

Engineering is a quantitative discipline that use the language of mathematics to make predictions.

الهندسة مهنة علمية (ارتياذ) ذات نهج كمي تستخدم لغة الرياضيات لتقدم توقعات.

Imagine the difficulty of designing a technology as complex as the space shuttle without using mathematics to quantify its mass, aerodynamics shape, and trajectory. Qualitative descriptions such as "it's heavy, pointy, and goes in a loop around the earth" are not very useful in the engineering world.

لنتخيل صعوبة تصميم منتج تقني معقد كمكوك الفضاء دون أن تُستخدم الرياضيات لتحديد: كتلته، شكله المناسب لتخفيف مقاومة الهواء، ومساره الدقيق حول الأرض. إن الاكتفاء بالحديث عنه بأوصاف كيفية (لاكمية) كالقول: "إنه ثقيل، مدبب ويدور حول الأرض" ليست مفيدا جدًا في عالم الهندسة". **فالهندسة مهنة أرقام وليس كلام.**

When engineers quantify relationships, they generally use algebra; thus, we begin our study of applied mathematics with a review of high school algebra.

يتبع المهندسون المنهج الكمي في تحديد العلاقات بين عناصر منتجاتهم وبينها وبين الاحتياجات التي تلبها. ويعد الجبر أبسط أدوات الرياضيات التطبيقية التي يحتاجونها. وهكذا، سنبدأ مدخلنا إلى الهندسة بمراجعة جبر المدرسة الثانوية.

Basic Number Operations: Operators and Antioperators

An operator is a mathematical rule that uniquely links numbers to other numbers.

The following example uses the addition operator to link any with a unique y :

$$y = 3 + x$$

x	\Rightarrow	y
1	\Rightarrow	4
2	\Rightarrow	5
3	\Rightarrow	6
4	\Rightarrow	7
etc.	\Rightarrow	Etc.

The antioperator is the inverse of the operator.

In this example, the antioperator would have to accomplish the following link:

$$y - 3 = x$$

x	\Leftarrow	y
1	\Leftarrow	4
2	\Leftarrow	5
3	\Leftarrow	6
4	\Leftarrow	7
etc.	\Leftarrow	Etc.

Thus, we see that subtraction is the antioperation of addition. (we also say that addition is the antioperation of subtraction). By a similar argument, we can conclude that division is the antioperation of multiplication.

Operator	(+) Addition	(\times) Multiplication
Antioperator	(-) Subtraction	(\div) Division

The multiplication operator is indicated four different ways; the following four equations are equivalent:

$$y = 2 \times x \quad y = 2 \cdot x \quad y = 2x \quad y = 2(x)$$

The division operator is indicated three different ways; the following three equations are equivalent:

$$y = 3 \div x \quad y = 3/x \quad y = \frac{3}{x}$$

$$a^1 \equiv a.$$

$$a^{n+1} = a^n \cdot a$$

$$a^n a^m = a^{n+m}$$

$$(a^n)^m = a^{nm} = (a^m)^n$$

$$(ab)^n = a^n b^n$$

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} = a^n b^{-n}, (b \neq 0)$$

$$\frac{a^n}{a^m} = a^n a^{-m} = a^{n-m}, (a \neq 0)$$

$$a^0 \equiv 1. (a \neq 0)$$

$$a^{-n} \equiv \frac{1}{a^n}, (a \neq 0)$$

$$a^{\frac{1}{n}} \equiv \sqrt[n]{a}, (a \geq 0, \text{ if } n \text{ is even})$$

$$a^{\frac{n}{m}} \equiv \sqrt[m]{a^n}, (a^n \geq 0, \text{ if } m \text{ is even})$$

$$|a| \equiv \begin{cases} a: & a \geq 0 \\ -a: & a < 0 \end{cases}$$

Problems

1. On Basic Number Operations

Calculate expressions in P.1.1 to P.1.7

1.1. $(-2)^{-3}$

1.2. $\left(\frac{1}{2}\right)^{-3}$

1.3. $\left(\frac{1}{2}\right)^{-2} + \left(\frac{1}{2}\right)^{-1}$

1.4. $\frac{(-2)^{-3} - (-3)^{-2}}{(-4)^{-1}} \left(\frac{2}{2}\right)^{-3}$

1.5. $((-2)^{-1} + (-3)^{-1}) \div ((-3)^{-1} - (-6)^{-1})$

1.6. $-4 \times 10^4 + 2.5 \times 10^5$

1.7. $0.5^{-1} + 0.25^{-2} + 0.125^{-3} + 0.0625^{-4}$



Problems

1. On Basic Number Operations

Calculate expressions in P.1.8 to P.1.15.

1.8. 2^0

1.9. $\left(\frac{1}{2}\right)^0$

1.10. $\left(-\frac{3}{8}\right)^0$

1.11. $(\sqrt{3} + \pi - 1)^0$

1.12. $(\cos x)^0$

1.13. $(e^{3x})^0$

1.14. $\left(\frac{3}{2} + \frac{\pi}{6}\right)^0 - \left(\frac{4}{27} - \frac{7\pi}{9}\right)^0$

1.15. $\left(\frac{3}{2} + \frac{\pi}{6}\right)^0 - \left(\frac{4}{27} - \frac{2^2}{3^3}\right)^0$

Calculate expressions in P.1.16 to P.1.18.

1.16. $2^{3000} \times 3^{2000}$

1.17. $3^{200} \times 4^{-300}$

1.18. $5^{-2000} \times 2^{3000}$

Problems

1. On Basic Number Operations

Calculate expressions in P.1.16 to P.1.18.

1.16. $2^{3000} \times 3^{2000}$

1.17. $3^{200} \times 4^{-300}$

1.18. $5^{-2000} \times 2^{3000}$

1.2 Fractional Powers and Radicals

Calculate expressions in P.1.19 to P.1.27.

1.19. $\left(\frac{16}{25}\right)^{\frac{1}{2}}$

1.20. $\left(\frac{1}{27}\right)^{-\frac{4}{3}}$

1.21. $\left(\frac{1}{2^{-6}}\right)^{\frac{3}{2}}$

1.22. $\left(\frac{1}{1024}\right)^{-\frac{2}{5}}$

1.23. $\left(\frac{1}{4}\right)^{-\frac{3}{2}} + \left(\frac{8}{27}\right)^{\frac{2}{3}}$

1.24. $\left(\frac{1}{256}\right)^{0.375}$

1.25. $0.25^{-0.5}$

1.26. $25^{-\frac{3}{2}}$

1.27. $0.001^{-\frac{1}{3}}$

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