^3 + 2x^2 - x = 2 \\
 & x^3 + 2x^2 - x - 2 = 0 \\
 & x^2(x+2) - 1(x+2) = 0 \\
 & (x^2 - 1)(x+2) = 0 \\
 & (x-1)(x+1)(x+2) = 0 \\
 & x-1=0 \quad x+1=0 \quad x+2=0 \\
 & \boxed{x=1 \quad x=-1 \quad x=-2}
 \end{aligned}$$

$$\begin{aligned}
 6. \quad & x^4 + 7x^3 = 8x + 56 \\
 & x^4 + 7x^3 - 8x - 56 = 0 \\
 & x^3(x+7) - 8(x+7) = 0 \\
 & (x^3 - 8)(x+7) = 0 \\
 & (x-2)(x^2 + 2x + 4)(x+7) = 0 \\
 & x-2=0 \quad x^2 + 2x + 4 = 0 \quad x+7=0 \\
 & \boxed{x=2} \quad -2 \pm \sqrt{4 - 4(1)(4)} \quad \boxed{x=-7} \\
 & \quad \quad \quad \frac{2}{-2 \pm \sqrt{-12}} \\
 & \quad \quad \quad \frac{2}{-2 \pm 2i\sqrt{3}} \\
 & \quad \quad \quad \frac{2}{2} \\
 & \quad \quad \quad \boxed{x = -1 \pm i\sqrt{3}}
 \end{aligned}$$

$$\begin{aligned}
 7. \quad & 2x^4 - 26x^2 + 72 = 0 \\
 & 2(x^4 - 13x^2 + 36) = 0 \\
 & 2(x^2 - 4)(x^2 - 9) = 0 \\
 & 2(x-2)(x+2)(x-3)(x+3) = 0 \\
 & x-2=0 \quad x+2=0 \quad x-3=0 \quad x+3=0 \\
 & \boxed{x=2 \quad x=-2 \quad x=3 \quad x=-3}
 \end{aligned}$$

$$\begin{aligned}
 8. \quad & 3x^7 = 243x^3 \\
 & 3x^7 - 243x^3 = 0 \\
 & 3x^3(x^4 - 81) = 0 \\
 & 3x^3(x^2 - 9)(x^2 + 9) = 0 \\
 & 3x^3(x-3)(x+3)(x^2+9) = 0 \\
 & 3x^3 = 0 \quad x-3 = 0 \quad x+3 = 0 \quad x^2+9 = 0 \\
 & \boxed{x = 0, \text{M.3} \quad x = 3 \quad x = -3 \quad x = \pm 3i}
 \end{aligned}$$

$$\begin{aligned}
 9. \quad & x^3 + 3x^2 - 2x - 6 = 0 \\
 & x^2(x+3) - 2(x+3) = 0 \\
 & (x^2 - 2)(x+3) = 0 \\
 & x^2 - 2 = 0 \quad x+3 = 0 \\
 & x^2 = 2 \quad \boxed{x = -3} \\
 & \boxed{x = \pm \sqrt{2}}
 \end{aligned}$$

$$\begin{aligned}
 10. \quad & 8x^3 + 9 = 10 \\
 & 8x^3 - 1 = 0 \\
 & (2x-1)(4x^2+2x+1) = 0 \\
 & 2x-1 = 0 \quad 4x^2+2x+1 = 0 \\
 & \boxed{x = \frac{1}{2}} \quad \frac{-2 \pm \sqrt{4 - 4(4)(1)}}{8} \\
 & \quad \quad \quad \frac{-2 \pm 2i\sqrt{3}}{8} \\
 & \quad \quad \quad \boxed{x = -\frac{1}{4} \pm \frac{i\sqrt{3}}{4}}
 \end{aligned}$$

$$\begin{aligned}
 11. \quad & x^3 = -8x^2 - 16x \\
 & x^3 + 8x^2 + 16x = 0 \\
 & x(x^2 + 8x + 16) = 0 \\
 & x(x+4)^2 = 0 \\
 & \boxed{x = 0} \quad x+4 = 0 \\
 & \quad \quad \quad \boxed{x = -4 \text{ M.2}}
 \end{aligned}$$

$$12. 4x^3 - 5x^2 - 25 = 3x^3 - 5x$$

$$x^3 - 5x^2 + 5x - 25 = 0$$

$$x^2(x-5) + 5(x-5) = 0$$

$$(x^2+5)(x-5) = 0$$

$$x^2+5=0 \quad x-5=0$$

$$x = \pm i\sqrt{5} \quad x = 5$$

$$13. 3x^4 + 3x^3 = 6x^2 + 6x$$

$$3x^4 + 3x^3 - 6x^2 - 6x = 0$$

$$3x(x^3 + x^2 - 2x - 2) = 0$$

$$3x(x^2(x+1) - 2(x+1)) = 0$$

$$3x(x^2-2)(x+1) = 0$$

$$3x=0 \quad x^2-2=0 \quad x+1=0$$

$$x=0 \quad x = \pm\sqrt{2} \quad x = -1$$

$$14. x^4 - x = 1 - x^3$$

$$x^4 + x^3 - x - 1 = 0$$

$$x^3(x+1) - 1(x+1) = 0$$

$$(x^3-1)(x+1) = 0$$

$$(x-1)(x^2+x+1)(x+1) = 0$$

$$x-1=0 \quad x^2+x+1=0 \quad x+1=0$$

$$x=1 \quad -1 \pm \frac{\sqrt{1-4(1)(1)}}{2} \quad x=-1$$

$$\frac{-1 \pm i\sqrt{3}}{2}$$

$$x = -\frac{1}{2} \pm \frac{i\sqrt{3}}{2}$$

$$15. 4x^4 + 20x^2 = -25$$

$$4x^4 + 20x^2 + 25 = 0$$

$$\left\{ \begin{array}{l} x^4 + 20x^2 + 100 \\ (x^2 + \frac{10}{4})(x^2 + \frac{10}{4}) \Rightarrow (x^2 + \frac{5}{2})(x^2 + \frac{5}{2}) \end{array} \right\}$$

$$(2x^2 + 5)(2x^2 + 5) = 0$$

$$2x^2 + 5 = 0$$

$$x^2 = -\frac{5}{2}$$

$$x = \pm \frac{i\sqrt{5}}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \boxed{\pm \frac{i\sqrt{10}}{2}}, \text{M.2}$$

$$16. -2x^6 = 16$$

$$0 = 2x^6 + 16$$

$$0 = 2(x^6 + 8)$$

$$0 = 2(x^2 + 2)(x^4 - 2x^2 + 4)$$

$$x^2 + 2 = 0$$

↑ can't

$$\boxed{x = \pm i\sqrt{2}}$$

solve from this form

$$17. 3x^7 = 81x^4$$

$$3x^7 - 81x^4 = 0$$

$$3x^4(x^3 - 27) = 0$$

$$3x^4(x-3)(x^2+3x+9) = 0$$

$$3x^4 = 0$$

$$x-3=0$$

$$x^2+3x+9=0$$

$$\boxed{x=0}$$

$$\boxed{x=3}$$

$$x = \frac{-3 \pm \sqrt{9-36}}{2}$$

M.4

$$\frac{-3 \pm 3i\sqrt{3}}{2}$$

$$\boxed{x = \frac{-3}{2} \pm \frac{3i\sqrt{3}}{2}}$$

$$18 \quad 2x^5 - 12x^3 = -16x$$

$$2x^5 - 12x^3 + 16x = 0$$

$$2x(x^4 - 6x^2 + 8) = 0$$

$$2x(x^2 - 4)(x^2 - 2) = 0$$

$$2x(x+2)(x-2)(x^2-2) = 0$$

$$2x=0 \quad x+2=0 \quad x-2=0 \quad x^2-2=0$$

$$x=0 \quad x=-2 \quad x=2 \quad x=\pm\sqrt{2}$$